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Income inequality and the stabilising role of the tax and transfer system in times of crisis

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Ecole des Hautes Etudes en Sciences Sociales (EHESS)



UMR Paris Jourdan Sciences Economiques (UMR 8545)

PhD Thesis

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Speciality Analysis and Policy in Economics

Vanda Almeida

Income inequality and the stabilising role of the tax and transfer system in times of crisis

Advisor: Romain Rancière

Defended at the Paris School of Economics on December 3rd 2019

Jury:

President:	Edouard Challe	Director of Research at the CNRS - CREST Professor of Economics at Ecole Polytechnique
Reviewers:	Hilary Hoynes	Professor of Public Economics at the University of California Berkeley Haas Distinguished Chair in Economic Disparities Co-Director of the Berkeley Opportunity Lab
	Fabrizio Perri	Monetary Advisor at the Research Department of the Federal Reserve Bank of Minneapolis
Examiners:	Axelle Ferriere	Assistant Professor of Economics at the Paris School of Economics Research Fellow at the CNRS
	Salvatore Morelli	Core Faculty and Senior Scholar at the Stone Center on Socio-Economic Inequality Director of the GC- Wealth Project Research Associate at the Center for Economics and Finance of the University of Naples, Federico II
Advisor	Romain Rancière	Professor of Economics at the University of Southern California, Dornsife

Ecole des Hautes Etudes en Sciences Sociales (EHESS)



UMR Paris Jourdan Sciences Economiques (UMR 8545)

Thèse de Doctorat

Pour l'obtention du grade de docteur en Sciences Economiques à la EHESS
dans la spécialité Analyse et Politique Economiques

Vanda Almeida

Inégalités de revenu et le role stabilisateur du système d'impôts et prestations sociales en temps de crise

Directeur de thèse: Romain Rancière

Soutenue à la Paris School of Economics le 3 décembre 2019

Jury:

Président:	Edouard Challe	Directeur de Recherche au CNRS - CREST Professeur d'Economie à l'Ecole Polytechnique
Rapporteurs:	Hilary Hoynes	Professeur d'Economie Publique à la University of California Berkeley Haas Distinguished Chair in Economic Disparities Co-Directrice du the Berkeley Opportunity Lab
	Fabrizio Perri	Conseiller de politique monétaire au Département de Recherche de la Federal Reserve Bank of Minneapolis
Examineurs:	Axelle Ferriere	Professeur Assistante d'Economie à la Paris School of Economics Research Fellow au CNRS
	Salvatore Morelli	Professeur au Stone Center on Socio-Economic Inequality Directeur du GC- Wealth Project Chercheur associé au Center for Economics and Finance of the University of Naples, Federico II
Directeur:	Romain Rancière	Professeur d'Economie à la University of Southern California, Dornsife

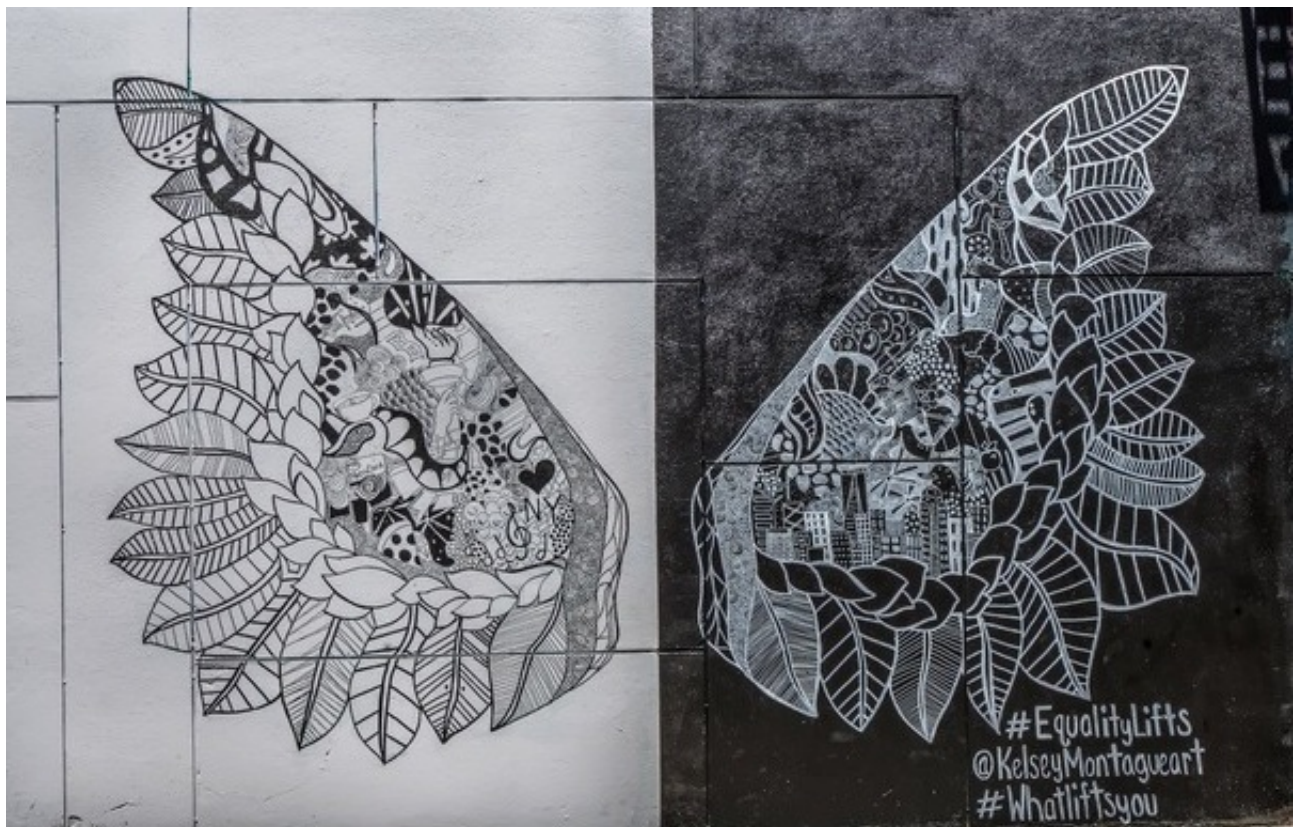
“Is this improvement in the circumstances of the lower ranks of the people to be regarded as an advantage or as an inconveniency to the society? The answer seems at first sight abundantly plain.

Servants, labourers, and workmen of different kinds, make up the far greater part of every great political society. But what improves the circumstances of the greater part can never be regarded as an inconveniency to the whole. No society can surely be flourishing and happy, of which the far greater part of the members are poor and miserable. It is but equity, besides, that they who feed, clothe, and lodge the whole body of the people, should have such a share of the produce of their own labour as to be themselves tolerably well fed, clothed, and lodged.”

Adam Smith

An inquiry into the nature and causes of the wealth of nations (1776)

Book I Chapter 8



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Abstract

Aggregate crises often bring tremendous economic disruptions, which may persist for many years. Understanding their consequences and how to effectively design crisis-coping policies is therefore of capital importance. The *aggregate* consequences of crises and the role of macroeconomic policies in stabilising aggregate outcomes in a crisis aftermath have been significantly studied in the literature. Much less attention, however, has been given to the *distributional* consequences of crises and even less to the possible *interactions* between a crisis-led increase in inequality and the post-crisis evolution of aggregate outcomes. If a rise in distributional imbalances following a crisis can feedback into an anemic recovery of economic activity, then the tax and transfer system may have a role in stabilising not only the income distribution but also the aggregate economy. Understanding how the system may affect both distributional and aggregate developments in a crisis aftermath is therefore also key.

This thesis aims at shedding new light on these issues, using multiple methodologies and datasets both at the micro and macro level, applying both an empirical and theoretical approach. It includes two empirical papers, focusing on the case studies of the 2007-2008 crisis in the United States (US) and in Portugal, and one theoretical paper, exploring several hypothetical crisis scenarios. Together, these papers constitute an attempt at contributing to the recent but flourishing literature on the relevance of considering distributional aspects and redistributive policies when targeting macroeconomic objectives.

The first paper provides a detailed empirical assessment of the evolution of income inequality and the redistributive effects of the tax and transfer system following the 2007-2008 crisis. It focuses on the US case, drawing on data from the Current Population Survey for the period 2007-2012. Contrary to most existing studies, it uses a wide range of inequality indicators and looks in detail at several sections of the income distribution, allowing for a clearer picture of the heterogeneous consequences of the crisis. Furthermore, it analyses the contribution of different components of the tax and transfer system, beyond its overall cushioning effect, which allows for a more refined assessment of

its effectiveness. Results show that although the crisis implied income losses across the whole income distribution, the burden was disproportionately born by low to middle income groups. Income losses experienced by richer households were relatively modest and transitory, while those experienced by poorer households were not only strong but also highly persistent. The tax and transfer system had a crucial role in taming the increase in income inequality in the immediate aftermath of the crisis, and during the Great Recession years, particularly cash transfers. After 2010, however, its effect became weaker and income inequality experienced a new surge.

The second paper (joint with Denisa M. Sologon and Philippe Van Kerm) develops a new method to model the household disposable income distribution and decompose changes in this distribution (or functionals such as inequality measures) over time. It integrates both a micro-econometric and microsimulation approach, combining a flexible parametric modelling of the distribution of market income with the EUROMOD microsimulation model to simulate the value of taxes and benefits. The method allows for the quantification of the contributions of four main factors to changes in the disposable income distribution between any two years: (i) labour market structure; (ii) returns; (iii) demographic composition; and (iv) tax-benefit system. We apply this new framework to the study of changes in the income distribution in Portugal between 2007 and 2013, accounting for the distributional effects of the 2007-2008 crisis and aftermath policies, in particular the Economic Adjustment Program (EAP). Results show that these effects were substantial and reflected markedly different developments over two periods: 2007-2009, when stimulus packages determined important income gains for the bottom of the distribution and a decrease in income inequality; 2010-2013, when the crisis and austerity measures took a toll on the incomes of Portuguese households, particularly those at the bottom and top of the distribution, leading to an increase in income inequality.

The third paper presents the ideas, preliminary results and future steps of a long term project aimed at investigating the distributional consequences of aggregate crises and the role of inequality and social insurance in shaping aggregate activity in times of crisis. For that, I develop a theoretical heterogeneous agents incomplete markets Dynamic Stochastic General Equilibrium (DSGE) model, with both ex-ante and ex-post household heterogeneity, and one important source of social insurance, unemployment insurance. A first quantitative experiment, aimed at exploring the model's main properties and mechanisms, produces several preliminary results. First, ex-ante heterogeneity matters. Results for economies where there is only ex-post heterogeneity are significantly different from results

for economies where there are both types of heterogeneity. Second, the model generates a substantial rise in inequality following a crisis, as a result of an increase in the probabilities of becoming or remaining unemployed. Third, social insurance helps to mitigate the impact of a crisis on aggregate consumption and this effect is stronger for a higher degree of heterogeneity. Finally, a progressive insurance scheme produces a higher mitigation effect than a flat one.

JEL codes: D31, E12, E32, E62, H23, H24, H53, I38, J21, J31, J38, J65

Keywords: Austerity measures; Crisis; EUROMOD; Heterogeneous agents DSGE models; Income and wealth distributions; Inequality; Inequality decomposition; Macroeconomic stabilisation; Microsimulation; Redistribution; Social insurance; Tax and transfer system; Unemployment insurance

Résumé

Les crises globales entraînent souvent d'énormes perturbations économiques, qui peuvent durer de nombreuses années. Il est donc d'une importance capitale de comprendre leurs conséquences et comment élaborer des politiques qui permettent de réduire efficacement leurs impacts. Les effets d'une crise au niveau agrégé et le rôle des politiques macroéconomiques dans la stabilisation des principaux agrégats économiques au lendemain d'une crise ont fait l'objet d'une littérature dense et abondante. Toutefois, on a accordé beaucoup moins d'attention aux conséquences distributives des crises et encore moins aux interactions possibles entre une augmentation des inégalités due à la crise et l'évolution de l'activité macroéconomique après la crise. Si une augmentation des déséquilibres distributifs à la suite d'une crise peut se traduire par une reprise anémique de l'activité économique, alors le système des impôts et prestations sociales peut jouer un rôle dans la stabilisation macroéconomique au-delà de son effet redistributif. Il est donc également essentiel de comprendre comment le système influence tant sur les effets agrégés, qu'au regard des inégalités au lendemain d'une crise.

Cette thèse vise à apporter un éclairage nouveau sur ces questions, en utilisant de multiples méthodologies et ensembles de données, à la fois au niveau micro et macro, avec une approche à la fois empirique et théorique. Elle comprend deux articles empiriques, axés sur les études de cas de la crise de 2007-2008 aux États-Unis et au Portugal, et un article théorique, explorant plusieurs scénarios hypothétiques de crise. Ensemble, ces documents constituent une tentative de contribution à la littérature récente et florissante s'étant penchée sur la question de la pertinence de la prise en compte des aspects distributives d'une part et des politiques de redistribution, d'autre part, dans la détermination d'objectifs macroéconomiques.

Le premier article fournit une évaluation empirique détaillée de l'évolution des inégalités de revenus et des effets redistributifs du système d'impôts et prestations sociales après la crise de 2007-2008. Il se concentre sur le cas des États-Unis, en s'appuyant sur les données de la Current Population Survey

pour la période 2007-2012. Contrairement à la plupart des études existantes, il utilise un large éventail d'indicateurs d'inégalités et examine en détail plusieurs sections de la distribution des revenus, ce qui permet d'avoir une image plus claire des conséquences hétérogènes de la crise. En outre, il analyse la contribution des différentes composantes du système d'impôts et prestations sociales, au-delà de son effet redistributif global, ce qui permet une évaluation plus fine de son efficacité. Les résultats montrent que, bien que la crise ait entraîné des pertes de revenus dans l'ensemble du spectre de la distribution des revenus, le fardeau a été supporté de manière disproportionnée par les groupes à revenus faibles ou moyens. Les pertes de revenu subies par les ménages plus riches ont été relativement modestes et transitoires, tandis que celles subies par les ménages plus pauvres ont été non seulement fortes mais aussi très persistantes. Le système d'impôts et prestations sociales a joué un rôle crucial dans l'atténuation de l'accroissement des inégalités de revenus au lendemain de la crise et pendant les années de la Grande Récession, en particulier les transferts monétaires. Après 2010, cependant, son effet s'est affaibli et l'inégalité des revenus a connu une nouvelle poussée.

Le deuxième article (écrit conjointement avec Denisa M. Sologon et Philippe Van Kerm) développe une nouvelle méthode pour modéliser la distribution des revenus disponibles des ménages et décomposer les changements de cette distribution (ou des fonctions de cette distribution telles que les mesures d'inégalité) dans le temps. Il intègre à la fois une approche micro-économétrique et une approche en microsimulation, combinant une modélisation paramétrique flexible de la distribution des revenus du marché avec le modèle de microsimulation EUROMOD pour simuler la valeur des impôts et des prestations sociales. La méthode permet de quantifier la contribution de quatre facteurs principaux à l'évolution de la répartition des revenus disponibles entre deux années quelconques : (i) structure du marché du travail ; (ii) rendements ; (iii) composition démographique ; et (iv) système d'impôts et prestations sociales. Nous appliquons ce nouveau dispositif à l'étude de l'évolution de la répartition des revenus au Portugal entre 2007 et 2013, en tenant compte des effets redistributifs de la crise de 2007-2008 et des politiques postérieures, en particulier le Programme d'Ajustement Économique (PAE). Les résultats montrent que ces effets ont été substantiels et ont eu des évolutions très différentes au cours de deux périodes : 2007-2009, lorsque les plans de relance ont induit une augmentation des revenus importante pour le bas de la distribution, et une diminution des inégalités de revenus ; 2010-2013, lorsque la crise et les mesures d'austérité ont grevé les revenus des ménages portugais, particulièrement ceux du bas et du haut de la distribution, entraînant une augmentation des inégalités de revenus.

Le troisième article présente les idées, les résultats préliminaires et les étapes futures d'un projet à long terme visant à étudier les conséquences distributives des crises globales et le rôle des inégalités et de l'assurance sociale dans la détermination de l'activité globale en temps de crise. Pour cela, je développe un modèle théorique DSGE d'agents hétérogènes à marchés incomplets, avec une hétérogénéité à la fois ex-ante et ex-post des ménages, et une source fondamentale d'assurance sociale : l'assurance chômage. Une première expérience quantitative, visant à explorer les principales propriétés et mécanismes du modèle, produit plusieurs résultats préliminaires. Premièrement, l'hétérogénéité ex ante est importante. Les résultats pour les économies où il n'y a qu'une hétérogénéité ex post sont significativement différents des résultats pour les économies où il y a les deux types d'hétérogénéité. Deuxièmement, le modèle génère une augmentation substantielle des inégalités à la suite d'une crise, conséquence d'une augmentation des probabilités de devenir ou de rester chômeur. Troisièmement, l'assurance sociale contribue à atténuer l'impact d'une crise sur la consommation agrégée et cet effet est d'autant plus fort que le degré d'hétérogénéité est élevé. Enfin, un régime d'assurance sociale progressive produit un effet d'atténuation plus élevé qu'un régime uniforme.

Codes JEL: D31, E12, E32, E62, H23, H24, H53, I38, J21, J31, J38, J65

Mots-clé: Mesures d'austerité; Crise; EUROMOD; Modèles DSGE à agents hétérogènes; Distributions des revenus et de la richesse; Inégalités; Décomposition des inégalités; Stabilisation macroéconomique; Microsimulation; Redistribution; Assurance sociale; Système des impôts et des prestations sociales; Assurance chômage

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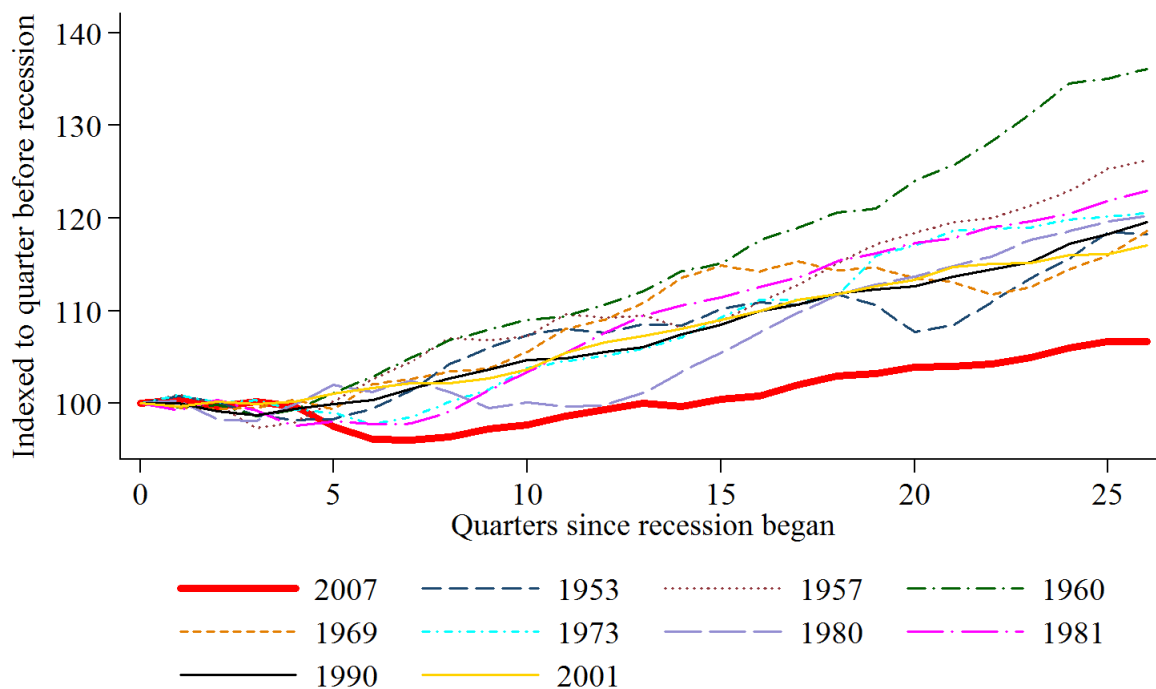
Chapter 1

General introduction

1.1 Motivation and main goals

The ideas and questions that motivated this thesis go back a long way. Early 2013, five years after the onset of the 2007-2008 crisis, I started to think about a possible connection between three main aspects that characterised the post-crisis years. First, the recovery from the 2007-2008 crisis was particularly dismal relative to previous recessions. This fact is illustrated in Figure 1.1, which shows that real GDP in the US grew at a considerably slower pace in the years after the Great Recession (GR) than following any other post WW2 recession.

Figure 1.1 – US real GDP growth following post WW2 recessions



Source: houseofdebt.org, based on NIPA data, May 2014.

Second, there was evidence that the recovery from the crisis was not only dismal but also largely unequal, with households at the bottom of the income distribution doing particularly bad. As discussed in Perri & Steinberg (2012), *"In 2010, the bottom 20 percent of the U.S. earnings distribution was doing much worse, relative to the median, than in the entire postwar period. This is because their earnings (...) fell by about 30 percent relative to the median over the course of the recession."* Saez (2013) also warned about the unevenness of the gains in the crisis recovery as illustrated in Figure 1.2, which shows that between 2009 and 2012 the incomes of households in the top 1% of the income

distribution grew by 31.4%, while those of the bottom 99% grew by only 0.4%.

Figure 1.2 – US real income growth by groups in post 1993 recessions and expansions

	Average Income Real Growth	Top 1% Incomes Real Growth	Bottom 99% Incomes Real Growth	Fraction of total growth (or loss) captured by top 1%
	(1)	(2)	(3)	(4)
Full period 1993-2012	17.9%	86.1%	6.6%	68%
Clinton Expansion 1993-2000	31.5%	98.7%	20.3%	45%
2001 Recession 2000-2002	-11.7%	-30.8%	-6.5%	57%
Bush Expansion 2002-2007	16.1%	61.8%	6.8%	65%
Great Recession 2007- 2009	-17.4%	-36.3%	-11.6%	49%
Recovery 2009-2012	6.0%	31.4%	0.4%	95%

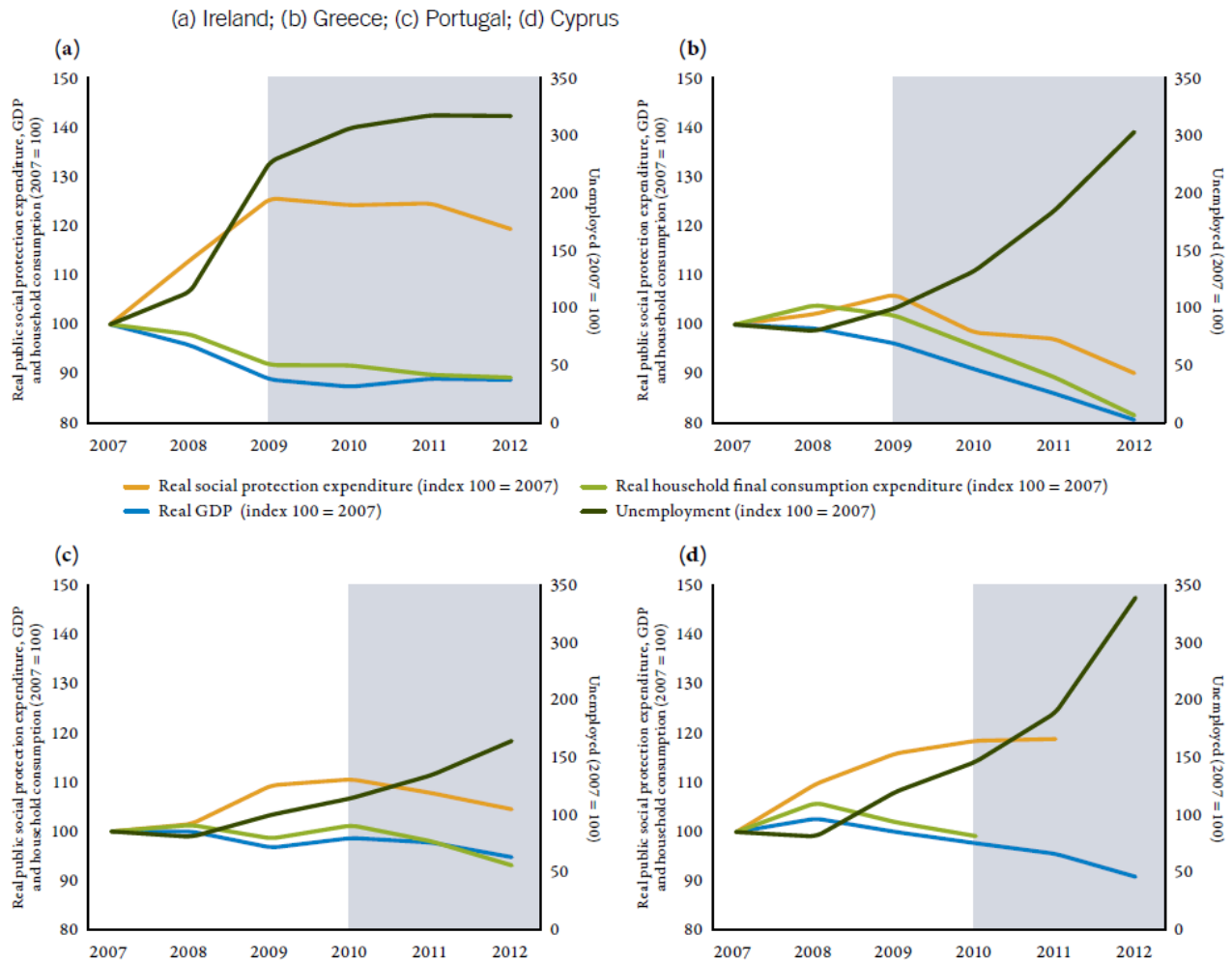
Source: Saez, E. (2013), "Striking it richer: the evolution of top incomes in the United States".

Third, these aggregate and distributional post-crisis developments occurred in a context of sizeable changes in the tax and transfer system in many countries. In Europe, following an initial fiscal stimulus in 2008 and 2009, several countries incurred in fiscal consolidation measures between 2010 and 2015, which significantly weakened the redistributive strength of the tax and transfer system. Figure 1.3 illustrates the decrease in social protection expenditures that occurred in the four European Union (EU) countries that were subject to an economic adjustment program following the 2007-2008 crisis, in a time when unemployment was rising and aggregate demand was falling.

Considering these three facts about the 2007-2008 crisis aftermath, I started wondering whether there could be a plausible, unexplored, link between them and I felt urged to study the distributional consequences of aggregate crises and the possible stabilising role of the tax and transfer system. In particular, I wanted to explore the following research questions: (i) What happens to the income distribution in times of crisis? Can an aggregate crisis have heterogeneous effects across the income distribution? If so, which households are likely to suffer the most?; (ii) Can the tax and transfer system play an important role in stabilising the income distribution in a crisis aftermath? If so, which

elements of the system are likely to be the most effective?; (iii) Can a crisis-led increase in income inequality feedback into aggregate activity, affecting the recovery from the crisis?¹; (iv) If this is the case, then can the tax and transfer system play a role in stabilising not only the income distribution but also aggregate outcomes, following a crisis?

Figure 1.3 – Social protection expenditure in EU countries under economic adjustment programmes



Source: ILO, "World Social Protection Report 2014/15", 2014.

When looking for existing literature, I confirmed my suspicion that there was still a gap to be filled. Although there was already a respectful number of studies exploring one or more of the questions that I was asking, there was still a lot of work to be done answer². At the same time, I was lucky to

¹The complementary question of whether an increase in income inequality can lead to a crisis, although not covered in this thesis, is certainly also an extremely relevant and interesting subject. For studies on this issue see e.g. Van Treeck & Sturn (2012), Atkinson & Morelli (2015) and Kumhof et al. (2015).

²In each of the three research papers that constitute the core of this thesis, I provide a comprehensive literature

come across an article by Joseph Stiglitz in the New York Times, Stiglitz (2013), which comforted me in my suspicion that the questions that I was asking myself were worth exploring.

This thesis brings together my first attempts at tackling this long-term research agenda. It aims at bringing useful information to other fellow researchers and policy-makers on some of the issues that I discussed above, using multiple methodologies and datasets both at the micro and macro level, applying both an empirical and theoretical approach. More generally, it hopes to contribute to the silent revolution that has been occurring in the macroeconomics discipline over the last thirty years, which has brought a profound shift from the previous belief that aggregate phenomena could be analysed independently from any distributional considerations. As discussed in Lucas (2003) and Heathcote, Storesletten & Violante (2009), developments like these are key for the macroeconomics discipline as they set the stage for the study, in a unified way, of the distributional impacts of aggregate policies and the aggregate implications of redistributive policies. Only this way can the possible trade-offs and complementarities between these two types of policies be assessed, such that true welfare-improving policies can be designed and implemented.

1.2 Three research papers

The core of this thesis is composed by three research papers, which correspond to Chapters 2, 3 and 4 of this manuscript. These papers are independent, but have in common the focus on one or more of the research questions discussed above. The first two papers are empirical, investigating two important case studies of crisis episodes, the 2007-2008 crisis in the US and in Portugal. The third paper is theoretical, exploring several hypothetical crisis scenarios. I briefly introduce each of these papers below, highlighting their objectives, methodology and key results.

1.2.1 First paper: a descriptive empirical analysis

The first paper, *"Income inequality and redistribution in the aftermath of the 2007-2008 crisis: the US case"*, uses a descriptive type of analysis to document in a new and detailed way some key facts about the distributional effects of the 2007-2008 crisis and the cushioning role of the tax and transfer system, in the US.

review, mentioning explicitly what had already been done and what my contribution is. Therefore, I abstract from repeating it in this general introduction but I refer the interested reader to the literature sections in Chapter 2, 3 and 4.

It draws on data from the March supplement of the Current Population Survey (CPS), for the period between 2007 and 2012. Contrary to most existing studies, it makes use of a wide range of inequality indicators and looks in detail at several sections of the income distribution, allowing for a clearer picture of the heterogeneous consequences of the crisis. Furthermore, it analyses the contribution of different components of the tax and transfer system, together with a decomposition into its main drivers, giving a more refined assessment of its effectiveness. In addition, it provides more up to date estimates, which proves to be crucial in obtaining a complete vision of the evolution of inequality and redistribution following the crisis. The evolution of income inequality is assessed through the use of multiple indicators namely: summary measures given by the Gini coefficient and percentiles ratios; comparison of changes in income for different percentiles; comparison of changes in average income and income shares for different income groups. Redistribution measures are obtained through a comparison of all these indicators applied to income measures with and without several types of taxes and transfers, and through a Gini-based inequality decomposition. The drivers of redistribution are estimated based on a decomposition into a progressivity, size and re-ranking effects.

Several interesting findings come out of the analysis. First, the crisis had dramatic distributional consequences, determining a significant increase in market income inequality. Although there were income losses across the whole income distribution, the burden was disproportionately born by low to middle income groups. Income losses experienced by richer households were relatively modest and transitory, while those experienced by poorer households were not only strong but also highly persistent. Second, the tax and transfer system had a crucial role in cushioning the negative distributional impacts of the crisis, with disposable income inequality increasing by much less than market income inequality. Several instruments played an important role, but cash transfers had the highest equalising effect. Third, despite their significant effect, redistributive mechanisms were not enough to fully prevent a widening of the income distribution. Five years after the start of the crisis, income inequality was higher even after taking into account the effect of taxes and transfers. The redistributive effect of the system was marked by two different phases: the years 2008 and 2009, when it was strong enough to prevent a widening of the disposable income distribution; the years between 2010 and 2012, when it was not, with disposable income inequality registering a positive growth, higher than the one of market income inequality. Although a strict causal analysis cannot be drawn in the context of this paper, these developments did coincide with two distinct phases in the setting of tax and transfer

policies: the first two post-crisis years, where these policies were significantly reinforced; the period from then onwards, where they were gradually phased out.

1.2.2 Second paper: a microeconomic-microsimulation empirical analysis

The second paper, "*Accounting for the distributional effects of the 2007-2008 crisis and the Economic Adjustment Program in Portugal*", (joint with Denisa M. Sologon and Philippe Van Kerm) uses a microeconomic-microsimulation approach to study the distributional impacts of the 2007-2008 crisis and subsequent policies on the Portuguese disposable income distribution and decompose these impacts into the contributions of four key factors.

The paper develops a new method to model the household disposable income distribution and decompose changes in this distribution (or functionals such as inequality measures) over time, which tackles the limitations of previous methods. It builds on the approach developed in Sologon, Van Kerm, Li & O'Donoghue (2018), adapting it to study changes in income distributions over time for one single country instead of differences in income distributions across countries in one given moment. The method combines a flexible micro-economic parametric modelling of the distribution of market income with the EUROMOD microsimulation model to simulate the value of taxes and benefits. It involves generating a multitude of counterfactual income distributions, obtained by "swapping" the characteristics of the country in two different moments in time along four main dimensions: (i) labour market structure; (ii) returns; (iii) demographic composition; and (iv) tax-benefit system. The comparison of these counterfactual distributions then allows to quantify the contribution of each dimension to the changes in the income distribution (and functionals) observed between any two moments in time. The model is constructed based on the European Union Statistics on Income and Living Conditions (EU-SILC) survey, which is available in a harmonised form for all European Union (EU) countries. The fact that the model relies on EU-SILC data and uses the pan-European EUROMOD microsimulation tool is a particularly useful feature, as it gives the model the potential to be easily adapted to examine changes in income distributions over time in any EU country.

This new framework is applied to the study of changes in the income distribution in Portugal between 2007 and 2013. This was a particularly intense period for the Portuguese economy, comprising: (i) the "direct" impacts of the 2007-2008 crisis; (ii) the effects of a fiscal stimulus package adopted in 2008 and 2009; and (iii) the effects of fiscal consolidation measures taken from 2010 onwards,

particularly in the context of the Economic Adjustment Program (EAP). The richness and complexity of the post 2007-2008 crisis Portuguese experience make it a particularly suitable and fruitful choice for an application of the framework, which produces new evidence on the distributional effects of stimulus and austerity measures in times of crisis. Results show that the distributional effects of the post 2007-2008 crisis in Portugal were substantial, and reflected markedly different developments over two periods: 2007-2009, when stimulus packages determined important income gains for the bottom of the distribution and a decrease in income inequality; 2010-2013, when the crisis and austerity measures took a toll on the incomes of Portuguese households, particularly those at the bottom and top of the distribution, leading to an increase in income inequality.

1.2.3 Third paper: a DSGE theoretical analysis

The third paper, "*Crisis, inequality and social insurance*", uses a theoretical DSGE approach to study the distributional and aggregate effects of a crisis and the role of unemployment insurance in shaping these effects, under several hypothetical crisis scenarios.

The paper develops a theoretical heterogeneous agents incomplete markets DSGE model, with both ex-ante and ex-post household heterogeneity, and one important source of social insurance, unemployment insurance. *Ex ante* heterogeneity arises due to three distinguishing features: (i) differences in labour efficiency, which reflect differences in skills; (ii) differences in the subjective time discount factor, which generates different degrees of "patience" in households' consumption decisions; (iii) differences in access to credit markets, which translates into different borrowing limits. *Ex post* heterogeneity arises due to one source of idiosyncratic risk faced by households in each period, corresponding to changes in their employment status between employed and unemployed, in the tradition of the so-called Aiyagari-Bewley-Huggett-Imrohoroglu models. There is one representative firm, which produces a single final good using capital and labour inputs. There is no aggregate uncertainty, but two deterministic aggregate states, a boom and a crisis, with a crisis being modelled as a drop in Total Factor Productivity (TFP) together with an increase in the probabilities of becoming or remaining unemployed. Finally, there is a government who provides unemployment benefits to the unemployed, financing them through a tax on the labour income of the employed.

A first quantitative experiment, aimed at exploring the model's main properties and mechanisms, is presented, together with some preliminary results. In this theoretical quantitative exercise, five

alternative scenario economies are considered, which differ along two main dimensions: the existence of household ex-ante heterogeneity and the degree of social insurance provided by the government. Among the several results, four are particularly noteworthy. First, ex-ante heterogeneity matters. Results for economies where there is only ex-post heterogeneity are significantly different from results for economies where there are both types of heterogeneity. Second, the model generates a substantial rise in inequality following a crisis, as a result of an increase in the probabilities of becoming or remaining unemployed. Third, social insurance helps to mitigate the impact of a crisis on aggregate consumption and this effect is stronger for a higher degree of heterogeneity. Finally, a progressive insurance scheme produces a higher mitigation effect than a flat one.

Chapter 2

Income inequality and redistribution in the aftermath of the 2007-2008 crisis: the US case

Abstract

This paper provides a detailed empirical assessment of the evolution of income inequality and the redistributive effects of the tax and transfer system following the 2007-2008 crisis. It focuses on the US case, drawing on data from the Current Population Survey for the period 2007-2012. Contrary to most existing studies, it uses a wide range of inequality indicators and looks in detail at several sections of the income distribution, allowing for a clearer picture of the heterogeneous consequences of the crisis. Furthermore, it analyses the contribution of different components of the tax and transfer system, beyond its overall cushioning effect, which allows for a more refined assessment of its effectiveness. Results show that although the crisis implied income losses across the whole income distribution, the burden was disproportionately born by low to middle income groups. Income losses experienced by richer households were relatively modest and transitory, while those experienced by poorer households were not only strong but also highly persistent. The tax and transfer system had a crucial role in taming the increase in income inequality in the immediate aftermath of the crisis, and during the Great Recession (GR) years, particularly cash transfers. After 2010, however, its effect became weaker and income inequality experienced a new surge. The findings of this paper contribute to a better understanding of the distributional consequences of aggregate crises and the role of tax and transfer policies in stabilising the income distribution in a crisis aftermath.

JEL codes: D31, E32, H23, H24, I38

Keywords: Crisis; Personal income distribution; Inequality; Redistribution; Safety net; Public transfers; Income tax; Inequality decomposition; Gini

2.1 Introduction

Macroeconomic shocks such as the 2007–2008 financial and economic crisis can have far-reaching effects on the distribution of resources both at the individual and at the household levels (Krueger, Perri, Pistaferri & Violante 2010, Heathcote, Perri & Violante 2010*a*, Heathcote, Perri & Violante 2010*b*). The possibility that these distributional effects may in turn have non-negligible implications for the aggregate economy, and therefore affect its recovery from the crisis, has recently gained widespread attention, from both the academic and policy-oriented communities (Stiglitz 2013, Cynamon & Fazzari 2016, Krueger, Mitman & Perri 2016*a*, Challe & Ragot 2016, Ahn, Kaplan, Moll, Winberry & Wolf 2017, Challe, Matheron, Ragot & Rubio-Ramirez 2017, Auclert & Rognlie 2018). If a crisis-led surge in distributional imbalances can feedback into an anemic aggregate economic activity, then a thorough assessment of the dynamics of the income distribution following a crisis can be crucial for an effective design of crisis-coping macroeconomic policies. Furthermore, if distributional developments may affect aggregate outcomes following a crisis, then redistributive policies, typically aimed at promoting a stabilisation of the income distribution, may also have an important macro-stabilisation role. In this case, a thorough assessment of the cushioning role of redistributive policies following a crisis may also be crucial for the design of well-informed and effective crisis-coping policies.

This paper provides new and detailed insights into the distributional effects of aggregate crises and the cushioning role of the tax and transfer system, focusing on one important case study: the 2007-2008 crisis in the US. It draws on data from the March supplement of the Current Population Survey (CPS), for the period between 2007 and 2012. Contrary to most existing studies, it makes use of a wide range of inequality indicators and looks in detail at several sections of the income distribution, allowing for a clearer picture of the heterogeneous consequences of the crisis. Furthermore, it analyses the contribution of different components of the tax and transfer system, together with a decomposition into its main drivers, giving a more refined assessment of its effectiveness. In addition, it provides more up to date estimates, which proves to be crucial in obtaining a complete vision of the evolution of inequality and redistribution following the crisis. The evolution of income inequality is assessed through the use of multiple indicators namely: summary measures given by the Gini coefficient and percentiles ratios; comparison of changes in income for different percentiles; comparison of changes in average income and income shares for different income groups. Redistribution measures are obtained

through a comparison of all these indicators applied to income measures with and without several types of taxes and transfers, and through a Gini-based inequality decomposition. The drivers of redistribution are estimated based on a decomposition into a progressivity, size and re-ranking effects.

Several interesting findings come out of the analysis. First, the crisis had dramatic distributional consequences, determining a significant increase in market income inequality. Although there were income losses across the whole income distribution, the burden was disproportionately born by low to middle income groups. Income losses experienced by richer households were relatively modest and transitory, while those experienced by poorer households were not only strong but also highly persistent. Second, the tax and transfer system had a crucial role in cushioning the negative distributional impacts of the crisis, with disposable income inequality increasing by much less than market income inequality. Several instruments played an important role, but cash transfers had the highest equalising effect. Third, despite their significant effect, redistributive mechanisms were not enough to fully prevent a widening of the income distribution. Five years after the start of the crisis, income inequality was higher even after taking into account the effect of taxes and transfers. The redistributive effect of the system was marked by two different phases: the years 2008 and 2009, when it was strong enough to prevent a widening of the disposable income distribution; the years between 2010 and 2012, when it was not, with disposable income inequality registering a positive growth, higher than the one of market income inequality. Although a strict causal analysis cannot be drawn in the context of this paper, these developments did coincide with two distinct phases in the setting of tax and transfer policies: the first two post-crisis years, where these policies were significantly reinforced; the period from then onwards, where they were gradually phased out.

The findings of this paper contribute to a better understanding of the distributional consequences of aggregate crises and the cushioning effects of the tax and transfer system. They set the stage for the study of how a crisis-led increase in inequality may influence the stabilisation of the aggregate economy, and whether redistributive policies may play an important role in shaping this relationship. This way, they contribute to the ongoing discussion on the importance of considering distributional aspects when targeting macroeconomic objectives. As discussed in Lucas (2003) and Heathcote et al. (2009), developments like these are key for the macroeconomics discipline as they set the road for the study, in a unified way, of the distributional impacts of aggregate stabilisation policies and the aggregate implications of redistributive policies.

The remainder of the paper is organised as follows: section 4.2 reviews related literature and presents the main contributions of the paper; section 2.3 describes important changes that occurred in the American tax and transfer system following the crisis; section 2.4 introduces the data and methods used; section 4.4 presents the results; section 5.1 concludes and discusses some implications.

2.2 Related literature and main contributions

Most studies focusing on the evolution of inequality in times of crisis find that crises are typically periods marked by sharp increases in earnings inequality. As discussed in Krueger et al. (2010), "one of the strongest evidence of the connection between inequality and the macroeconomy appears during recessions, when the overall macroeconomic activity slows down and, at the same time, inequality in many variables changes". In all the nine countries considered in this study, a common pattern that emerges is that "during bad times earnings inequality at the bottom of the distribution increases sharply", which is largely attributed to the rise in unemployment that pushes a larger number of individuals to the bottom of the earnings distribution. Focusing on the US, Heathcote et al. (2010a) and Heathcote et al. (2010b) also present evidence that recessions are times when earnings inequality widens sharply, with the bottom percentiles of the earnings distribution suffering the largest and more persistent losses. Bitler & Hoynes (2015) look at the effects of cycles at different points of the income-to-poverty ratio distribution and find that lower levels of this distribution are more affected by recessions than higher ones¹.

The extent to which an increase in earnings inequality following a crisis translates into a rise in disposable income inequality seems to considerably depend on country specific government policies. However, a general pattern emerges that, as put in Krueger et al. (2010), "in all countries and in all recessions, inequality in disposable income during the recession rises less than inequality in earnings", pointing to an important mitigating effect of the tax and transfer system. For the US, Heathcote et al. (2010b) find that "public transfers play a very important role in compressing inequality at the bottom of the income distribution" and "serve as a powerful stabilizing antidote to countercyclical surges in pre-government income inequality". Taxes are also found to have a significant role. Focusing on the case of the 2007-2008 crisis and subsequent recession and recovery periods, the evidence is somewhat mixed. In particular, there seems to be a disparity in results depending on the data,

¹The income-to-poverty ratio is defined as the ratio between individual income and the national poverty threshold.

income definitions and inequality measures used as well as on the time frame considered. Two broad phases can be identified: a first one, the so-called "recession years" (2008-2009); and a second one, the so-called "recovery years" (from 2010 onwards).

Concerning the first phase, studies using survey data and inequality measures such as the Gini coefficient or the 90/10 percentile ratio, typically find a significant increase in market income inequality (Perri & Steinberg (2012), OECD (2013), Meyer & Sullivan (2013), Thompson & Smeeding (2013), Hellebrandt (2014)). Considering data on 17 OECD countries, OECD (2013) reports that the Gini of market income increased by more between 2007 and 2010 than in the previous 12 years. In several studies, the bottom of the earnings distribution is pointed out as having been hit particularly hard (Meyer & Sullivan (2013), Perri & Steinberg (2012)). Perri & Steinberg (2012) find that "In terms of earnings, the bottom 20% of the US population has never done so poorly, relative to the median, during the whole postwar period.". Studies using administrative tax data and top income shares as inequality measures give a less clear picture, with results depending on whether capital gains are included or not. Considering the top 10% income share, Piketty & Saez (2013) and Saez (2013) find a decrease in market income inequality between 2007 and 2009 when capital gains are included but an increase when they are excluded. The effect of tax and transfer policies during this period is also not clear-cut. Most studies indicate that both automatic stabilisers and the stimulus measures taken in 2008 and 2009 in many countries had a crucial role in offsetting increases in market income inequality (Perri & Steinberg (2012), OECD (2013), Thompson & Smeeding (2013), Armour, Burkhauser & Larrimore (2015), Thompson & Smeeding (2014)). The extent of the offset, however, seems to have varied across groups. For example, it appears to have been successful at shielding the incomes of the elderly but not those of the working-age population (Thompson & Smeeding (2013)). Furthermore, making use of panel data for 2006 and 2008, Perri & Steinberg (2012) show that households who were already in the bottom of the distribution in 2006 did experience significant losses in their disposable income, suggesting that cross-section analysis may be undermined by important composition effects, understating the true distributional effects of the GR.

When considering the second phase, a clearer picture arises, with the literature almost unanimously pointing to an unequal recovery. Looking at the shares of money income by quintile, in the US, Thompson & Smeeding (2014) show that the share received by the bottom three quintiles of the distribution declined steadily between 2007 and 2012, while the share of the fourth quintile remained

approximately the same and the one of the top quintile experienced a significant rise. Saez (2013) finds that between 2009 and 2012 US top 1% incomes grew by 31.4% while bottom 99% incomes grew by only 0.4%. By 2012, top 1% incomes were close to fully recovering from the losses suffered during the GR, while the bottom 99% incomes had hardly started to recover. He discusses that, based on the US historical record, falls in income concentration due to economic downturns are temporary unless drastic regulation and tax policy changes are implemented to prevent income concentration from bouncing back. In an interesting comparison with the Great Depression (GD), he states that such policy changes took place after the GD during the New Deal permanently reducing income concentration until the 1970s,. He contrasts this with the policy changes that took place coming out of the GR, which although not negligible were relatively more modest. Indeed, some studies point to a muting of the positive offsetting effects of tax and transfer policies from the end of 2009 onwards (Armour et al. (2015), Jenkins, Brandolini, Micklewright & Nolan (2013)). Armour et al. (2015) discuss that although stimulus programs managed to substantially offset the loss of market income for middle and lower income Americans in 2008 and 2009 these effects "were of a temporary nature": 2009 represented the start of the withdrawn of tax stimulus for the middle of the distribution and from 2010 to 2011 tax and transfer stimulus measures were further scaled back. They suggest that these shifts may have been done too prematurely, at a time when the bottom half of the distribution was still in an overall vulnerable position. Focusing on Europe, Jenkins et al. (2013) speculate (based on preliminary data) that the post-2009 distributional impacts of the GR are likely to have been considerably larger, in the context of the fiscal consolidation plans undertaken in several countries.

Although the focus of this paper is on inequality, it should be mentioned that there is also an important literature studying the effects of the 2007-2008 crisis and cycles more generally on poverty, and the role of the tax and transfer system in taming these effects. Bitler, Hoynes & Kuka (2017a) find that business cycles significantly affect child poverty, particularly at lower points of the income-to-poverty ratio distribution and that the social safety net provides significant protection. Bitler & Hoynes (2016) show that poverty among the non-elderly also exhibits a substantial degree of cyclicity, which was particularly strong during the GR. Furthermore, they find that the social safety net is crucial at taming the cyclicity of poverty and that during the GR unemployment insurance was the instrument that provided the most protection. Focusing on the poverty rate for the whole population, Meyer & Sullivan (2011) also find that poverty is sensitive to macroeconomic conditions,

particularly at lower percentiles of the income distribution.

The present work draws on the previous literature studying the relationship between cycles, inequality and the cushioning role of the tax and transfer system, but extends it in several ways. First, it uses a wide range of inequality indicators, considering not only summary measures, as typically done, but also looking in detail at different sections of the income distribution, which allows for a clearer understanding of the heterogeneous effects of the crisis. Second, it decomposes the overall redistributive effect of the tax and transfer system into the contribution of different types of taxes and transfers and their main drivers, which allows for a more refined assessment of the effectiveness of the system. Third, it gives an informative description of the evolution of the US tax and transfer system following the crisis, including the main policy changes, which allows for a better understanding of the factors underlying the obtained redistribution estimates. Fourth, it considers the whole population, including individuals with zero earnings and the elderly, which is essential to capture the effect of certain transfers, in particular unemployment benefits and pensions. Finally, it considers not only the GR years as in most studies, but also the recovery years, which allows for a longer-term view on the persistence of the distributional effects of the crisis. All these aspects allow for a deeper understanding of distributional developments and the cushioning effect of the tax and transfer system following the 2007-2008 crisis. This provides useful information for the development of effective crisis-coping policies, rooted in a thorough understanding of its need and consequences.

2.3 The US tax and transfer system in the aftermath of the crisis

Several important changes were introduced to the US tax and transfer system, following the outburst of the 2007-2008 crisis. Although an exhaustive description of these changes is beyond the scope of this study, a summary of the main ones is provided in this section, which is useful for a better understanding of the results presented in section 4.4.

The first major component of the crisis-coping policy mix was the Economic Stimulus Act (ESA) of 2008 (enacted February 2008). This was an extraordinary stimulus package, designed to promote spending by consumers and businesses during 2008, using targeted individual tax rebates to low and middle-income taxpayers and targeted tax incentives to private companies. Tax rebates were paid to individual taxpayers who filed tax returns concerning the year 2007 and had a taxable income of

at least \$3000. The value of the rebate ranged between \$300 (\$600 for joint filers) and \$600 (\$1200 for joint filers), depending on the individual's 2007 income value, with phase out starting at \$75000 (\$150000 for joint filers). In addition to their individual payment, eligible taxpayers received \$300 per dependent child under the age of 17. People with no net tax liability were still eligible to receive a rebate, provided that they met the minimum qualifying income of \$3000 per year. The total cost of this bill was projected at \$152 billion for 2008².

Another important initiative was the Food, Conservation and Energy Act (FCEA) of 2008 (enacted May 2008), which followed the 2002 Farm Bill, focusing on agricultural subsidies, energy, conservation, nutrition and rural development. The FCEA included significant increases in the funding and access to the Supplemental Nutrition Assistance Program (SNAP), formerly the Food Stamp Program, and The Emergency Food Assistance Program (TEFAP). The bill increased both funding and access to these programs. In the case of, e.g., SNAP, some important changes were: increased the minimum amount of income that is ignored when benefits are calculated; discounted of all income spent on dependent care when calculating benefits; relaxed eligibility rules relating to liquid assets such as retirement, savings and education savings; and expanded transitional benefits for those leaving public assistance programs allowing states to provide eligibility for up to 5 months' transitional benefits. The overall cost of the Act was estimated at about \$307 billion over the 2008-2012 period³.

Besides the ESA and the FCEA, the federal government also introduced the Emergency Unemployment Compensation (EUC) program in 2008, which extended unemployment benefits to eligible claimants beyond their regular 26 weeks benefits, and relaxed the criteria for establishing eligibility based on past work. In some states benefit durations were extended to almost two years. The program began in July 2008 and ended up being extended several times, with the final expiration date having been December 2013. However, as described in Rothstein (2011), the program proceeded in "fits and starts" after its introduction. It was left to expire in several occasions, notably throughout 2010, and was designed in a way such that actual benefit durations were often well below statutory benefit durations, an effect that was stronger from 2010 onwards.

A second wave of stimulus measures was brought by the American Recovery and Reinvestment Act (ARRA) of 2009 (enacted February 2009). Its main objectives were to save and create jobs, provide temporary relief for those most impacted by the recession and invest in infrastructure, education,

²<https://www.cbo.gov/sites/default/files/hr5140pgo.pdf>.

³<https://www.cbo.gov/publication/24782>.

health and renewable energy. On the benefits side, some important measures were: an extension of unemployment benefits through December 31; an increase in food stamp benefits through 2011; a provision of temporary welfare payments and of one-time \$250 dollar payments to recipients of Supplemental Security Income, Social Security Insurance, Veterans pension, Railroad retirement or State retirement systems. On the tax incentives side, a main measure was the introduction of the Making Work Pay (MWP) tax credit, which replaced the one provided by the ESA. It provided a credit of up to \$400 for working individuals with a tax liability (\$800 for joint filers), with annual taxable income between \$8100 and \$95000 (\$190000 for joint filers), in both 2009 and 2010, with phaseout starting at \$75000 (\$150000 for joint filers). Additionally, the ARRA provided: an increase in the amount of the child tax credit and a reduction of the income floor for recipients; an increase in the benefit ceilings of the EITC, especially for larger families, and a more generous schedule for families with three or more children; the introduction of a new tax credit, the American Opportunity Tax Credit (AOTC), to help students and their families cover the cost of college tuition in 2009 and 2010; a home energy credit, given to homeowners who made their homes more energy-efficient in 2009 and 2010; an exclusion from taxation of the first \$2400 received by individuals in unemployment compensation, in 2009. The total cost of the package was estimated to be nearly \$840 billion over the period 2009-2019⁴.

Additional measures came with the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 (also known as the Middle Class Tax Relief Act (MCTRA), enacted December 2010). The Act centered on extending for two years (2011 and 2012) the tax cuts defined in the Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2001 and the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) of 2003 (known as the "Bush tax cuts"), which were set to expire at the end of 2010. The Act also extended some provisions from the ARRA and introduced new ones intended to have an additional stimulatory effect. On the tax side, key aspects of the bill included: extension of the EGTRRA 2001 income tax rates for two years; extension of the child tax credit refundability threshold established by the ARRA for two years; extension of ARRA's treatment of the EITC for two years; extension of ARRA's AOTC for two years; temporary one-year (2011) 2 p.p. reduction in the FICA payroll tax rate⁵; end of partial exclusion of unemployment benefits from taxable income. On the benefits side, the agreement provided an additional year (2011) of emergency

⁴<https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/49958-ARRA.pdf>.

⁵The FICA tax cut was subsequently extended for a second year being therefore in place both in 2011 and 2012.

unemployment insurance benefits at the level established by the ARRA. The overall cost of the Act was estimated at \$858 billion⁶.

A final law was the American Taxpayer Relief Act (ATRA) of 2012 (enacted January 2013). It readdressed the expiration of the "Bush tax cuts", which had already been extended by the MCTRA. It gave permanence to much of these cuts for low to middle income families, while allowing for their expiration for upper income levels. Furthermore, it: established a phase-out of several tax deductions and credits for tax payers with incomes over \$250000 (\$300000 for joint fillers); extended some credits for poorer families for five years, including the AOTC and the EITC; provided an additional year (2013) expansion of emergency unemployment insurance benefits.

Table 2.1 – Main post-crisis extraordinary government programs

Enactment date	Program	Estimated cost	Main changes to the tax and transfer system
February 2008	Economic Stimulus Act	\$152 billion	Provision of extraordinary tax credits to low and middle-income taxpayers.
May 2008	Food Conservation and Energy Act	\$307 billion	Increase in funding and access to food assistance programs for low-income families.
June 2008	Emergency Unemployment Compensation Program	n.a.	Extension of unemployment benefits to individuals who had exhausted their regular ones.
February 2009	American Recovery and Reinvestment Act	\$840 billion	Expansion of unemployment benefits; new tax credits (MWP, AOTC, energy); increase in amount of EITC; increase in food assistance; increase in welfare payments.
December 2010	Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act	\$858 billion	Extension of the Bush tax cuts; reduction of the FICA rate; extension of emergency unemployment benefits.
January 2013	American Taxpayer Relief Act	n.a.	Further extension of Bush tax cuts; additional expansion of emergency unemployment benefits; additional expansion of some tax credits for low and middle-income families.

2.4 Data and methods

This section presents the main aspects of the data and methods used in this study.

2.4.1 Data sources and sample selection

The data is obtained from the Annual Social and Economic (ASEC) (also known as March) supplement of the Current Population Survey (CPS), for the period 2007-2012⁷. The CPS questionnaire directly

⁶<https://www.cbo.gov/sites/default/files/111th-congress-2009-2010/costestimate/sa47530.pdf>.

⁷The data was obtained from the Integrated Public Use Microdata Series (IPUMS)-CPS project, which provides harmonisation of CPS variables since 1962. Official citation reads as: Sarah Flood, Miriam King, Renae Rodgers, Steven Ruggles, and J. Robert Warren. Integrated Public Use Microdata Series, Current Population Survey: Version 6.0 [dataset]. Minneapolis, MN: IPUMS, 2018. <https://doi.org/10.18128/D030.V6.0>.

captures all cash income, including transfers income⁸. Additionally, it provides imputed values for some in-kind transfers, including nutrition and energy assistance. The values of tax liabilities and tax credits are also imputed, based on the Census Bureau's tax-simulation model, which incorporates information from non-CPS sources, such as the Internal Revenue Service's Statistics of Income series, the American Housing Survey and the State Tax Handbook⁹.

The CPS is subject to two sources of nonresponse: noninterview (when an individual is selected by the sampling procedure but is not captured by the survey) and item nonresponse (when an individual does not know or refuses to provide the answer to a question). To compensate for the first data loss, the weights on noninterviewed households are distributed among interviewed households. To compensate for the second data loss, the Census Bureau imputes missing income data using a "hot deck" procedure which matches individuals with missing observations to others with similar sociodemographic and economic information who did answer the questions.

The whole population is included in the sample, as opposed to restricting to households with an employed head or positive earnings or to the working-age population. By doing this, I explore the available information on all individuals who are affected by the tax and transfer system. In particular, by keeping the unemployed and the elderly in the sample, I am able to account for the effects of unemployment benefits and pensions. The option to include children is less straightforward, as they are not income earners by definition. They are, however, individuals benefiting/suffering from the developments concerning their parents income and therefore excluding them would understate the real impacts of income changes on the population as a whole.

The use of survey data instead of administrative data on tax returns, is crucial for this study for two reasons: it allows to capture people at the very bottom of the distribution whose income is typically too low to be taxable and who are therefore not captured in tax returns data; it provides information on transfers, which is typically not contained in tax returns data as these are often nontaxable either. One should, however, keep in mind that survey data is often subject to a higher degree of sampling variation, as it contains information on only a small sample of the population, whereas administrative data typically considers a large sample or even the whole population. Furthermore, survey data often suffers from undersampling or underreporting of very low or high incomes. Notwithstanding, in the case of the CPS and other broadly used surveys, the sampling process is carefully designed

⁸The CPS does not provide a measure of capital gains and therefore these cannot be included in the analysis.

⁹Details on the model can be found in O'Hara (2004).

to be representative of the whole population and weights are attributed to account for potential underrepresentativeness of certain groups.

Section 2.7.3 of the Appendix presents descriptive statistics of the data and provides some additional details on the structure of the CPS in general and the March supplement in particular.

2.4.2 Income measures

The analysis relies on five main measures of income going from market to disposable income, by sequentially accounting for four main categories of redistributive mechanisms namely cash transfers, taxes, tax credits and in-kind transfers. These are given below:

1. Y^{mark} : Pre-government (or market) income, equal to the sum of earnings, private transfers and net asset income.
2. Y^{trnsf} : Post-cash transfers income, equal to the sum of Y^{mark} and public cash transfers.
3. Y^{tax} : Post-tax income, equal to the difference between Y^{trnsf} and taxes.
4. Y^{cred} : Post-tax credits income, equal to the sum of Y^{tax} and tax credits.
5. Y^{kind} : Post-in-kind transfers (or disposable) income, equal to the sum of Y^{cred} and public in-kind transfers.

Table 2.2 gives a list of the components of each income measure, while sections 2.7.2 and 2.7.3 of the Appendix provide detailed explanations and descriptive statistics, respectively¹⁰. The classification that is used is broadly in line with the ones usually adopted in income distribution studies, although there is not a consensus on the subject (see e.g. CBO (2011), Burkhauser, Larrimore & Simon (2012) and Armour, Burkhauser & Larrimore (2013) for a discussion). An important issue is the treatment of in-kind transfers. Including them in disposable income seems natural as they are an important instrument through which the government provides assistance to low-income households. However, they are subject to important measurement problems, particularly health related transfers. I restrict the analysis to nutrition and energy assistance related transfers since these are the only in-kind transfers available in IPUMS¹¹. Also subject to debate is the classification of pensions. Some

¹⁰Throughout the analysis I will use as synonyms market income and pre-government income. Likewise, I will use interchangeably disposable income and post-in-kind transfers income.

¹¹Housing subsidies and school lunch subsidies are two other types that are typically considered. In IPUMS, however, they are available only from 2010 onwards.

studies argue that these are essentially "forced savings", destined at intra-personal life-cycle transfers, and should therefore be a part of pre-government income. Most studies, however, consider that they also contain important elements of inter-personal redistribution (e.g. they can substitute for unemployment and welfare benefits, particularly in crisis times when early retirement often occurs) and should therefore be a part of transfers. I adopt this later perspective. Finally, there are doubts on whether tax credits should be added to cash transfers or deducted from taxes. I consider tax credits separately, as a category on its own.

All income measures are deflated using the BLS CPI-U series available in IPUMS, which converts current dollars to 1999 dollars. The analysis is performed using person-equivalised household income measures, with an equivalence scale equal to the square root of the household size¹²¹³. Each equivalised observation is weighted using the CPS March supplement individual weights. The choices of the income unit, unit of analysis and equivalence scales are discussed in detail in section 2.7.1 of the Appendix, for the interested reader.

2.4.3 Inequality and redistribution analysis

I apply several methods to study the evolution of inequality. I start by considering four summary measures, which provide somewhat complementary information, namely the Gini coefficient and the P90-P20, P90-P50 and P50-P20 percentile ratios. The Gini coefficient is an "overall" measure of inequality, reflecting the evolution of the whole income distribution, and being particularly sensitive to asymmetries in the middle of the distribution. Percentile ratios focus on disparities between two particular sections of the distribution. The P90-P20 ratio measures the distance between the top and bottom of the distribution; the P90-P50 ratio focuses on disparities at the top half of the distribution; and the P50-P20 ratio captures disparities at the bottom half of the distribution. Other popular methods include the variance of the logarithm of income and entropy indices. These, however, are often incompatible with negative and zero income values and are therefore not applicable to the present study, where these values are kept¹⁴.

¹²Other equivalence scales were applied, namely the OECD equivalence scale and per capita income, which did not alter the results significantly. Results are available upon request.

¹³Specifically, the following steps are taken to obtain person-equivalised observations. Market income, cash transfers, tax credits and taxes are all computed at the individual level and then summed up across household members to obtain household-level measures. In-kind transfers are directly available at the household-level in the CPS. The household-level observations are then divided by the equivalence scale and for each household the resulting value is attributed to each member of the household, generating the set of person-equivalised observations.

¹⁴As previously mentioned, all individuals are kept in the sample, including those with zero market income.

Table 2.2 – Income variables list

Income concept	Components
(1) <i>Earnings</i>	Labour earnings Self-employment earnings (farm and business)
(2) <i>Private transfers</i>	Child alimony Child support Friends and family assistance Retirement benefits (private) Disability benefits (private) Survivor's benefits (private) Worker's compensation (private) Educational assistance (private) Other sources
(3) <i>Net asset income</i>	Interests Dividends Rents
(4) <i>Pre-government income</i>	(1) + (2) + (3)
(5) <i>Public cash transfers</i>	Social security (SS) Supplemental security income (SSI) Unemployment benefits Welfare Veteran's compensation Retirement benefits (public, non SS) Disability benefits (public, non SS) Survivor's benefits (public, non SS) Worker's compensation (public) Educational assistance (public)
(6) <i>Post-cash transfers income</i>	(4) + (5)
(7) <i>Taxes</i>	Federal income tax liability State income tax liability Social security payroll deduction (FICA) Federal retirement payroll deduction
(8) <i>Post-tax income</i>	(6) - (7)
(9) <i>Tax credits</i>	Earned income tax credit (EITC) Child tax credit Additional child tax credit Stimulus Making work pay credit
(10) <i>Post-tax credits income</i>	(8) + (9)
(11) <i>Public in-kind transfers</i>	Nutritional assistance (SNAP) Energy assistance (LIHEAP)
(12) <i>Post-in-kind transfers income</i>	(10) + (11)

These measures, although useful to get an overall picture of the evolution of income inequality, do not allow for a deep understanding of the heterogeneity in income changes across the income distribution. Only by looking in detail at different parts of the distribution can one obtain a comprehensive insight into the disparities of the distributional effects of the crisis and the effectiveness of the redistributive system, which is the main focus of this paper. To achieve this, I look at changes in different percentiles (specifically percentiles 10, 25, 50, 75 and 90) and in average income and income shares by income group (specifically the groups composed by the bottom 10th, 20th and 50th percentiles and the top 50th, 20th and 10th percentiles).

Assessing the redistributive effect of taxes and transfers is a trickier issue. I start by computing the different inequality measures for all the income variables and comparing their changes between 2007 and 2012, to obtain a first quantitative idea. I then perform a formal assessment using a Gini-based sequential decomposition, based on the seminal works by Reynolds & Smolensky (1977) and Kakwani (1986) and recently used in Mahler & Jesuit (2006), Immervoll & Richardson (2011) and Fuest, Niehues & Peichl (2013), among others. Other methods have been used in the literature including the factor source decomposition developed by Shorrocks (1982), and the marginal impact decomposition proposed by Lerman & Yitzhaki (1985). I opt for the Gini-based sequential method since: it is based on the Gini coefficient, which allows for the incorporation of negative and zero income values and is the most widely used measure of inequality; it provides fairly intuitive results, in line with the majority of the evidence in comparable micro studies.

The approach decomposes the trajectory of the Gini from market to disposable income into the contributions of the different redistributive instruments by: (1) sequentially applying each instrument to income; (2) computing the corresponding Ginis; (3) comparing the Gini of income including a given instrument with the Gini of income without the instrument. Formally, consider a population of individuals $i = 1, \dots, n$ and define the income of individual i at time t after instrument $k \in \{trnsf, tax, cred, kind\}$ is considered, $Y_{i,t}^k$, according to the following general expression:

$$Y_{i,t}^k = Y_{i,t}^{mark} + \sum_{j=trnsf}^k \alpha_j T_{i,t}^j, \quad i = 1, 2, \dots, n \quad , \quad j \in \{trnsf, tax, cred, kind\} \quad (2.1)$$

where $Y_{i,t}^{mark}$ is market income of individual i at time t , $T_{i,t}^j$ is instrument j for individual i at time t ,

and α_j is an indicator equal to 1 for $j \in \{trnsf, cred, kind\}$ and -1 for $j = tax$ ¹⁵.

The Gini coefficient can then be computed for each income measure. For any period t , denote G_t^{mark} the Gini for market income, G_t^k the Gini for income after instrument k is considered, and G_t^{k-} the Gini for income before instrument k is considered. One can then compute several indicators of redistribution. The main one is the Reynolds-Smolensky index (Reynolds & Smolensky (1977)). It is a measure of **absolute redistribution** giving the reduction in the level of the Gini coefficient resulting from the effect of the redistributive system as a whole, AR_t^{all} , or from the effect of one particular instrument, AR_t^k . Formally, we have:

$$AR_t^{all} = G_t^{mark} - G_t^{kind}, \quad AR_t^k = G_t^{k-} - G_t^k \quad (2.2)$$

To obtain an idea of how meaningful these values are, it is common to compute them as a percentage of the Gini of market income, which indicates what fraction of market income inequality was "eliminated" due to the redistributive effect of the tax and transfer system. These correspond to measures of **relative redistribution** and, analogously to absolute redistribution, can be obtained for the system as a whole, RR_t^{all} , and for each instrument, RR_t^k . Formally:

$$RR_t^{all} = \frac{AR_t^{all}}{G_t^{mark}}, \quad RR_t^k = \frac{AR_t^k}{G_t^{mark}} \quad (2.3)$$

The importance of each instrument in total redistribution can then be computed as the **weight of instrument k in redistribution**, WR_t^k , given by the ratio of the redistributive effect of instrument k to the overall redistributive effect of the system. Formally:

$$WR_t^k = \frac{AR_t^k}{AR_t^{all}} = \frac{RR_t^k}{RR_t^{all}} \quad (2.4)$$

It is also useful to look at the evolution of redistribution, which allows us to grasp not only its levels but also its dynamics, given by the annual **change in absolute redistribution**, both overall, ΔAR_t^{all} , and partial, ΔAR_t^k . This is equivalent to the difference between the change in pre instrument

¹⁵It should be noted that this is done using the person-equalised variables, not the original individual ones.

Gini and the change in post instrument Gini. Formally:

$$\Delta AR_t^{all} = AR_t^{all} - AR_{t-1}^{all} = \Delta G_t^{mark} - \Delta G_t^{kind} \quad (2.5)$$

$$\Delta AR_t^k = AR_t^k - AR_{t-1}^k = \Delta G_t^{k^-} - \Delta G_t^k$$

And finally, we can compute the **contribution of instrument k to the change in absolute redistribution**, CR_t^k , as the ratio between the change in redistribution done by instrument k and the change in overall redistribution. Formally:

$$CR_t^k = \Delta AR_t^k / \Delta AR_t^{all} \quad (2.6)$$

A closer look at the redistributive effect of each instrument can be obtained by decomposing the partial effects in (2.2) into a size, a progressivity and a re-ranking effect. This gives information on the determinants of redistribution, which may be crucial when choosing between different instruments. For instance, when deciding to reinforce one of two instruments by the same amount, choosing the most progressive one will result in higher redistribution. The **size effect** of instrument k is a function of the average instrument rate, g_t^k , computed as the amount of the instrument paid or received by all individuals divided by the corresponding pre-instrument income. Formally:

$$g_t^k = \sum_{i=1}^n T_{i,t}^k / \sum_{i=1}^n Y_{i,t}^{k^-} \quad (2.7)$$

The **progressivity effect** of instrument k , K_t^k , corresponds to the Kakwani index (Kakwani (1977)), given by the difference between the concentration coefficient of the instrument relative to pre-instrument income, $C(T_t^k, Y_t^{k^-})$, and the Gini coefficient of pre-instrument income. It quantifies the departure of instrument k 's distribution from proportionality, ranging from plus 1 (maximum progressivity) to minus 2 (maximum regressivity). An instrument that is distributed in proportion to pre-instrument income has zero progressivity and redistribution. Formally:

$$K_t^k = C(T_t^k, Y_t^{k^-}) - G_t^{k^-} \quad (2.8)$$

The **re-ranking effect**, R_t^k , is given by the difference between the concentration coefficient of

post-instrument income relative to pre-instrument income, $C(Y_t^k, Y_t^{k-})$, and the Gini coefficient of post-instrument income. It results from the fact that for the Gini of each income individuals are ranked according to that income and therefore different rankings are subjacent to the different Ginis. The concentration coefficient takes the same form as the Gini coefficient but individuals are ranked by their pre-instrument income, and therefore the difference between the two provides the part of the Gini measure that can be attributed to the change in ranking. Formally:

$$R_t^k = G_t^k - C(Y_t^k, Y_t^{k-}) \quad (2.9)$$

The redistributive effect of instrument k is then given by:

$$AR_t^k = \frac{g_t^k}{1 - g_t^k} K_t^k - R_t^k \quad (2.10)$$

where $\frac{g_t^k}{1 - g_t^k}$ is the size effect. For a progressive instrument ($K_t^k > 0$), an increase in size increases redistribution, whereas for a regressive instrument ($K_t^k < 0$) it is the other way around. For a given size of the instrument, an increase in progressivity increases its redistributive effect. Finally, a higher re-ranking effect is associated with a smaller level of redistribution.

2.4.4 Some limitations

Before turning to the results, some limitations of the data and methodology should be discussed. A first limitation is that this study is admittedly descriptive, using methods that do not allow for a strict identification of causality, which is particularly relevant for two aspects of the analysis. First, concerning the evolution of the market income distribution, results may reflect not only the effects of the 2007-2008 crisis but also some structural developments that started before the crisis. However, as shown in subsection 2.5.1, market income inequality was stable or even decreased (depending on the indicator considered) before the crisis so it seems unlikely that the strong post-crisis increase reflected an underlying structural trend. Second, a direct link cannot be established between the discretionary policy actions described in section 2.3 and changes in redistribution. Indeed, the evolution of redistribution reflects the combined effects of both discretionary measures and automatic stabilisers, which in turn are the result of mechanical changes in taxes and transfers arising from

changes in pre-government incomes¹⁶. Disentangling the effects of discretionary measures from the ones of automatic stabilisers would require the use of a microsimulation or theoretical model. Despite the absence of a causal identification, the paper provides a detailed and comprehensive analysis of post-crisis distributional developments, unveiling new and informative evidence and discussing possible links with the policies that were implemented.

A second limitation relates to the fact that the CPS is not an adequate source for the study of the very high end of the income distribution, as it suffers from a low response rate of higher income earners and measurement issues for capital income (which is typically more concentrated at the very top of the distribution). Furthermore, the CPS applies top-coding, such that very high incomes are replaced by a maximum value defined by the Census Bureau in each year. An analysis of the evolution of top incomes is best left to studies using tax returns data (in the line of the works by Thomas Piketty and co-authors), which are not affected by these problems, despite suffering from other issues such as tax evasion and avoidance. Therefore, I do not focus on the evolution of the very top of the income distribution in this paper¹⁷.

A third limitation is that the sequence of redistributive instruments is not irrelevant for the assessment of their contribution to overall redistribution¹⁸. Here I implicitly assume that there are no interactions between the different stages of redistribution, but in reality this is often not the case as transfers may depend on the amount of taxes paid and taxes may depend on the amount of transfers received. By first adding transfers to market income, e.g., we may overestimate its effect by not taking into account that a part of these transfers may be absorbed as a tax. Similarly, by first deducting taxes we may face cases of negative post-tax income, if these taxes are being charged not on market income but on transfers. To account for this issue, I choose a sequence that reflects as much as possible the actual legal sequence in the American tax-benefit system. In the US, a considerable amount of individuals have zero market income and are taxed on their benefits. It therefore seems more appropriate to consider the effect of taxes on post-transfers income, and not the other way

¹⁶Since most taxes depend on pre-tax incomes, changes in these incomes will alter the amount of taxes to be paid, even without any policy change. Likewise, means-tested benefits can change due to changes in pre-benefit incomes, even with unchanged policies.

¹⁷As a robustness check, I compared my results for the evolution of market income inequality with the most comparable ones provided in Piketty & Saez (2013) and Saez (2013). When considering the series excluding capital gains (which is the one consistent with this paper, as capital gains are not included), results are qualitatively the same: the top 10% market income share increased between 2007 and 2012, indicating an increase in market income concentration following the 2007-2008 crisis.

¹⁸Naturally, this is not an issue when computing the overall effect of the system.

around. Tax credits are often a function of after-tax income and therefore their effect is assessed after deducting taxes. In-kind transfers are typically attributed after all other instruments have been taken into account and therefore are the last element of the sequence.

Finally, possible behavioural responses are not accounted for in the analysis. A purely budget incidence method is applied, where only budgetary changes in taxes and transfers are considered. In reality, tax and transfer policies may not only directly add/subtract to market income but also change it indirectly, by creating incentives and/or constraints for individual behaviour. Accounting for these indirect effects would require building a counterfactual market income distribution equal to the distribution that would exist in the absence of a tax and transfer system, modelling the different behavioural reaction channels to the introduction of the system, and then disentangling the effect in income due to budgetary changes from the effect due to changes in behaviour. This is beyond the scope of this paper, and is left for future research.

2.5 Findings

This section presents and discusses the main findings of this study^{19,20}. Additional results can be found in section 2.7.4 of the Appendix.

2.5.1 Impact of the crisis on the market income distribution

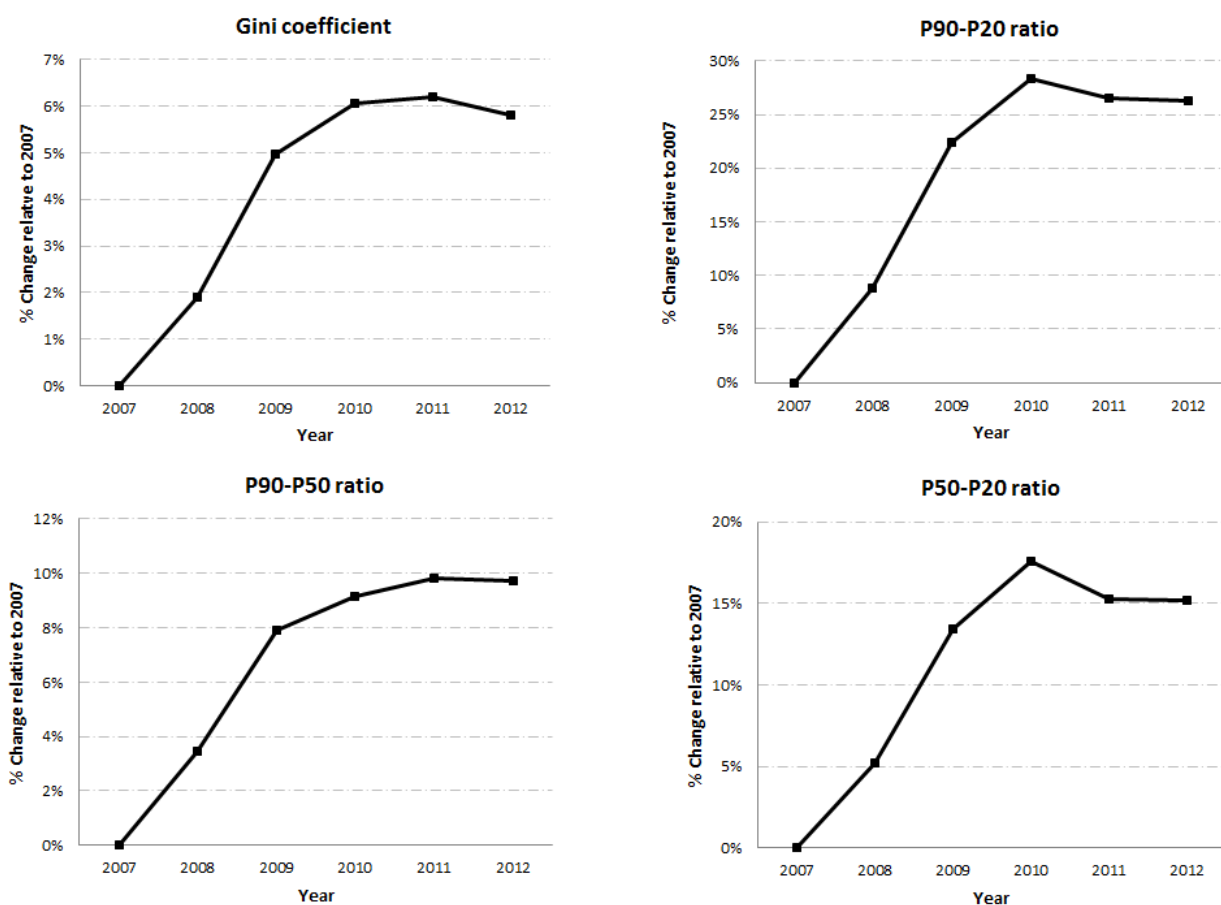
I start by investigating the "pure" market distributional effects of the crisis, prior to any government redistribution. Figure 2.1 displays the levels and accumulated percentage changes (relative to 2007) of the summary measures of inequality introduced in subsection 2.4.3, for market income. It undoubtedly shows that market income inequality experienced a noteworthy rise in the aftermath of the 2007-2008 crisis. Inequality as measured by the Gini coefficient and the P90-P50 ratio rose by approximately 6% and 10%, respectively, between 2007 and 2012, while inequality as measured by the P90-P20 and P50-P20 ratios exhibited particularly significant increases, of 26% and 15%, respectively. This points to the increase in market income inequality being largely driven by significant losses at the bottom of the distribution, relative to both the middle and the top. Another interesting aspect is that for

¹⁹For all the statistics here presented standard errors have been computed by bootstrapping using 1000 repetitions, showing that results are statistically significant. The standard errors and corresponding p-values are not presented here to keep the exposition concise but they are available upon request.

²⁰Since my main interest is to study the dynamics of the income distribution following the crisis, I mostly focus on changes in the relevant indicators, but the corresponding levels can all be found in Tables 2.12 to 2.15 of the Appendix.

all indicators most of the increase occurred between 2007 and 2010, comprising the GR years. After 2010, the so-called recovery years, the growth rate of these measures was considerably smaller, being even negative in 2012. However, although market income inequality did not increase significantly after 2010 it did not decrease significantly either, pointing to a sizeable persistence of the market distributional impacts of the crisis.

Figure 2.1 – Summary measures of market income inequality (2007 - 2012)



The preliminary assessment that the crisis hit harder individuals in the lower part of the market income distribution, is confirmed by the analysis of the evolution of average income for different income groups, as described in subsection 2.4.3^{21, 22}. Figure 2.2 clearly shows that bottom income groups were relatively more penalised by the crisis and that their losses were not only strong but

²¹It should be noted that the individuals composing each percentile and income group are not the same across years. Therefore, results should be interpreted in terms of the evolution of the income corresponding to particular sections of the distribution and not to particular individuals.

²²To keep the analysis concise, results for percentiles and income shares are presented only in the Appendix (in Figures 2.10 and 2.11) but with no substantial loss of information, as they provide the same qualitative conclusions.

also highly persistent. By 2012, five years after the onset of the crisis, individuals in the bottom 10, 20 and 50 income groups had respectively an average income 80%, 40% and 20% lower than individuals in those same groups had in 2007. In contrast, individuals in the top 10 and 20 income groups experienced very modest losses, of only 5%. Furthermore, consistently with the evidence from inequality summary measures, it can be seen that the bulk of the market income losses occurred between 2007 and 2010, and that 2011 and 2012 brought about only a stabilisation of incomes, without any sizeable improvement.

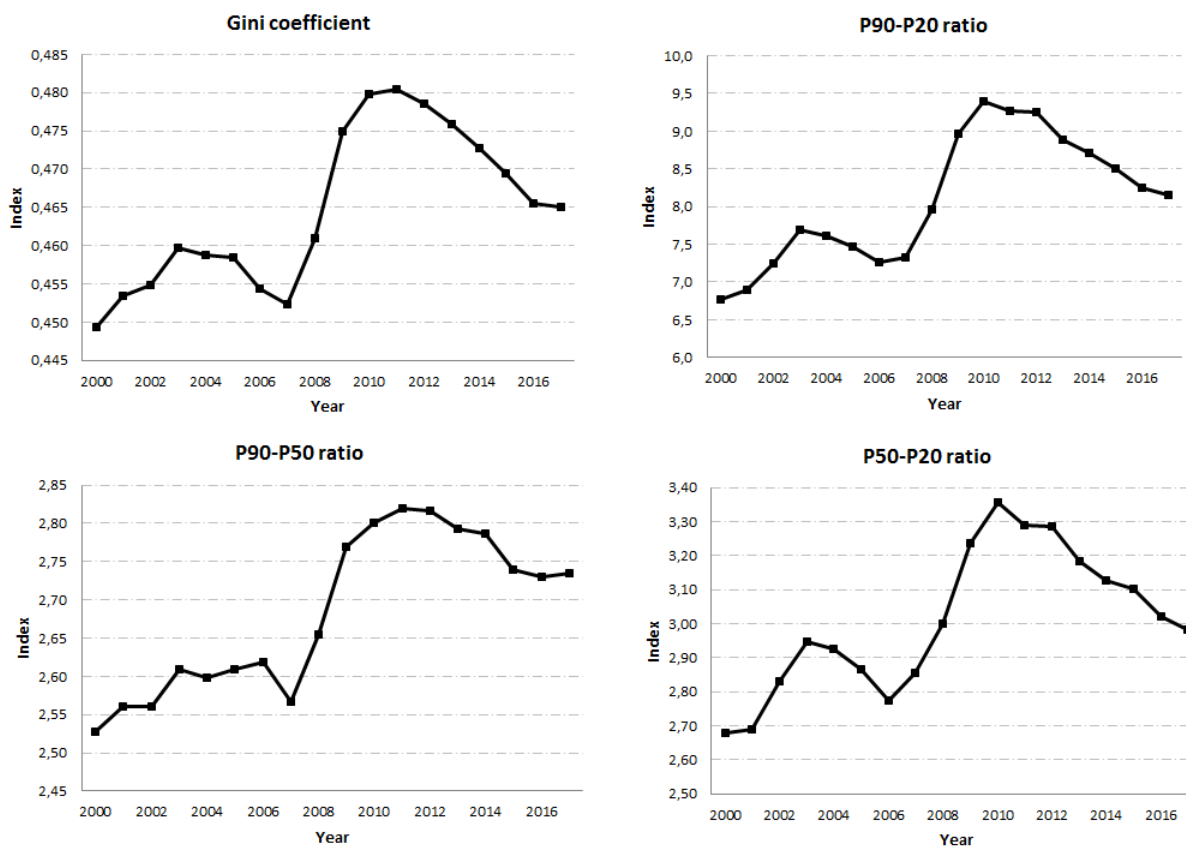
Figure 2.2 – Average market income by income group



These findings are consistent with other studies that also point to a significant increase in market income inequality, largely driven by losses for households at the bottom of the income distribution. Perri & Steinberg (2012), e.g., find that earnings inequality at the bottom, as measured by the P50-P20 ratio of the earnings distribution, increased sharply during the recession from roughly 2.7 to nearly 3.5. This was an historically high level, significantly higher than 2.9, which was the highest that had been observed since 1967. Looking at the change in average market income for different quintiles, Armour et al. (2015) find that the bottom quintile lost 30.2% between 2007 and 2010, while for the top quintile the loss amounted to only 4.6%.

Figure 2.3 shows the levels of the indicators presented in Figure 2.1 between 2000 and 2017, which gives a longer term picture of the evolution of market income inequality, putting the changes observed

Figure 2.3 – Summary measures of market income inequality (2000 - 2017)



between 2007 and 2012 into perspective. A first interesting finding arises from the comparison of the results between 2007 and 2012 with the results between 2000 and 2005, following the early 2000s crisis. One can see that market income inequality also increased following this crisis and although the magnitude of the changes was smaller than in the case of the 2007-2008 crisis (the early 2000s recession was much less severe than the GR), the pattern was remarkably similar. Indeed, the bulk of the increase occurred in the first two years, with a stabilisation at high levels occurring afterwards, and the percentile ratios P90-P20 and P50-P20 exhibited the most significant increases. A second interesting finding is that market income inequality was not increasing in the years preceding the 2007-2008 crisis and was even decreasing, which shows that the rise observed after 2007 was not simply a continuation of a previous upward trend. Finally, considering the most recent years, it is clear that 2012 was a turning point, with market income inequality decreasing afterwards. Notwithstanding, by 2017 it was still well above its pre-crisis level, showing that the increase observed following the crisis was still far from being reversed.

The analysis done in this subsection shows that the crisis entailed a dramatic widening of the market income distribution. There were losses along the whole distribution, but the bottom and middle sections were hit the hardest, exhibiting strong and persistent income losses.

2.5.2 Size and structure of the tax and transfer system

Before turning to the redistributive effect of the tax and transfer system, it is informative to characterise its size and structure and quantify the changes that occurred following the crisis. It should be noted that, as discussed in subsection 2.4.4, the results presented here reflect the combined effects of changes induced by discretionary policy measures and "mechanical" changes associated with automatic stabilisers. Therefore, it is not possible to establish a strict causal relationship between the observed changes and the measures described in section 2.3. Nevertheless, it is informative to interpret the results in light of these measures and identify possible links.

I start by investigating the importance of the different components of the tax and transfer system for households' resources, by looking at the composition of disposable income in terms of market income and all the benefits and taxes considered²³. Results are given in Table 2.3, as an average over all the years in the sample, for the whole population and for different income groups.

When all households are considered, market income accounts for approximately 110% of disposable income, which means that on average the amount of benefits received is smaller than the amount of taxes paid, such that the average individual is a net taxpayer. Indeed, cash transfers, tax credits and in-kind transfers together account for 15% of disposable income, while taxes account for 25%. Among the three types of benefits, cash transfers are clearly the most significant one, accounting for almost 13% of disposable income, while tax credits and in-kind transfers represent only 2% and 1%, respectively. Among the different types of cash transfers, social security, (non SS) retirement benefits and unemployment benefits are the most significant ones. In the case of taxes, the largest burden is the one imposed by the federal income tax, followed by social security contributions. The EITC is the most significant tax credit, while nutritional assistance makes up for almost all the contribution done by in-kind transfers.

The composition of disposable income differs substantially across the income distribution. Cash transfers are important for the bottom (they represent 38% of disposable income for the bottom 10%),

²³From here onwards the tax credits in "stimulus" and "making work pay credit" are grouped in one single variable named "extraordinary", which embodies all extraordinary credits given following the crisis.

Table 2.3 – Importance of taxes and transfers in disposable income, overall and by income group

Variable	Share in disposable income (average over 2007-2012)						
	Bot 10	Bot 20	Bot 50	Top 50	Top 20	Top 10	Overall
<i>Market income</i>	<i>49,8%</i>	<i>59,3%</i>	<i>81,8%</i>	<i>118,9%</i>	<i>127,8%</i>	<i>132,8%</i>	<i>109,3%</i>
<i>Cash transfers</i>							
Social security (SS)	22,3%	22,1%	15,4%	5,0%	3,5%	2,9%	7,7%
Supplemental security income (SSI)	8,2%	4,7%	1,8%	0,2%	0,1%	0,1%	0,6%
Unemployment benefits	2,9%	2,5%	1,9%	0,7%	0,4%	0,3%	1,0%
Welfare	2,5%	1,2%	0,4%	0,0%	0,0%	0,0%	0,1%
Veteran's compensation	0,4%	0,4%	0,5%	0,5%	0,5%	0,5%	0,5%
Retirement benefits (non SS)	0,7%	0,9%	1,6%	2,2%	2,0%	1,8%	2,1%
Disability benefits (non SS)	0,2%	0,2%	0,2%	0,1%	0,1%	0,0%	0,1%
Survivor's benefits (non SS)	0,1%	0,1%	0,2%	0,1%	0,1%	0,1%	0,1%
Worker's compensation	0,1%	0,1%	0,1%	0,1%	0,0%	0,0%	0,1%
Educational assistance	0,4%	0,3%	0,3%	0,2%	0,1%	0,1%	0,2%
<i>Overall</i>	<i>37,9%</i>	<i>32,6%</i>	<i>22,4%</i>	<i>9,1%</i>	<i>6,9%</i>	<i>5,9%</i>	<i>12,5%</i>
<i>Taxes</i>							
Federal income tax	3,4%	2,5%	4,2%	17,0%	22,0%	25,2%	13,7%
State income tax	1,9%	1,5%	2,1%	4,3%	5,0%	5,5%	3,8%
SS payroll tax (FICA)	3,4%	4,1%	5,6%	7,6%	7,8%	7,9%	7,1%
Federal retirement payroll tax	0,1%	0,1%	0,1%	0,2%	0,3%	0,3%	0,2%
<i>Overall</i>	<i>8,7%</i>	<i>8,3%</i>	<i>12,0%</i>	<i>29,1%</i>	<i>35,1%</i>	<i>38,9%</i>	<i>24,7%</i>
<i>Tax credits</i>							
Earned income tax credit (EITC)	6,3%	6,5%	2,7%	0,1%	0,0%	0,0%	0,8%
Child tax credit	0,0%	0,1%	1,0%	0,5%	0,1%	0,0%	0,6%
Additional child tax credit	1,0%	2,0%	1,0%	0,0%	0,0%	0,0%	0,3%
Extraordinary	1,0%	1,0%	0,9%	0,5%	0,3%	0,2%	0,6%
<i>Overall</i>	<i>8,3%</i>	<i>9,5%</i>	<i>5,6%</i>	<i>1,1%</i>	<i>0,4%</i>	<i>0,2%</i>	<i>2,3%</i>
<i>In-kind transfers</i>							
Nutritional assistance (SNAP)	12,3%	6,6%	2,1%	0,0%	0,0%	0,0%	0,6%
Energy assistance (LIHEAP)	0,4%	0,3%	0,1%	0,0%	0,0%	0,0%	0,0%
<i>Overall</i>	<i>12,7%</i>	<i>6,8%</i>	<i>2,2%</i>	<i>0,0%</i>	<i>0,0%</i>	<i>0,0%</i>	<i>0,6%</i>
<i>Transfers net of taxes</i>	<i>50,2%</i>	<i>40,7%</i>	<i>18,2%</i>	<i>-18,9%</i>	<i>-27,8%</i>	<i>-32,8%</i>	<i>-9,3%</i>
<i>Disposable income</i>	<i>100,0%</i>	<i>100,0%</i>	<i>100,0%</i>	<i>100,0%</i>	<i>100,0%</i>	<i>100,0%</i>	<i>100,0%</i>

Note: All statistics refer to per-person equivalised household income and consider individual weights.

while almost negligible for the top (6% for the top 10%). For taxes, the picture is reversed. They represent a large burden for top income groups (39% for the top 10%) but are much less significant for the bottom (9% for the bottom 10%). Tax credits are almost irrelevant for top income groups, but are non-negligible for the bottom ones (10% for the bottom 20%). Interestingly, the weight of the extraordinary credits given after the crisis is more similar across groups, than that of the other

"regular" credits, indicating that these measures were not concentrated on the lower parts of the income distribution. Finally, in-kind transfers almost exclusively benefit the bottom of the income distribution (13% for the bottom 10%).

I now turn to the size of the tax and transfer system. Table 2.4 provides the levels and annual percentage changes of each component and subcomponent, together with the weight of each subcomponent in the corresponding component. Starting with total transfers net of taxes, we see that automatic stabilisers and discretionary policies together injected hundreds of billions of dollars into American households' incomes between 2007 and 2012. This increase in households' resources was highly concentrated in the GR years, being much less expressive from 2009 onwards.

Cash transfers increased substantially during the GR years, mostly reflecting a sharp rise in unemployment benefits and significant rises in social security and other retirement benefits expenditures. The dramatic increase in unemployment benefits is likely to result from both the massive surge in the number of unemployed people and the measures taken in the context of the EUC and the ARRA, related to the extension of the duration up to 99 weeks and the relaxation of the eligibility criteria. In the following years, this growth came to a halt with the overall value of cash transfers slightly dropping between 2009 and 2012. This was mostly led by sharp declines in unemployment benefits, which are likely to reflect an improvement in labour market conditions in the context of the recovery on the one hand, and the phase out of the previous stimulus measures on the other hand. Despite these drops in later years, cash transfers still remained at considerably higher levels than before the start of the crisis, being approximately 24% higher.

Tax liabilities declined during the GR years, mostly resulting from decreases in income taxes, which are likely to reflect a reduction in personal taxable income due to sharp employment losses. In 2010 the value of tax liabilities stabilised, following the positive impact of the beginning of the recovery in households' market income and the extinction of the partial exclusion of unemployment benefits from taxable income, bringing about a positive growth of the federal income tax. In 2011, a significant negative growth was observed, as a result of a decrease in FICA tax liabilities, in the context of the temporary reduction of 2 p.p. in the tax rate introduced by the MCTRA²⁴. In 2012,

²⁴It should be noted that the cut in the FICA rate was partially intended to compensate for the extinction of the MWP credit and could therefore be considered as a tax credit. However, this objective was not fully achieved, as many low-income individuals who did not contribute to Social Security were left out of the cut in the payroll tax rate while still losing access to the tax credit. Furthermore, throughout the whole analysis I consider payroll taxes as a part of taxes. Therefore, to ensure consistency, the cut in the FICA rate is reflected in the evolution of taxes.

Table 2.4 – Size of the tax and transfer system

Variable	Levels, in \$ billions				Weight in component, in percentage				Annual percentage change			
	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Cash transfers												
Social security (SS)	551	584	631	622	653	668	65%	63%	59%	58%	61%	63%
Supplemental security income (SSI)	40	45	48	48	52	51	5%	5%	4%	4%	5%	5%
Unemployment benefits	29	50	129	124	86	66	3%	5%	12%	12%	8%	6%
Welfare	8	9	9	10	10	8	1%	1%	1%	1%	1%	1%
Veteran's compensation	35	39	43	41	47	48	4%	4%	4%	4%	4%	5%
Retirement benefits (non SS)	148	161	165	176	175	173	17%	17%	15%	17%	16%	16%
Disability benefits (non SS)	8	7	8	8	9	9	1%	1%	1%	1%	1%	1%
Survivor's benefits (non SS)	11	11	12	12	11	9	1%	1%	1%	1%	1%	1%
Worker's compensation	6	6	7	6	5	6	1%	1%	1%	1%	0%	1%
Educational assistance	13	14	16	18	17	17	2%	2%	2%	2%	2%	2%
<i>Overall</i>	<i>849</i>	<i>925</i>	<i>1069</i>	<i>1065</i>	<i>1064</i>	<i>1054</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>
Taxes												
Federal income tax	1150	1124	1069	1077	1080	1071	54%	55%	54%	54%	58%	58%
State income tax	313	299	298	292	297	311	15%	15%	15%	15%	16%	17%
SS payroll tax (FICA)	636	618	608	604	462	464	30%	30%	31%	30%	25%	25%
Federal retirement payroll tax	14	14	16	16	17	16	1%	1%	1%	1%	1%	1%
<i>Overall</i>	<i>2113</i>	<i>2056</i>	<i>1991</i>	<i>1989</i>	<i>1856</i>	<i>1862</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>
Tax credits												
Earned income tax credit (EITC)	50	49	66	64	66	67	40%	19%	31%	30%	47%	49%
Child tax credit	59	55	51	49	48	46	47%	22%	24%	23%	34%	33%
Additional child tax credit	16	15	26	25	25	25	13%	6%	12%	12%	18%	18%
Extraordinary	0	135	72	73	0	0	0%	53%	33%	35%	0%	0%
<i>Overall</i>	<i>125</i>	<i>255</i>	<i>215</i>	<i>212</i>	<i>139</i>	<i>138</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>
In-kind transfers												
Nutritional assistance (SNAP)	26	33	48	54	54	54	96%	95%	96%	96%	97%	97%
Energy assistance (LIHEAP)	1	2	2	2	2	2	4%	5%	4%	4%	3%	3%
<i>Overall</i>	<i>27</i>	<i>34</i>	<i>50</i>	<i>56</i>	<i>56</i>	<i>56</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>	<i>100%</i>
Transfers net of taxes	-1111	-841	-658	-656	-598	-614	100%	100%	100%	100%	100%	100%

Note: All statistics refer to per-person equalised household income and consider individual weights.

no additional measures were taken and tax spending exhibited a mild increase, standing at a level approximately 12% lower than in 2007.

The evolution of tax credits is particularly interesting. In 2008, a significant increase occurred, of more than 100%, reflecting the tax rebates given by the ESA. In 2009 and 2010, although the value of tax credits remained high, there was a decrease relative to 2008 as the MWP credit given by the ARRA was less generous than the one provided by the ESA. 2011 marked the end of the extraordinary tax credits, implying a sharp decrease in the overall level. In 2012 no major changes occurred, with tax credits remaining at their 2011 level, 10% higher than in 2007.

As for in-kind transfers, big increases were observed between 2008 and 2010, following the expansion of food assistance programs in the context of the FCEA and the ARRA. The level then remained stable at its 2010 value up to 2012, representing an increase of 100% relative to 2007.

The analysis done in this subsection shows that significant changes occurred in the size and composition of the tax and transfer system following the crisis. This evolution was marked by two distinct phases. The years of the GR were characterised by an important stimulus, while the years of the recovery brought about a less notable boost. Although a causal relationship cannot be drawn, these developments are aligned with the evolution of tax and transfer policies, marked by significant expansionary measures in 2008 and 2009 and a progressive withdrawal from thereafter.

2.5.3 The cushioning effect of the tax and transfer system

I now turn to the analysis of the cushioning effect of the tax and transfer system. I start by doing the same type of exercise as in subsection 2.5.1 for the post tax and transfer income aggregates, and then move to a formal Gini-based inequality decomposition as described in subsection 2.4.3.

Preliminary analysis

Figure 2.4 displays the changes in the same measures of inequality considered in Figure 2.1, but this time for the five income aggregates of interest. Several interesting facts emerge. First, disposable income inequality rose by much less than market income inequality, which points to an important cushioning role of the tax and transfer system. Second, until 2009 disposable income inequality barely increased or even decreased, depending on the indicator considered, but from 2010 onwards it started to grow, in line with market income inequality. This seems to have been mostly induced by a

stronger recovery of the top of the distribution. Indeed, by 2012, both the P90-P20 and P90-P50 ratios were approximately 4% higher than in 2007, while the P50-P20 ratio was slightly lower. The Gini coefficient, encompassing developments in the whole distribution, was higher by approximately 3%. The offsetting role of taxes and transfers in the post-crisis period, although significant, was only partial and more effective in the early stage of the crisis aftermath. The system prevented the bottom and the middle of the distribution from growing apart, but not the top from distancing itself from both the bottom and the middle. Third, concerning the redistributive role of each instrument, cash transfers were clearly the most significant contributor. Tax credits also had a non-negligible role in cushioning the increase in inequality, while in-kind transfers were important at containing the divergence between the bottom and the rest of the distribution. Taxes were slightly disequalising.

Figure 2.4 – Summary measures of pre and post tax and transfer income inequality

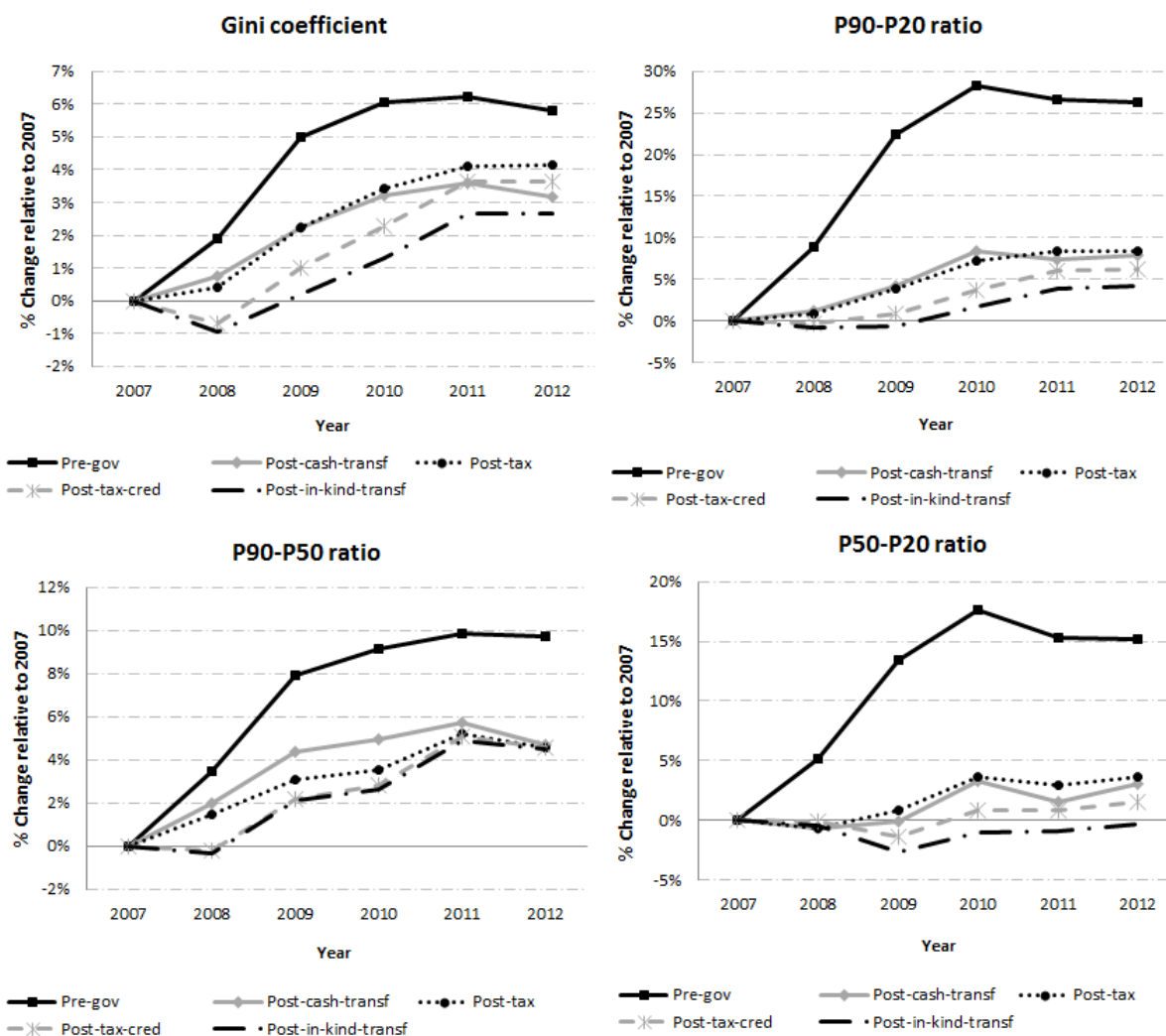


Figure 2.5 shows the evolution of average income by income group for the four post government income aggregates of interest²⁵. The figure confirms that the system played an important role in taming the increase in inequality stemming from the crisis, as differences between the losses for higher and lower income groups are much less pronounced than those for market income (in Figure 2.2). Furthermore, it supports the finding that the system was effective at preventing a widening of the disposable income distribution up to 2010, but not from then onwards. Indeed, losses in disposable income of bottom and middle groups were smaller than those of top groups in the first period, but in the second period the situation reversed, with the top starting to recover while the bottom continued to lose. Finally, it gives some indication on the relevance of each instrument in cushioning market income losses for the different income groups. Cash-transfers were relevant for all income groups, although particularly crucial for bottom ones. Taxes, on the contrary, were an important determinant of the recovery of top income groups from 2010 onwards, while having a minor effect for the bottom ones. Tax credits and in-kind transfers both provided significant cushioning of income losses for bottom income groups, particularly during the GR years.

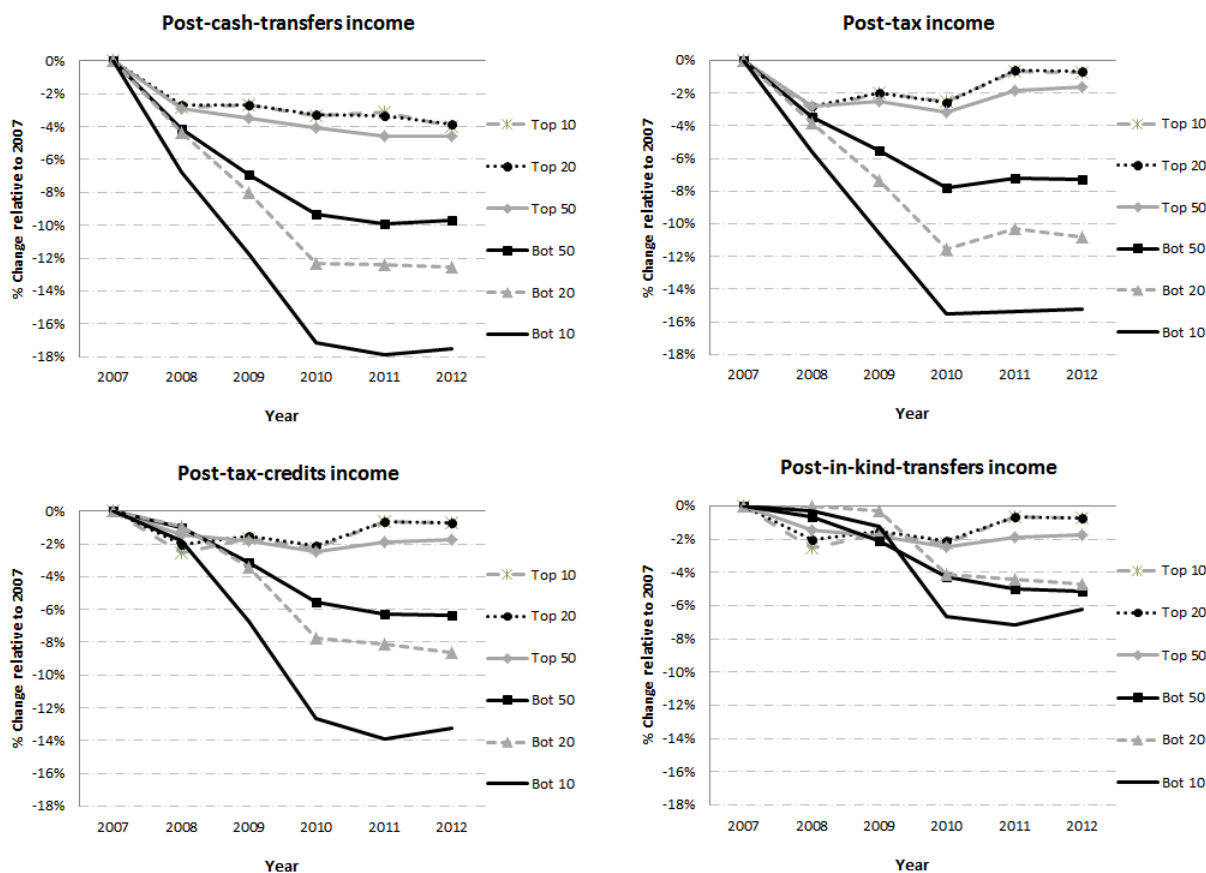
Gini-based decomposition analysis

I now move to a Gini-based decomposition analysis, to precisely quantify the redistributive effect of the tax and transfer system. Results are given in Table 2.5, and the most important ones are illustrated in Figures 2.6-2.8. Figure 2.6 focuses on the levels of absolute redistribution. The left-hand panel presents the level of overall redistribution, confirming that the system had a sizeable role in decreasing income inequality throughout the post-crisis period (by almost 13 Gini points on average, i.e. 27% of market income inequality). The right-hand panel presents the contribution of each tax and transfer type to overall redistribution, showing that cash transfers played the most important role (50%, on average), followed by taxes (35%, on average), with tax credits and in-kind transfers playing a smaller role (10% and 5% on average, respectively).

Figure 2.7 focuses on the changes in absolute redistribution. The left-hand panel presents the annual change, while the right-hand panel presents the cumulative change, relative to 2007. When considering the whole post-crisis period, it is clear that redistribution increased, by 1.7 points, such that it was 15% higher in 2012 than in 2007. However, as previously seen, this overall evolution embodied

²⁵To keep the analysis concise, results for percentiles and income shares are presented only in the Appendix (in Figures 2.12 and 2.13) but with no loss of information, as they provide the same conclusions.

Figure 2.5 – Average post tax and transfer income by income group



two very distinct phases. The GR years were marked by a significant increase in redistribution, which completely cushioned the increase in market income inequality. Indeed, although market income inequality increased by 2.25 points between 2007 and 2009, redistribution increased by 2.19 points, leaving disposable income inequality practically unchanged. From 2010 onwards, however, the mitigation effect of taxes and transfers started to decrease (while still remaining at high levels). In 2010, market income inequality continued to increase, by 0.5 points, and redistribution increased only slightly, by 0.1, such that disposable income inequality also increased, by 0.4. In 2011 and 2012 however the situation reversed, with redistribution decreasing such that the change in disposable income inequality was actually higher than the change in market income inequality. Whereas the later decreased by 0.12 points during the two years, the former increased by 0.46 points, reflecting a decrease in redistribution of 0.58 points.

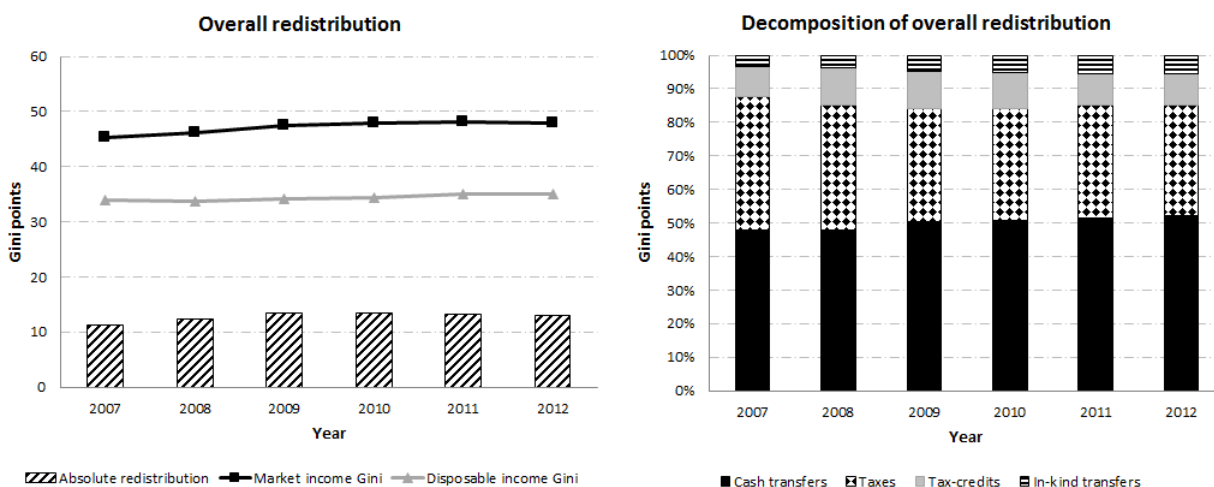
Figure 2.8 decomposes the changes in absolute redistribution into the contributions done by each

Table 2.5 – Gini-based redistribution measures

Variable	2007	2008	2009	2010	2011	2012
<i>Gini (X 100)</i>						
Pre-government	45,24	46,10	47,49	47,98	48,05	47,86
Post-cash-transfers	39,87	40,16	40,75	41,15	41,29	41,13
Post-tax	35,42	35,56	36,21	36,63	36,88	36,88
Post-tax-credits	34,41	34,18	34,76	35,20	35,66	35,67
Post-in-kind-transfers	34,04	33,72	34,10	34,49	34,94	34,95
<i>Change in Gini</i>						
Pre-government		0,86	1,39	0,49	0,07	-0,19
Post-cash-transfers		0,29	0,59	0,40	0,14	-0,16
Post-tax		0,14	0,65	0,41	0,25	0,01
Post-tax-credits		-0,23	0,58	0,44	0,46	0,01
Post-in-kind-transfers		-0,32	0,38	0,39	0,45	0,01
<i>Absolute redistribution</i>						
Cash-transfers	5,37	5,94	6,74	6,82	6,76	6,73
Taxes	4,45	4,59	4,54	4,52	4,41	4,25
Tax-credits	1,01	1,38	1,45	1,43	1,21	1,21
In-kind-transfers	0,37	0,46	0,66	0,71	0,72	0,72
Overall	11,20	12,38	13,39	13,49	13,11	12,91
<i>Relative redistribution</i>						
Cash-transfers	11,9%	12,9%	14,2%	14,2%	14,1%	14,1%
Taxes	9,8%	10,0%	9,5%	9,4%	9,2%	8,9%
Tax-credits	2,2%	3,0%	3,1%	3,0%	2,5%	2,5%
In-kind-transfers	0,8%	1,0%	1,4%	1,5%	1,5%	1,5%
Overall	24,8%	26,9%	28,2%	28,1%	27,3%	27,0%
<i>Weight in redistribution</i>						
Cash-transfers	48,0%	48,0%	50,3%	50,6%	51,6%	52,1%
Taxes	39,7%	37,1%	33,9%	33,5%	33,7%	32,9%
Tax-credits	9,0%	11,2%	10,9%	10,6%	9,2%	9,4%
In-kind-transfers	3,3%	3,7%	4,9%	5,3%	5,5%	5,6%
Overall	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
<i>Change in absolute redistribution</i>						
Cash-transfers		0,57	0,80	0,08	-0,07	-0,03
Taxes		0,15	-0,06	-0,01	-0,11	-0,16
Tax-credits		0,38	0,07	-0,02	-0,22	0,00
In-kind-transfers		0,09	0,20	0,05	0,01	0,00
Overall		1,18	1,01	0,10	-0,38	-0,19
<i>Contribution to change in redistribution</i>						
Cash-transfers		48,0%	79,4%	82,7%	17,5%	15,6%
Taxes		12,6%	-5,9%	-10,5%	28,6%	84,2%
Tax-credits		31,9%	7,1%	-24,3%	56,6%	-0,4%
In-kind-transfers		7,5%	19,4%	52,0%	-2,7%	0,6%
Overall		100,0%	100,0%	100,0%	100,0%	100,0%

Note: All statistics refer to per-person equivalised household income and consider individual weights.

Figure 2.6 – Absolute redistribution



type of redistributive instrument. As in the previous figure, the left-hand panel presents annual changes, while the right-hand panel presents cumulative changes. Several interesting conclusions also emerge. Between 2008 and 2009, cash transfers were clearly the main drivers of the increase in redistribution, accounting for 1.37 points of the overall increase of 2.19 points. Tax credits also contributed significantly, with its redistributive effect increasing by 0.45 points across the two years. They were followed by in-kind transfers, which contributed with an increase of 0.28 points. The smallest contribution was given by taxes, which increased by a total of only 0.09 points. In 2010, the small increase in redistribution was driven by the positive contributions of cash transfers and in-kind transfers, of 0.08 and 0.05 points, respectively. Tax credits and taxes, however, contributed negatively, with decreases of 0.02 and 0.01 in their redistributive effect, respectively. Between 2011 and 2012, all instruments but in-kind transfers contributed negatively to the change in redistribution. Taxes exhibited the most significant drop, of 0.27 points in total, followed by tax credits and cash transfers with drops of 0.22 points and 0.1 points, respectively. Overall, when considering the whole post-crisis period, cash transfers were clearly the most important contributor to the increase in redistribution, accounting for 1.35 points of the overall value of 1.71 points. In-kind transfers and tax credits also contributed positively although to a much smaller extent, with a change of 0.35 and 0.21 points, respectively. Taxes, however, contributed negatively, exhibiting a redistributive effect 0.19 points lower in 2012 than in 2007.

The finding that the tax and transfer system was crucial in offsetting a decrease in market incomes

Figure 2.7 – Change in absolute redistribution

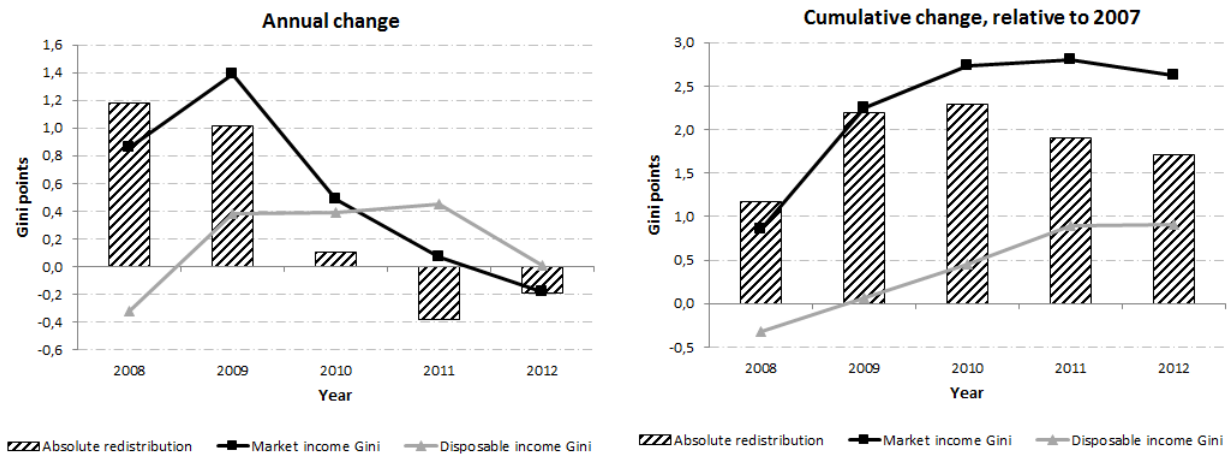
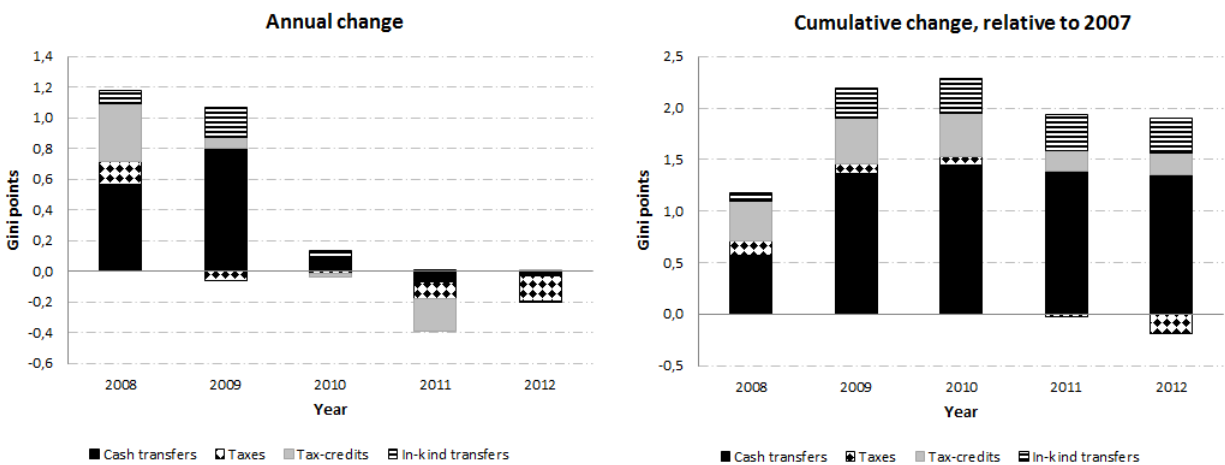


Figure 2.8 – Decomposition of change in absolute redistribution



and an increase in market income inequality during the GR years is common to other studies (Armour et al. (2015), Perri & Steinberg (2012), Thompson & Smeeding (2013)). The muting of these offsetting effects from 2009 onwards had also been referred to by some authors (Armour et al. (2015), Jenkins et al. (2013), Thompson & Smeeding (2013)), although based on preliminary data and a shorter time period. Thompson & Smeeding (2013), e.g., find that the Gini coefficient and the P90-P10 ratio fell between 2007 and 2009 (-0.8% and -2.9%, respectively) and then rose between 2009 and 2011 (3.0% and 3.8%, respectively). Perri & Steinberg (2012) find a decrease in the P50-P20 ratio between 2007 and 2009 and then an increase in 2010.

Finally, Figure 2.9 provides the decomposition of the redistributive effect of each instrument into

a size, progressivity and re-ranking effect as described in subsection 2.4.3²⁶. Results are depicted as an average over the whole post-crisis period and are multiplied by 100, for ease of exposition. We can see that the size effect is substantially higher for taxes than for cash transfers, in line with the results in Tables 2.3 and 2.4. However, cash transfers are considerably more progressive, which more than compensates their smaller size effect rendering them more effective in terms of redistribution. Interestingly, in-kind transfers are the most progressive instrument and tax credits are more progressive than taxes. However, due to their small size, these two instruments are considerably less redistributive than cash transfers or taxes. The re-ranking effect is small except for cash transfers, as they include pensions, which for many individuals determines a significant rise in their position in the income distribution. This however, does not change the results qualitatively, the same conclusions are obtained excluding the re-ranking effect.

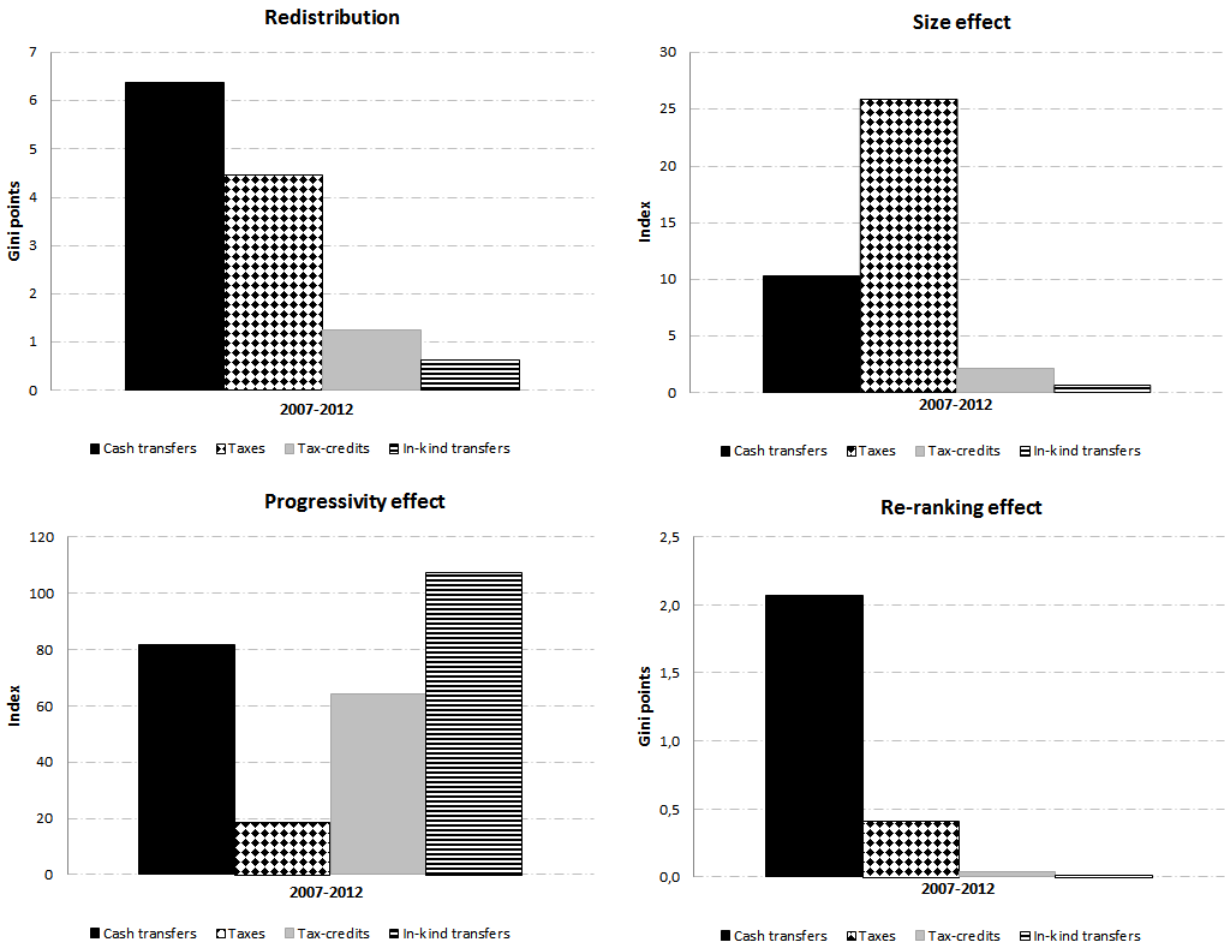
A discussion of the key results

The analysis done in this subsection reveals a number of facts about the role of taxes and transfers in shaping distributional developments following the 2007-2008 crisis. As previously mentioned, the methodology used in this paper does not allow for the establishment of a strict causal link between these facts and the changes in the tax and transfer system that occurred after the crisis, as described in section 2.3 and subsection 2.5.2. Nevertheless, some common patterns can be discussed, unveiling potential connections between these developments.

Over the whole 2007-2012 period, taxes and transfers were crucial at taming the rise in market income inequality observed after the 2007-2008 crisis. The substantial increase in the amount of resources made available to American households through the tax and transfer system seems to have had not only an important stimulus effect but also a significant redistributive effect. This is particularly true for cash transfers, in line with unprecedented increases in unemployment benefits and with smaller although non-negligible increases in welfare and social security benefits. These increases are likely to reflect the functioning of automatic stabilisers, with unemployment and other benefits increasing mechanically due to an increase in unemployment, as well as the discretionary measures introduced by the EUC, the ARRA and the MCTRA, which increased both the duration

²⁶One should note that technically, transfers and tax credits are regressive as they decline at higher income levels and therefore their progressivity index is negative. Likewise, their size index is negative, as they represent a "negative tax rate". The combination of a negative progressivity index with a negative size indicator results in a positive redistributive effect. To allow for a simpler interpretation, both indices are presented here as positive.

Figure 2.9 – Drivers of redistribution



and magnitudes of several benefits. Tax-credits and in-kind transfers also contributed positively to the increase in redistribution observed over the 2007-2012 period. In the case of tax-credits, this is likely to reflect to a large extent the extraordinary rebates that were introduced by the ESA and the ARRA as well as the extension of the so-called "Bush tax cuts" provided by the MCTRA and the ATRA. In the case of in-kind transfers, the observed higher redistributive effect is presumably closely associated with the increases in funding and access to the SNAP given in the FCEA and the ARRA. Changes in taxes contributed the least to the increase in redistribution. This is likely to result from the low degree of progressivity of the American tax system on the one hand, and the reduction in the FICA tax rate introduced in the MCTRA on the other hand, which benefitted more individuals with medium to high earnings.

Despite its positive effect, the redistributive system did not fully cushion the distributional impacts

of the crisis. Five years into the start of the crisis, disposable income inequality was still above its pre-crisis level, with higher income groups being close to having fully recovered from their crisis-led income losses, while lower income groups were still experiencing non-negligible losses. The system was only capable of preventing the bottom and the middle of the distribution from growing apart, but not the top from distancing itself relative to both the bottom and the middle.

This evolution reflects two very distinct phases: the GR years, when redistribution increased significantly and fully cushioned the increase in market income inequality, such that disposable income inequality did not increase; the recovery years, when redistribution decreased and disposable income inequality grew more than market income inequality. These two phases match two distinct moments in the setting of tax and transfer policies. It was during the GR years that the bulk of the stimulus measures were taken, which provided substantial extraordinary tax credits, significant increases in SNAP and energy assistance, an unprecedented extension of unemployment benefits, and increases in several other benefits. From 2010 onwards, the stimulus effort was reduced, with many of the previous measures being phased out or scaled back. It is likely that the decrease in redistribution after 2009 also reflects the slow-growing recovery that began to take place. Nevertheless, it seems plausible that the reduction in stimulus efforts may have accounted for an important part of this decrease. The setting of tax and transfer policies may have missed the true persistence of the adverse distributional consequences of the crisis, determining a premature unwind of the measures that had a crucial cushioning effect in the immediate crisis aftermath.

2.6 Concluding remarks

This paper analysed in detail the evolution of income inequality and the cushioning effect of the tax and transfer system following the 2007-2008 financial and economic crisis, in the US.

A crucial finding is that the crisis led to a strong and persistent increase in market income inequality. This was largely driven by dramatic and persistent losses for lower income households, which contrasted with weaker and more transitory losses for higher income ones. The tax and transfer system was key at cushioning these adverse distributional effects, with redistribution increasing and disposable income inequality rising significantly less than market income inequality. The increase in redistribution is likely to reflect not only the effect of automatic stabilisers but also discretionary

changes introduced in the tax and transfer system following the crisis. These changes were substantial and across the board, including an increase in the duration and magnitude of several cash-transfers, in particular unemployment benefits, the introduction of extraordinary tax credits, and an increase in the amounts of in-kind transfers, in particular food assistance.

Despite its positive effect, the redistributive system did not fully cushion the distributional impacts of the crisis. Five years into the onset of the crisis, disposable income inequality was still above its pre-crisis level, with higher income groups being close to having fully recovered from their crisis-led income losses, while lower income groups were still experiencing non-negligible losses. The system was only capable of preventing the bottom and the middle of the distribution from growing apart, but not the top from distancing itself relative to both the bottom and the middle. Importantly, this evolution reflected two very distinct phases. The first one corresponded to the GR years, when redistribution increased significantly and fully cushioned the increase in market income inequality, such that disposable income inequality did not increase. This was the period during which the bulk of the stimulus measures were taken. The second one corresponded to the recovery years, when redistribution decreased and disposable income inequality grew more than market income inequality. This period was marked by a clear reduction of the stimulus effort, with many of the previous measures being gradually phased out or scaled back. These results suggest that tax and transfer policies may have missed the true persistence of the negative distributional consequences of the crisis, determining a premature unwind of the measures taken in the immediate crisis aftermath, fueling a rise in inequality.

The analysis done in this paper provides clear evidence on the link between income inequality and the business cycle, showing that aggregate crises may have substantial heterogeneous impacts across the income distribution, being particularly penalising for lower income groups. It underscores the importance of having well designed redistributive policies that promote a more equal sharing of the burden of adjustment to income losses in a crisis context. In particular, it sheds light on the need to account for a significant persistence in losses for households at the bottom of the income distribution, and the importance of choosing an appropriate policy mix, with a stronger focus on the most progressive instruments, which are more targeted to lower income groups.

2.7 Appendix

2.7.1 Unit of analysis and equivalence scales

When doing distributional analyses, the ultimate source of concern is typically the welfare of the individual. However, an individual is usually not the appropriate choice for income unit as it fails to capture the fact that economic decisions are largely made at the household level (in particular labour-supply decisions) and that a substantial sharing of resources occurs among members of a given household. For instance, children and spouses working at home do not have recorded income, but may nevertheless enjoy a high standard of living as a result of income sharing with parents and spouses. To consider these individuals as enjoying zero income would be misleading. An alternative is to pool the income of all individuals living in the same household and consider the household as the unit of income and analysis, with one household corresponding to one observation in the income distribution. This, however, is also misleading as it completely ignores differences in household size and composition, which naturally affect the true living standards of its members. For instance, individuals living in a household of four people with a total income of 400 euros will enjoy a smaller standard of living than a single individual receiving the same 400 euros.

A more sensible way to proceed is to compute person-equivalised household income measures. These consider the household as the unit of income but the person as the unit of analysis, adjusting household income by dividing it by an equivalence scale to arrive at a measure of equivalent per-person income. They take into account the fact that economies of scale typically exist at the household level, since there are expenses that do not increase with the size of the household (internet connection, e.g.) and savings that can arise by buying large quantities. A typical formulation is one where Equivalence scale = $(\text{Household size})^\alpha$. This formulation implicitly considers that adults and children are counted equally. An alternative formulation takes into account differences in the composition of the household: instead of considering each element of the household as one unit of the household size, weights are attributed to each element, according to their importance in the household's budget. These typically give less weight to children than to adults and often differentiate between the first child and the following ones. This is the case for the official OECD equivalence scale, e.g.. The value of α determines the amount of economies of scale considered. $\alpha = 1$ implies that equivalised income is simply per capita income, in which case there are no economies of scale. $\alpha = 0$ implies

that equivalised income is equal to household income, in which case there are infinite economies of scale. I consider the intermediate value of $\alpha = 1/2$, which is the one typically considered in studies performing income distribution analysis (see e.g. Jenkins (1995), Armour et al. (2013), Thompson & Smeeding (2013) or CBO (2014)). This implies, e.g., that a household composed by two people with total income equal to 200 is equivalent to two separate individuals earning 141 each. With no economies of scale ($\alpha = 1$) it would be equivalent to each individual earning 100, whereas with full economies of scale ($\alpha = 0$) it would be equivalent to each individual earning 200.

2.7.2 Income variables

Labour earnings

Labour earnings correspond to each respondent's pre-tax wages and salaries, i.e. income received as an employee.

Self-employment earnings

Self-employment earnings indicates each respondent's pre-tax income accruing to any activity where the respondent is working directly for her own benefit, as opposed to working for an employer. It is split into non-farm (or business) and farm self-employment earnings. The former corresponds to income coming from a personal business and/or professional practice, while the later corresponds to income obtained as a tenant farmer, sharecropper or operator on an own farm. Income earned as an employee on a farm is a part of labour earnings.

These are net concepts, obtained after deducting all expenses from gross receipts. They may therefore assume negative values.

Private transfers

Private transfers correspond to all pre-tax income received from friends or family members (or ex members), not living in the same household. They include:

- Child alimony: child support payments made from one ex-spouse to the other. They are tax deductible to the person who pays it and taxable income to the person who receives it.

- Child support: similar to child alimony but a non-deductible expense for the payer and tax-free income for the receiver.
- Friends and family assistance: income obtained from regular financial assistance from friends or relatives, not living in the same household.
- Retirement funds (private): payments received from a private pension or retirement scheme. These include company or union pension, regular payments from annuities or paid-up insurance policies and regular payments from IRA, KEOGH or 401K.
- Disability benefits (private): payments received as a result of a health condition, disability or handicap, from a private source. Include company or union disability funds and private accident/disability insurance payments.
- Survivor's benefits (private): payments received as a dependent of a deceased worker, from a private source. Include company or union survivor pensions, regular payments from estates or trusts and regular payments from annuities or paid-up life insurance.
- Worker's compensation (private): payments received as a result of a job-related injury or illness, from private entities. Includes employer's insurance and own insurance. Distinct from non-work related sick and disability payments, which are counted as disability benefits.
- Educational assistance (private): financial aid given by private entities for studies beyond the high school level. Can cover tuition fees, books or living expenses while attending school. Includes non-governmental scholarships and grants and financial assistance from employers, friends or relatives (excluding household members).
- Other sources: income from non-specified sources. Includes small amounts of income from hobbies, severance pay and foster child care.

Net asset income

Net asset income corresponds to all financial pre-tax income received by the respondent. It includes:

- Interests: on saving accounts, certificates of deposit, money market funds, bonds, treasury notes, IRAs, and other investments paying interest.

- Dividends: from stocks and mutual funds.
- Rents: from charges to roomers or boarders and from money paid by estates, trusts and royalties. It is a net concept, obtained after deducting all expenses. It may therefore assume negative values.

Public cash transfers

Public cash transfers correspond to all pre-tax cash income received from the government. They include:

- Social security (SS): payments to retired persons, dependents of deceased insured workers (survivors) and disabled workers, funded by workers' contributions to social security.
- Supplemental security income (SSI): means-tested, non-contributory income assistance given to needy aged, blind and disabled adults and children who have limited income and resources.
- Unemployment Insurance benefits: payments provided by the government to unemployed people, funded in large part by state and federal payroll taxes levied against employers. Generally, unemployed people who meet certain eligibility requirements can receive unemployment insurance for a maximum of 26 weeks. The US Department of Labor oversees the system, but each state administers its own program, with eligibility conditions and maximum benefit levels differing from state to state. Unemployment insurance benefit income is subject to both Federal and State government income tax, but is exempted from social security taxes.
- Welfare (public assistance): non-contributory financial aid aimed at insuring a minimal level of well-being and social support for all citizens. Includes several instruments in particular: the Temporary Assistance for Needy Families (TANF), which provides cash assistance to eligible indigent families with dependent children, being limited to a federal lifetime limit of 60 months (states may decide on shortening or extending this limit); the General Assistance Program, which is the equivalent of the TANF for persons without dependent children; the Emergency Assistance, which is provided to people who are homeless, at immediate risk of becoming homeless or having experienced a substantial loss of housing, food, clothing or household furnishings due to fire, flood or similar disaster.

- Veteran's compensation (VC): payments provided to veterans by the Veteran's Administration. May include service-related disability compensation, survivor's benefits, pensions, educational assistance, among others.
- Retirement funds (public, non-SS, non-VC): retirement-related payments received from the government, excluding social security and veteran's compensation. Includes federal, state and local government employee pensions, and US military and railroad retirement.
- Disability benefits (public, non-SS, non-VC): payments received from the government, as a result of a health condition, disability or handicap, excluding social security and veteran's compensation. Includes federal, state and local government employee disability and US military and railroad disability.
- Survivor's benefits (public, non-SS, non-VC): payments received from the government, as a dependent of a deceased worker, excluding social security and veteran's compensation. Includes federal, state and local government and US military and railroad employee survivor benefits.
- Workers's Compensation (public): payments received from the government as a result of a job-related injury or illness. Distinct from non-work related sick and disability payments, which are counted as disability benefits.
- Educational assistance (public): non-contributory financial aid given by the state to people studying beyond the high school level. Can cover tuition, fees, books or living expenses while attending school. Includes Pell grants and other aid from government sources.

Taxes

Taxes correspond to all direct personal income taxes levied by the government. They include:

- Federal income tax: provides for several federal government spending needs in particular for national programs such as defense, foreign affairs, law enforcement, and interest on the national debt.
- State income tax: collected by most states (currently 43), in addition to the federal income tax, to account for state-level spending needs. The spending mix varies from state to state, but a significant amount is typically devoted to education, health care and infrastructures.

- Social Security Payroll Deduction (Federal Insurance Contributions Act (FICA)): taxes imposed on labour earnings to finance social security benefits and Medicare (which provides health care for the elderly).
- Federal retirement payroll deduction: taxes imposed on labour earnings of people employed by the federal government, to help fund retirement benefits via programs such as Civil Service Retirement System (CSRS) or Federal Employees Retirement Systems (FERS).

Tax credits

Tax credits are tax incentives which allow certain taxpayers to subtract the amount of the credit from the total tax liabilities they owe the state. A credit directly reduces tax bills, unlike tax deductions and tax exemptions, which indirectly reduce tax bills by reducing the size of the base from which the tax bill is calculated. Tax credits can be nonrefundable, meaning that they can only be used to the point at which no more taxes are owed, or refundable, meaning that if the credit exceeds the amount of taxes owed, the difference is received by the taxpayer as a cash payment. They include:

- Earned income tax credit (EITC): refundable tax credit that reduces or eliminates the amount of income tax of low-to moderate-income working individuals and couples, particularly those with children. Operates as a wage subsidy for low-income workers. The amount attributed depends on the household's income and composition (e.g. single, couple without children, couple with one child).
- Child tax credit: tax credit given to low-to moderate-income working people with dependent children, as a function of the household's income and the number of children, according to some qualification criteria that must be met by each child (concerning age, relationship, support, dependence, citizenship and residence).
- Additional child tax credit: if the child tax credit exceeds the household's tax liability, the "unused" portion of the credit is refundable as the additional child tax credit.
- Stimulus: part of the Economic Stimulus Act of 2008, provided payments, in the form of refundable tax payments, to persons with a 2008 tax liability or with 3000 dollars in "qualifying income". Ranged from 300 dollars for single people without a tax liability to 1200 for married

couples with a tax liability. For households with dependent children, additional 300 dollar payments per “qualifying child” were given (see section 2.3 for a more thorough description).

- Making work pay tax credit: extraordinary refundable tax credit, provided only in 2009 and 2010 as a part of the American Recovery and Reinvestment Act (ARRA) of 2009. Available to all working single taxpayers earning between \$8100 and \$95000 per year and joint filers earning between \$8100 and \$190000 per year. It gave up to 400 dollars for individuals and up to 800 dollars for joint fillers.

In-kind transfers

Public in-kind-transfers correspond to transfers given or paid by the government in goods, commodities, or services, instead of cash. They include:

- Supplement nutrition assistance program (SNAP) (formerly known as the Food stamp program): food-purchasing assistance given to eligible low-income people. They are provided at the household level, with the amount of assistance each household gets depending on the household’s size, income, and expenses. For most of its history, the program used paper-denominated "stamps" or coupons bound into booklets of various denominations, to be torn out individually and used in single-use exchange. Since 2004 stamps have been replaced by a specialised debit card system known as Electronic Benefit Transfer (EBT), in all states. Each month, SNAP food stamp benefits are directly deposited into the household’s EBT card account. Households may use EBT to pay for food at supermarkets, convenience stores, and other food retailers, including certain farmers’ markets. They are not included in the means test of any other benefit and are not taxable. They are given indefinitely, as long as eligibility conditions are fulfilled.
- Low income home energy assistance program (LIHEAP): initiatives that assist low-income people in managing energy associated costs, in particular: home energy bills, energy crises, weatherisation and energy-related minor home repairs.

2.7.3 Data

The CPS is a statistical survey sponsored jointly by the US Census Bureau and the US Bureau of Labor Statistics (BLS), corresponding to the primary source of labor force statistics for the population

of the United States. It provides individual and household-level data on a wide range of issues relating to employment and income, as well as sociodemographic conditions.

The sample is representative of the civilian noninstitutional population, including members of the armed forces who live in off-base housing or on base with their families. The sampling is done at the household level, with households selected using a multistage stratified statistical sampling scheme, and interviewed under a 4-8-4 rotating panel design²⁷. Each household is interviewed for 4 successive months, then not interviewed for 8 months, then returned to the sample for 4 months after that. While it is sometimes possible to follow households from one year to the next, it is not always possible to match records across consecutive years. Thus, we ignore the limited panel dimension of the CPS, and treat it as a pure cross section.

The basic CPS has a monthly frequency, and focuses on labor force statistics. It considers a sample of approximately 60,000 households. Several supplements complement the basic CPS, containing information on additional topics and in some cases having a different frequency. The ASEC, which has been running since 1962, applies to the sample surveyed in March and extends the basic set of sociodemographic and labour force questions to include detailed questions on income for each household member aged 15 or older. For the ASEC supplement, the basic CPS monthly sample is extended to include an additional 4,500 Hispanic households (since 1976), and an additional 34,500 households (since 2001) as part of an effort to improve estimates of children's health insurance. This constitutes the so-called State Children's Health Insurance Program (SCHIP) sample, which is the one used in this study.

Tables 2.6 and 2.7 provide some basic information on the characteristics of the sample. Table 2.6 gives the number of observations at both the individual and household levels, for each of the years included in the sample, both unweighted and weighted (using individual weights for individuals and household weights for households). Table 2.7 gives descriptive statistics on some relevant sociodemographic characteristics of the individuals in the sample, namely: age group, sex, race, marital status, education level, employment status and class of worker. These statistics are computed using individual weights.

In Tables 2.8 and 2.9, information is given on aggregate income measures, as defined in subsection

²⁷A "household" is defined as all persons, related or unrelated, living together in a dwelling unit. It contrasts with a "tax unit" or "family", defined as all persons living together who are related by blood, marriage or adoption. A household can be composed by more than one tax unit or family.

2.4.2. All statistics are based on person-equivalised household income, weighted using individual weights (which corresponds to what is done in the distributional analysis performed in section 4.4). Table 2.8 considers the full sample, while Table 2.9 considers only individuals for whom the value of each aggregate is higher than zero, i.e. those who effectively benefit from that type of income. The last column of Table 2.9 gives the fraction that these individuals represent out of the whole sample.

Tables 2.10 and 2.11 provide the same type of information for the four main categories of redistributive mechanisms considered in this study, together with all their components.

Table 2.6 – Number of observations by year

Year	Households	Individuals
<i>Non weighted</i>		
2007	75 510	205 660
2008	76 154	207 809
2009	76 215	209 647
2010	75 164	204 909
2011	74 366	201 361
2012	74 802	202 589
Total	452 211	1 231 975
<i>Weighted</i>		
2007	116 297 894	297 944 628
2008	117 216 356	301 356 799
2009	118 450 185	304 053 000
2010	119 952 675	306 429 561
2011	121 138 353	308 767 580
2012	122 520 230	311 050 965
Total	715 575 693	1 829 602 533

Table 2.7 – Descriptive statistics of sociodemographic characteristics

Variable	Freq	% Freq
Sex		
Male	897 188 029	49%
Female	934 185 210	51%
Age group		
Child (age<15)	366 874 552	20%
Working age (15=age=65)	1 244 048 310	68%
Older (age>65)	220 450 377	12%
Race		
White	1 443 616 273	79%
Black	234 051 448	13%
Other	153 705 518	8%
Marital status		
Married	751 053 592	41%
Divorced or separated	178 324 524	10%
Widow	85 848 876	5%
Single	816 146 247	45%
Education		
Up to middle school	79 494 486	4%
Secondary school, no diploma	185 146 512	10%
Secondary school, diploma	423 016 330	23%
Higher education, no diploma	270 986 481	15%
Higher education, diploma	505 854 878	28%
NIU (children)	366 874 552	20%
Employment status		
Armed forces	5 532 086	0%
Employed	844 525 579	46%
Unemployed	78 333 329	4%
NILF (not in labour force)	536 107 693	29%
NIU (children)	366 874 552	20%
Class of worker		
Armed forces	5 532 086	0%
Self-employed	93 879 019	5%
Private entity employee	699 507 037	38%
Government employee	132 085 425	7%
NIU (children and NILF)	900 369 672	49%

Notes:

¹Age is top-coded at 80 years; average age is 37.

²Statistics are computed using individual weights.

³The total number of observations is 1 829 602 533 for all variables.

Table 2.8 – Descriptive statistics of income aggregates, full sample

Variable	Mean	Median	Min	Max	N
Pre-government income	28 753	22 839	-17 526	296 731	1 829 602 533
Post-cash-transfers income	32 047	25 935	-14 819	325 166	1 829 602 533
Post-tax income	25 561	22 330	-14 819	244 228	1 829 602 533
Post-tax-credits income	26 153	22 932	-14 819	244 228	1 829 602 533
Post-in-kind-transfers income	26 305	22 965	-14 819	244 228	1 829 602 533

Notes:

¹All statistics are in dollars, except for N (N as a %), which refers to the number (proportion) of individuals.

²All statistics refer to per-person equivalised household income and use individual weights.

Table 2.9 – Descriptive statistics of income aggregates, only positive values

Variable	Mean	Median	Min	Max	N	N as % of all individuals
Pre-government income	30 636	24 580	0	296 731	1 717 339 078	94%
Post-cash-transfers income	32 410	26 215	0	325 166	1 809 182 843	99%
Post-tax income	25 851	22 552	0	244 228	1 809 165 119	99%
Post-tax-credits income	26 450	23 153	0	244 228	1 809 173 424	99%
Post-in-kind-transfers income	26 514	23 124	0	244 228	1 815 286 507	99%

Notes:

¹All statistics are in dollars, except for N (N as a %), which refers to the number (proportion) of individuals.

²All statistics refer to per-person equivalised household income and consider individual weights.

Table 2.10 – Descriptive statistics of redistributive mechanisms, full sample

Variable	Mean	Median	Min	Max	N
<i>Cash transfers</i>					
Social security (SS)	2 027	0	0	67 290	1 829 602 533
Supplemental security income (SSI)	155	0	0	27 471	1 829 602 533
Unemployment benefits	264	0	0	77 698	1 829 602 533
Welfare	29	0	0	20 100	1 829 602 533
Veteran's compensation	138	0	0	77 698	1 829 602 533
Retirement benefits (non SS)	546	0	0	69 930	1 829 602 533
Disability benefits (non SS)	27	0	0	38 318	1 829 602 533
Survivor's benefits (non SS)	36	0	0	47 899	1 829 602 533
Worker's compensation	19	0	0	54 941	1 829 602 533
Educational assistance	52	0	0	25 149	1 829 602 533
<i>Overall</i>	<i>3 294</i>	<i>0</i>	<i>0</i>	<i>116 548</i>	<i>1 829 602 533</i>
<i>Taxes</i>					
Federal income tax	3 592	1 365	0	108 043	1 829 602 533
State income tax	989	358	0	80 398	1 829 602 533
SS payroll tax (FICA)	1 853	1 467	0	37 458	1 829 602 533
Federal retirement payroll tax	51	0	0	58 050	1 829 602 533
<i>Overall</i>	<i>6 486</i>	<i>3 456</i>	<i>0</i>	<i>181 131</i>	<i>1 829 602 533</i>
<i>Tax credits</i>					
Earned income tax credit (EITC)	198	0	0	3 369	1 829 602 533
Child tax credit	168	0	0	2 234	1 829 602 533
Additional child tax credit	73	0	0	1 776	1 829 602 533
Stimulus	74	0	0	1 523	1 829 602 533
Making work pay credit	79	0	0	871	1 829 602 533
<i>Overall</i>	<i>592</i>	<i>359</i>	<i>0</i>	<i>4 444</i>	<i>1 829 602 533</i>
<i>In-kind transfers</i>					
Nutritional assistance (SNAP)	147	0	0	8 039	1 829 602 533
Energy assistance (LIHEAP)	6	0	0	1 607	1 829 602 533
<i>Overall</i>	<i>152</i>	<i>0</i>	<i>0</i>	<i>8 978</i>	<i>1 829 602 533</i>

Notes:

¹All statistics are in dollars, except for N (N as a %), which refers to the number (proportion) of individuals.

²All statistics refer to per-person equivalised household income and consider individual weights.

Table 2.11 – Descriptive statistics of redistributive mechanisms, only positive values

Variable	Mean	Median	Min	Max	N	N as % of all individuals
<i>Cash transfers</i>						
Social security (SS)	9 035	8 359	0,4	67 290	410 500 435	22,4%
Supplemental security income (SSI)	3 701	3 130	0,3	27 471	76 716 883	4,2%
Unemployment benefits	3 034	1 948	0,3	77 698	159 252 896	8,7%
Welfare	1 381	1 083	0,3	20 100	39 060 142	2,1%
Veteran's compensation	6 311	4 004	0,4	77 698	39 885 242	2,2%
Retirement benefits (non SS)	13 214	11 318	0,3	69 930	75 592 066	4,1%
Disability benefits (non SS)	6 573	4 753	0,4	38 318	7 569 632	0,4%
Survivor's benefits (non SS)	8 134	5 911	0,4	47 899	8 114 234	0,4%
Worker's compensation	3 807	2 190	0,3	54 941	9 213 626	0,5%
Educational assistance	3 032	2 054	0,3	25 149	31 449 318	1,7%
<i>Overall</i>	<i>8 806</i>	<i>6 876</i>	<i>0,3</i>	<i>116 548</i>	<i>684 395 154</i>	<i>37,4%</i>
<i>Taxes</i>						
Federal income tax	4 986	2 636	0,2	108 043	1 318 176 200	72,0%
State income tax	1 482	884	0,3	80 398	1 221 351 587	66,8%
SS payroll tax (FICA)	2 187	1 785	1,3	37 458	1 550 177 143	84,7%
Federal retirement payroll tax	2 722	2 258	1,7	58 050	34 539 597	1,9%
<i>Overall</i>	<i>7 252</i>	<i>4 207</i>	<i>0,4</i>	<i>181 131</i>	<i>1 636 490 857</i>	<i>89,4%</i>
<i>Tax credits</i>						
Earned income tax credit (EITC)	893	859	0,3	3 369	405 521 010	22,2%
Child tax credit	540	464	0,3	2 234	570 960 009	31,2%
Additional child tax credit	467	425	0,4	1 776	284 700 459	15,6%
Stimulus	527	536	0,5	1 523	257 000 104	14,0%
Making work pay credit	307	306	0,4	871	471 707 062	25,8%
<i>Overall</i>	<i>940</i>	<i>726</i>	<i>0,3</i>	<i>4 444</i>	<i>1 152 472 468</i>	<i>63,0%</i>
<i>In-kind transfers</i>						
Nutritional assistance (SNAP)	1 308	1 228	3,8	8 039	205 143 458	11,2%
Energy assistance (LIHEAP)	189	145	0,3	1 607	56 696 335	3,1%
<i>Overall</i>	<i>1 252</i>	<i>1 143</i>	<i>0,4</i>	<i>8 978</i>	<i>222 741 003</i>	<i>12,2%</i>

Notes:

¹All statistics are in dollars, except for N (N as a %), which refers to the number (proportion) of individuals.

²All statistics refer to per-person equivalised household income and consider individual weights.

2.7.4 Findings

Table 2.12 – Summary measures of income inequality

Variable	Levels						% Change relative to 2007				
	2007	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
<i>Gini index</i>											
Pre-government	0,45	0,46	0,47	0,48	0,48	0,48	1,9%	5,0%	6,1%	6,2%	5,8%
Post-cash-transfers	0,40	0,40	0,41	0,41	0,41	0,41	0,7%	2,2%	3,2%	3,6%	3,2%
Post-tax	0,35	0,36	0,36	0,37	0,37	0,37	0,4%	2,2%	3,4%	4,1%	4,1%
Post-tax-credits	0,34	0,34	0,35	0,35	0,36	0,36	-0,7%	1,0%	2,3%	3,6%	3,6%
Post-in-kind-transfers	0,34	0,34	0,34	0,34	0,35	0,35	-0,9%	0,2%	1,3%	2,6%	2,7%
<i>P90-P20 ratio</i>											
Pre-government	7,32	7,97	8,97	9,40	9,27	9,25	8,8%	22,4%	28,4%	26,6%	26,3%
Post-cash-transfers	5,17	5,23	5,39	5,60	5,55	5,58	1,2%	4,3%	8,4%	7,4%	7,9%
Post-tax	4,16	4,20	4,32	4,47	4,51	4,51	0,8%	3,9%	7,3%	8,3%	8,4%
Post-tax-credits	3,89	3,88	3,92	4,04	4,13	4,13	-0,4%	0,8%	3,7%	6,0%	6,2%
Post-in-kind-transfers	3,85	3,82	3,83	3,92	4,01	4,02	-0,8%	-0,6%	1,6%	3,9%	4,2%
<i>P90-P50 ratio</i>											
Pre-government	2,57	2,66	2,77	2,80	2,82	2,82	3,5%	7,9%	9,1%	9,8%	9,7%
Post-cash-transfers	2,39	2,44	2,50	2,51	2,53	2,51	2,0%	4,4%	4,9%	5,7%	4,7%
Post-tax	2,09	2,12	2,15	2,16	2,20	2,18	1,5%	3,1%	3,6%	5,2%	4,6%
Post-tax-credits	2,05	2,05	2,10	2,11	2,16	2,15	-0,2%	2,2%	2,8%	5,1%	4,6%
Post-in-kind-transfers	2,05	2,05	2,10	2,11	2,15	2,15	-0,3%	2,1%	2,6%	4,9%	4,5%
<i>P50-P20 ratio</i>											
Pre-government	2,85	3,00	3,24	3,36	3,29	3,29	5,2%	13,5%	17,6%	15,2%	15,2%
Post-cash-transfers	2,16	2,14	2,16	2,23	2,19	2,23	-0,7%	-0,1%	3,3%	1,6%	3,1%
Post-tax	1,99	1,98	2,01	2,06	2,05	2,07	-0,6%	0,8%	3,6%	3,0%	3,7%
Post-tax-credits	1,90	1,89	1,87	1,91	1,91	1,92	-0,1%	-1,4%	0,9%	0,8%	1,5%
Post-in-kind-transfers	1,88	1,87	1,83	1,86	1,86	1,87	-0,5%	-2,6%	-1,0%	-0,9%	-0,3%

Notes:

¹All statistics refer to per-person equivalised household income and consider individual weights.

Table 2.13 – Income percentiles

Variable	Levels						% Change relative to 2007				
	2007	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
P10											
Pre-government	2 381	1 843	1 346	918	856	916	-22,6%	-43,5%	-61,5%	-64,0%	-61,5%
Post-cash-transfers	8 040	7 662	7 342	7 028	7 074	7 074	-4,7%	-8,7%	-12,6%	-12,0%	-12,0%
Post-tax	7 451	7 177	6 885	6 627	6 754	6 691	-3,7%	-7,6%	-11,1%	-9,4%	-10,2%
Post-tax-credits	8 325	8 233	8 037	7 738	7 745	7 640	-1,1%	-3,5%	-7,0%	-7,0%	-8,2%
Post-in-kind-tranfers	8 688	8 679	8 692	8 346	8 447	8 322	-0,1%	0,0%	-3,9%	-2,8%	-4,2%
P25											
Pre-government	11 390	10 466	9 428	9 015	9 158	9 075	-8,1%	-17,2%	-20,8%	-19,6%	-20,3%
Post-cash-transfers	15 102	14 461	14 002	13 668	13 501	13 501	-4,2%	-7,3%	-9,5%	-10,6%	-10,6%
Post-tax	13 699	13 214	12 912	12 570	12 575	12 603	-3,5%	-5,7%	-8,2%	-8,2%	-8,0%
Post-tax-credits	14 330	14 149	13 953	13 583	13 431	13 430	-1,3%	-2,6%	-5,2%	-6,3%	-6,3%
Post-in-kind-tranfers	14 412	14 265	14 180	13 844	13 688	13 643	-1,0%	-1,6%	-3,9%	-5,0%	-5,3%
P50											
Pre-government	24 905	23 534	22 431	22 055	21 889	21 916	-5,5%	-9,9%	-11,4%	-12,1%	-12,0%
Post-cash-transfers	27 416	26 388	25 746	25 558	25 219	25 219	-3,8%	-6,1%	-6,8%	-8,0%	-8,0%
Post-tax	23 224	22 450	22 185	21 966	22 051	22 159	-3,3%	-4,5%	-5,4%	-5,0%	-4,6%
Post-tax-credits	23 625	23 438	22 897	22 655	22 457	22 534	-0,8%	-3,1%	-4,1%	-4,9%	-4,6%
Post-in-kind-tranfers	23 631	23 467	22 931	22 702	22 510	22 561	-0,7%	-3,0%	-3,9%	-4,7%	-4,5%
P75											
Pre-government	42 241	40 758	40 034	39 860	39 440	39 736	-3,5%	-5,2%	-5,6%	-6,6%	-5,9%
Post-cash-transfers	44 341	42 971	42 638	42 466	42 237	42 237	-3,1%	-3,8%	-4,2%	-4,7%	-4,7%
Post-tax	35 153	34 234	34 218	34 070	34 338	34 384	-2,6%	-2,7%	-3,1%	-2,3%	-2,2%
Post-tax-credits	35 455	35 177	34 838	34 668	34 608	34 631	-0,8%	-1,7%	-2,2%	-2,4%	-2,3%
Post-in-kind-tranfers	35 455	35 182	34 840	34 682	34 611	34 636	-0,8%	-1,7%	-2,2%	-2,4%	-2,3%
P90											
Pre-government	63 919	62 487	62 118	61 778	61 703	61 710	-2,2%	-2,8%	-3,3%	-3,5%	-3,5%
Post-cash-transfers	65 646	64 424	64 347	64 223	63 843	63 843	-1,9%	-2,0%	-2,2%	-2,7%	-2,7%
Post-tax	48 504	47 582	47 755	47 507	48 447	48 388	-1,9%	-1,5%	-2,1%	-0,1%	-0,2%
Post-tax-credits	48 526	48 034	48 066	47 837	48 480	48 406	-1,0%	-0,9%	-1,4%	-0,1%	-0,2%
Post-in-kind-tranfers	48 526	48 035	48 069	47 837	48 480	48 406	-1,0%	-0,9%	-1,4%	-0,1%	-0,2%

Notes:

¹All statistics refer to per-person equalised household income and consider individual weights.

Table 2.14 – Average income by income groups

Variable	Levels						% Change relative to 2007				
	2007	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Bottom 10											
Pre-government	382	249	133	70	63	60	-34,9%	-65,1%	-81,7%	-83,6%	-84,3%
Post-cash-transfers	4 558	4 251	4 024	3 776	3 743	3 743	-6,7%	-11,7%	-17,2%	-17,9%	-17,9%
Post-tax	4 234	3 998	3 785	3 575	3 584	3 589	-5,6%	-10,6%	-15,6%	-15,4%	-15,2%
Post-tax-credits	4 751	4 665	4 430	4 149	4 091	4 122	-1,8%	-6,8%	-12,7%	-13,9%	-13,2%
Post-in-kind-transfers	5 276	5 262	5 209	4 926	4 897	4 947	-0,3%	-1,3%	-6,6%	-7,2%	-6,2%
Bottom 20											
Pre-government	3 064	2 637	2 183	1 932	1 954	1 975	-13,9%	-28,8%	-37,0%	-36,2%	-35,6%
Post-cash-transfers	7 464	7 141	6 866	6 546	6 540	6 540	-4,3%	-8,0%	-12,3%	-12,4%	-12,4%
Post-tax	6 917	6 654	6 411	6 120	6 207	6 168	-3,8%	-7,3%	-11,5%	-10,3%	-10,8%
Post-tax-credits	7 612	7 540	7 350	7 024	6 993	6 954	-0,9%	-3,4%	-7,7%	-8,1%	-8,6%
Post-in-kind-transfers	7 988	7 986	7 965	7 658	7 637	7 614	0,0%	-0,3%	-4,1%	-4,4%	-4,7%
Bottom 50											
Pre-government	11 316	10 465	9 598	9 266	9 241	9 277	-7,5%	-15,2%	-18,1%	-18,3%	-18,0%
Post-cash-transfers	14 941	14 323	13 912	13 552	13 461	13 461	-4,1%	-6,9%	-9,3%	-9,9%	-9,9%
Post-tax	13 247	12 785	12 513	12 209	12 293	12 282	-3,5%	-5,5%	-7,8%	-7,2%	-7,3%
Post-tax-credits	13 847	13 711	13 410	13 081	12 976	12 962	-1,0%	-3,2%	-5,5%	-6,3%	-6,4%
Post-in-kind-transfers	14 025	13 934	13 731	13 431	13 325	13 310	-0,7%	-2,1%	-4,2%	-5,0%	-5,1%
Top 50											
Pre-government	49 777	48 073	47 350	47 116	46 825	46 908	-3,4%	-4,9%	-5,3%	-5,9%	-5,8%
Post-cash-transfers	51 853	50 356	50 066	49 751	49 499	49 499	-2,9%	-3,4%	-4,1%	-4,5%	-4,5%
Post-tax	39 361	38 248	38 366	38 115	38 641	38 712	-2,8%	-2,5%	-3,2%	-1,8%	-1,6%
Post-tax-credits	39 602	39 016	38 883	38 624	38 858	38 918	-1,5%	-1,8%	-2,5%	-1,9%	-1,7%
Post-in-kind-transfers	39 605	39 021	38 893	38 641	38 869	38 928	-1,5%	-1,8%	-2,4%	-1,9%	-1,7%
Top 20											
Pre-government	72 127	70 062	69 685	69 319	69 243	69 019	-2,9%	-3,4%	-3,9%	-4,0%	-4,3%
Post-cash-transfers	74 000	72 022	72 037	71 590	71 506	71 506	-2,7%	-2,7%	-3,3%	-3,4%	-3,4%
Post-tax	53 262	51 755	52 204	51 896	52 930	52 908	-2,8%	-2,0%	-2,6%	-0,6%	-0,7%
Post-tax-credits	53 331	52 251	52 511	52 209	52 983	52 953	-2,0%	-1,5%	-2,1%	-0,7%	-0,7%
Post-in-kind-transfers	53 332	52 253	52 514	52 216	52 983	52 955	-2,0%	-1,5%	-2,1%	-0,7%	-0,7%
Top 10											
Pre-government	89 502	86 970	86 658	86 172	86 260	85 755	-2,8%	-3,2%	-3,7%	-3,6%	-4,2%
Post-cash-transfers	91 342	88 779	88 912	88 309	88 469	88 469	-2,8%	-2,7%	-3,3%	-3,1%	-3,1%
Post-tax	63 498	61 572	62 243	61 887	63 096	63 027	-3,0%	-2,0%	-2,5%	-0,6%	-0,7%
Post-tax-credits	63 520	61 890	62 446	62 102	63 113	63 042	-2,6%	-1,7%	-2,2%	-0,6%	-0,8%
Post-in-kind-transfers	63 520	61 897	62 448	62 107	63 115	63 043	-2,6%	-1,7%	-2,2%	-0,6%	-0,8%

Notes:

¹All statistics refer to per-person equalised household income and consider individual weights.

Table 2.15 – Income shares by income groups

Variable	Levels						Change in p.p. relative to 2007				
	2007	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Bottom 10											
Pre-government	0,1%	0,1%	0,0%	0,0%	0,0%	0,0%	0,0%	-0,1%	-0,1%	-0,1%	-0,1%
Post-cash-transfers	1,4%	1,3%	1,3%	1,2%	1,2%	1,2%	-0,1%	-0,1%	-0,2%	-0,2%	-0,2%
Post-tax	1,6%	1,6%	1,5%	1,4%	1,4%	1,4%	0,0%	-0,1%	-0,2%	-0,2%	-0,2%
Post-tax-credits	1,8%	1,8%	1,7%	1,6%	1,6%	1,6%	0,0%	-0,1%	-0,2%	-0,2%	-0,2%
Post-in-kind-transfers	2,0%	2,0%	2,0%	1,9%	1,9%	1,9%	0,0%	0,0%	-0,1%	-0,1%	-0,1%
Bottom 20											
Pre-government	2,0%	1,8%	1,5%	1,4%	1,4%	1,4%	-0,2%	-0,5%	-0,6%	-0,6%	-0,6%
Post-cash-transfers	4,5%	4,4%	4,3%	4,2%	4,2%	4,2%	-0,1%	-0,2%	-0,3%	-0,3%	-0,3%
Post-tax	5,3%	5,2%	5,0%	4,9%	4,9%	4,8%	0,0%	-0,2%	-0,4%	-0,4%	-0,4%
Post-tax-credits	5,7%	5,7%	5,6%	5,4%	5,4%	5,4%	0,0%	-0,1%	-0,3%	-0,3%	-0,3%
Post-in-kind-transfers	6,0%	6,0%	6,1%	5,9%	5,9%	5,8%	0,1%	0,1%	-0,1%	-0,1%	-0,1%
Bottom 50											
Pre-government	18,5%	17,9%	16,9%	16,5%	16,5%	16,5%	-0,6%	-1,7%	-2,1%	-2,0%	-2,0%
Post-cash-transfers	22,4%	22,1%	21,7%	21,4%	21,4%	21,4%	-0,2%	-0,6%	-1,0%	-1,0%	-1,0%
Post-tax	25,2%	25,1%	24,6%	24,3%	24,1%	24,1%	-0,1%	-0,6%	-0,9%	-1,0%	-1,1%
Post-tax-credits	25,9%	26,0%	25,6%	25,3%	25,0%	25,0%	0,1%	-0,3%	-0,6%	-0,9%	-0,9%
Post-in-kind-transfers	26,2%	26,3%	26,1%	25,8%	25,5%	25,5%	0,2%	-0,1%	-0,4%	-0,6%	-0,7%
Top 50											
Pre-government	81,5%	82,1%	83,1%	83,5%	83,5%	83,5%	0,6%	1,7%	2,1%	2,0%	2,0%
Post-cash-transfers	77,6%	77,9%	78,3%	78,6%	78,6%	78,6%	0,2%	0,6%	1,0%	1,0%	1,0%
Post-tax	74,8%	74,9%	75,4%	75,7%	75,9%	75,9%	0,1%	0,6%	0,9%	1,0%	1,1%
Post-tax-credits	74,1%	74,0%	74,4%	74,7%	75,0%	75,0%	-0,1%	0,3%	0,6%	0,9%	0,9%
Post-in-kind-transfers	73,8%	73,7%	73,9%	74,2%	74,5%	74,5%	-0,2%	0,1%	0,4%	0,6%	0,7%
Top 20											
Pre-government	47,2%	47,9%	48,9%	49,2%	49,4%	49,1%	0,7%	1,7%	2,0%	2,2%	1,9%
Post-cash-transfers	44,3%	44,5%	45,0%	45,2%	45,4%	45,4%	0,2%	0,7%	0,9%	1,1%	1,1%
Post-tax	40,5%	40,6%	41,0%	41,2%	41,6%	41,5%	0,1%	0,5%	0,7%	1,1%	1,0%
Post-tax-credits	39,9%	39,6%	40,2%	40,4%	40,9%	40,8%	-0,3%	0,3%	0,5%	1,0%	0,9%
Post-in-kind-transfers	39,8%	39,5%	39,9%	40,1%	40,6%	40,5%	-0,3%	0,1%	0,3%	0,8%	0,8%
Top 10											
Pre-government	29,3%	29,7%	30,4%	30,6%	30,8%	30,5%	0,4%	1,1%	1,3%	1,5%	1,2%
Post-cash-transfers	27,4%	27,4%	27,8%	27,9%	28,1%	28,1%	0,1%	0,4%	0,5%	0,7%	0,7%
Post-tax	24,1%	24,1%	24,5%	24,6%	24,8%	24,7%	0,0%	0,3%	0,5%	0,6%	0,6%
Post-tax-credits	23,8%	23,5%	23,9%	24,0%	24,4%	24,3%	-0,3%	0,1%	0,2%	0,6%	0,5%
Post-in-kind-transfers	23,7%	23,4%	23,7%	23,8%	24,2%	24,1%	-0,3%	0,1%	0,2%	0,5%	0,5%

Notes:

¹All statistics refer to per-person equalised household income and consider individual weights.

Figure 2.10 – Market income percentiles

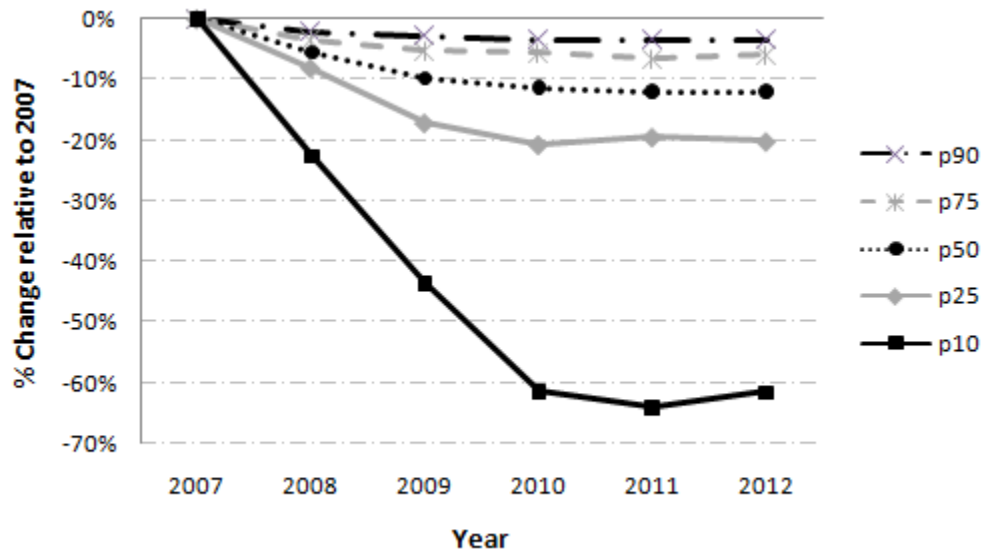


Figure 2.11 – Market income shares by income group

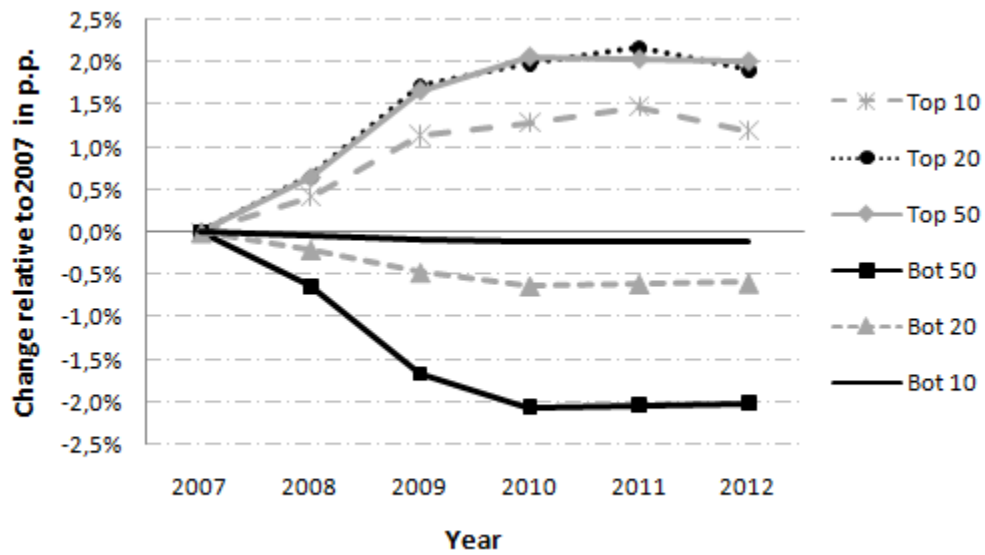


Figure 2.12 – Post tax and transfer income percentiles

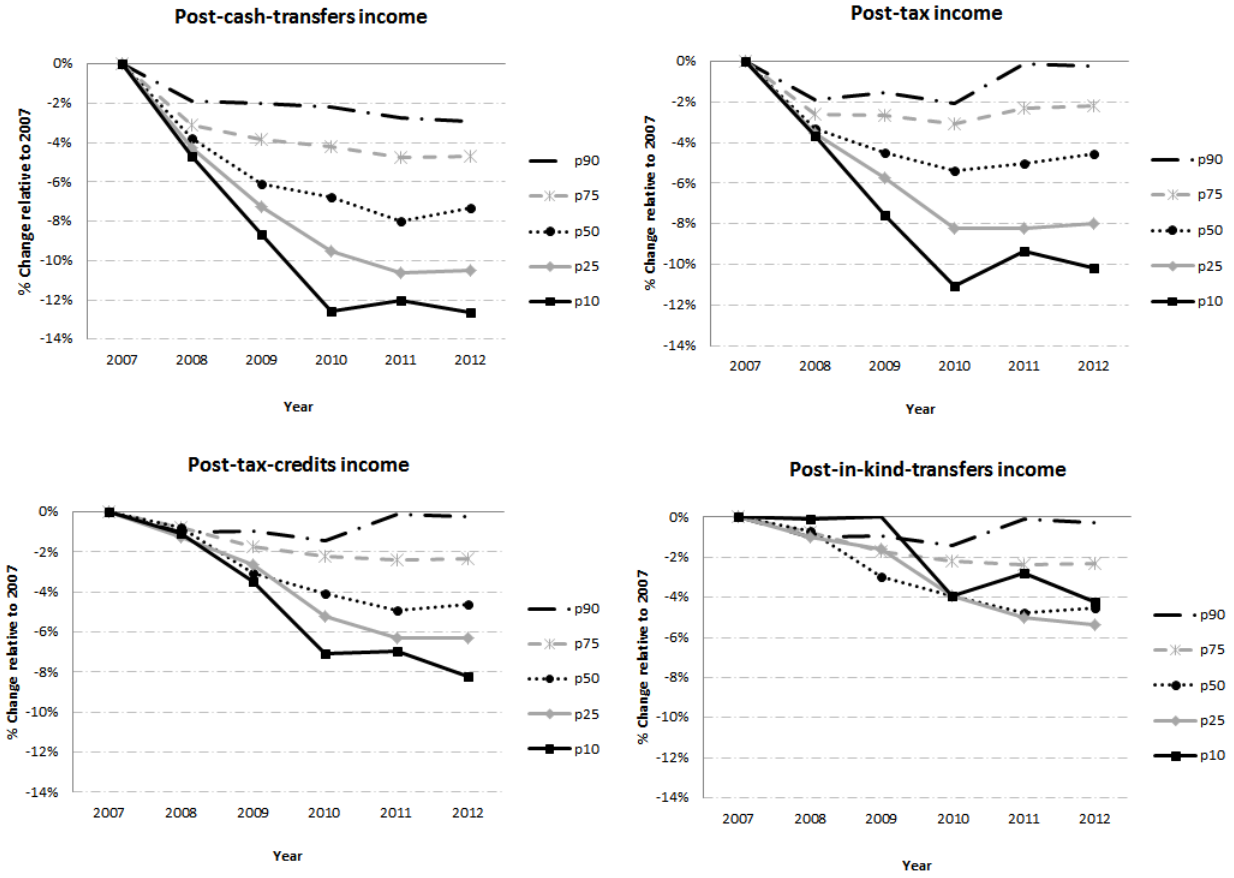
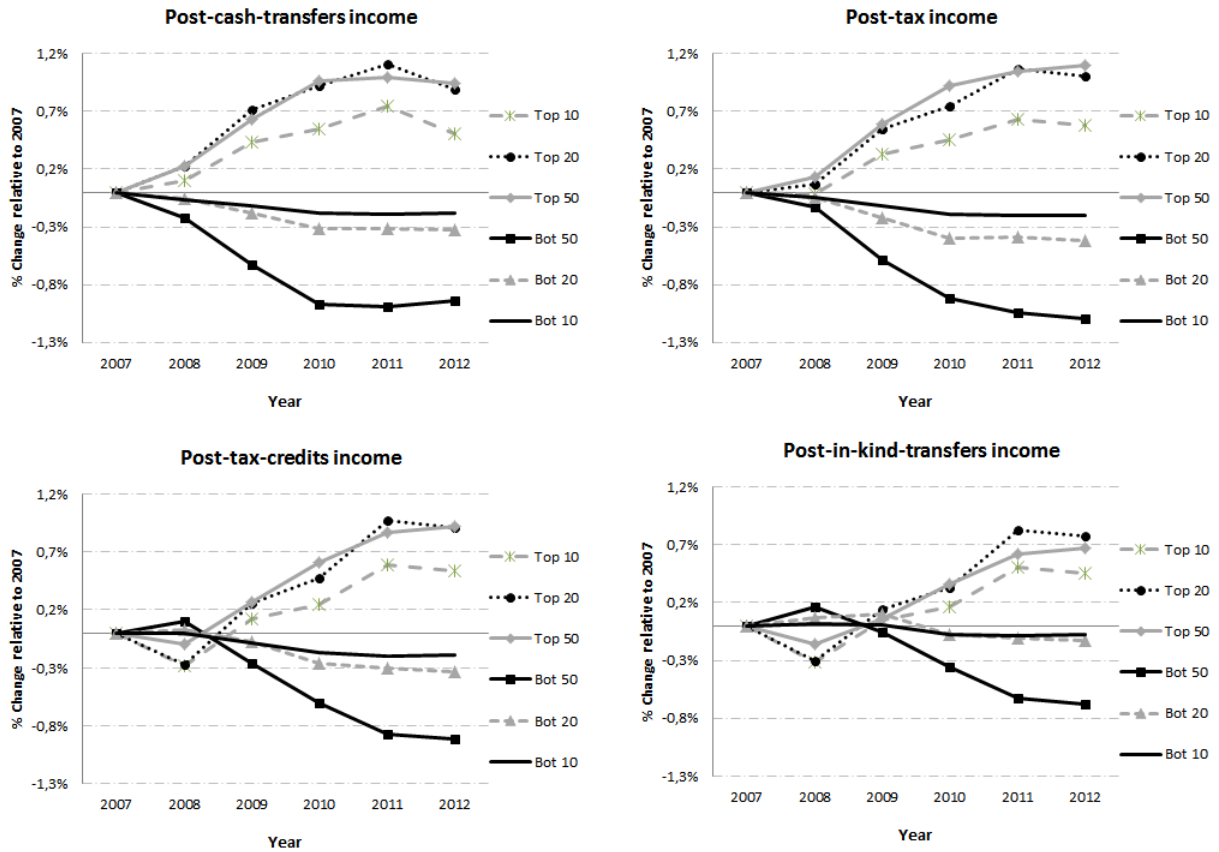


Figure 2.13 – Post tax and transfer income shares by income group



Chapter 3

Accounting for the distributional effects of the 2007-2008 crisis and the Economic Adjustment Program in Portugal¹

¹This chapter is a result of a joint work with Denisa M. Sologon from the Luxembourg Institute of Socio-Economic Research (LISER) and Philippe Van Kerm from the LISER and the University of Luxembourg. This work is part of the SimDeco project (*Tax-benefit systems, employment structures and cross-country differences in income inequality in Europe: a micro-simulation approach*) supported by the National Research Fund, Luxembourg (grant C13/SC/5937475). We are indebted to the many people who have contributed to the development of EUROMOD, which is maintained, developed and managed by the ISER at the University of Essex and the Joint Research Centre (JRC) of the European Commission, in collaboration with national teams from the EU member states.

Abstract

This paper develops a new method to model the household disposable income distribution and decompose changes in this distribution (or functionals such as inequality measures) over time. It integrates both a micro-econometric and microsimulation approaches, combining a flexible parametric modelling of the distribution of market income with the EUROMOD microsimulation model to simulate the value of taxes and benefits. The method allows for the quantification of the contributions of four main factors to changes in the disposable income distribution between any two years: (i) labour market structure; (ii) returns; (iii) demographic composition; and (iv) tax-benefit system. We apply this new framework to the study of changes in the income distribution in Portugal between 2007 and 2013, accounting for the distributional effects of the 2007-2008 crisis and aftermath policies, in particular the Economic Adjustment Program (EAP). Results show that these effects were substantial and reflected markedly different developments over two periods: 2007-2009, when stimulus packages determined important income gains for the bottom of the distribution and a decrease in income inequality; 2010-2013, when the crisis and austerity measures took a toll on the incomes of Portuguese households, particularly those at the bottom and top of the distribution, leading to an increase in income inequality.

JEL codes: D31, H23, I38, J21, J31

Keywords: Income distribution; Income inequality; Inequality decomposition; Microsimulation; Tax-benefit system; Crisis; Austerity measures; Overtime comparison

3.1 Introduction

Understanding what drives changes in income distributions over time is a central issue in economic research and policy analysis. Various strategies have been used in the literature to investigate this important topic. Traditional approaches compute one particular inequality summary index in two different moments in time and then use decomposition methods to break down the observed changes into the contribution of a number of components (these are typically based on the methodologies proposed in Reynolds & Smolensky (1977), Shorrocks (1980), Shorrocks (1982), Shorrocks (1984) and Lerman & Yitzhaki (1985)). A second strand of literature focuses on modelling the market income distribution using parametric and semi-parametric econometric techniques and building counterfactual scenarios that allow for an assessment of the contributions of various factors to the overall evolution of the distribution (see for example Juhn, Murphy & Pierce (1993), DiNardo, Fortin & Lemieux (1996) and Bourguignon, Ferreira & Leite (2008)). Finally, there is a sizeable literature that departs from an observed fixed market income distribution and focuses on assessing the role of the tax-benefit system in determining changes in the disposable income distribution, through the use of tax-benefit microsimulation models (see for example Bourguignon & Spadaro (2006) and Bargain (2014)).

These strategies, while interesting and useful in their own right, are limited in their scope, as they refer to the analysis of either a summary measure or only one part of the income distribution, be it market incomes or taxes and benefits. In this paper we propose a new method that tackles these limitations, allowing for the modelling of the whole household disposable income distribution and a detailed assessment of the anatomy and drivers of changes in this distribution (or functionals such as inequality measures) between any two moments in time. This is a methodological development, and constitutes one of our two main contributions to the literature. We build on the approach developed in Sologon et al. (2018), adapting it to study changes in income distributions over time for one single country instead of differences in income distributions across countries in one given moment. The method integrates both a micro-econometric and microsimulation approaches, combining a flexible parametric modelling of the distribution of household market income with the EUROMOD model to simulate the value of taxes and benefits. We generate a multitude of counterfactual income distributions, obtained by "swapping" the characteristics of the country in two different moments in time along four main dimensions: (i) labour market structure; (ii) returns; (iii) demographic

composition; and (iv) tax-benefit system. The comparison of these counterfactual distributions then allows us to quantify the contribution of each dimension to the changes in the income distribution (and functionals) observed between any two moments in time. The model is constructed on the basis of the European Union Statistics on Income and Living Conditions (EU-SILC) survey, a household survey that is available in a harmonised form for all European Union (EU) countries. The fact that the model relies on EU-SILC data and uses the pan-European EUROMOD microsimulation tool is a particularly useful feature, as it gives the model the potential to be easily adapted to examine changes in income distributions over time in any EU country.

We apply this new framework to the study of changes in the income distribution in Portugal between 2007 and 2013. This was a particularly intense period for the Portuguese economy, comprising: (i) the "direct" impacts of the 2007-2008 crisis; (ii) the effects of a fiscal stimulus package adopted in 2008 and 2009; and (iii) the effects of fiscal consolidation measures taken from 2010 onwards, particularly in the context of the Economic Adjustment Program (EAP). The richness and complexity of the post 2007-2008 crisis Portuguese experience make it a particularly suitable choice for an application of our framework. By studying the changes in the disposable income distribution that occurred during this period and decomposing them into the contributions of several key factors we are able to shed light on the distributional consequences of the crisis and aftermath policies. This gives important information for decision makers on the design of crisis-coping policies and fiscal consolidation programs. Although the aggregate effects of crises and fiscal consolidation episodes have been extensively investigated in the literature, only more recently have their distributional effects began to be studied in detail (see for e.g. Agnello & Sousa (2012), Ball, Furceri, Leigh & Loungani (2013), Bova, Kinda, Zhang & Woo (2013), Rawdanowicz, Wurzel & Christensen (2013)). Our work provides an innovative empirical assessment of this issue, focusing on one particularly relevant case study, which constitutes our second main contribution to the literature. Results show that the distributional effects of the post 2007-2008 crisis in Portugal were substantial, and reflected markedly different developments over two periods: 2007-2009, when stimulus packages determined important income gains for the bottom of the distribution and a decrease in income inequality; 2010-2013, when the crisis and austerity measures took a toll on the incomes of Portuguese households, particularly those at the bottom and top of the distribution, leading to an increase in income inequality.

The remainder of the paper is organised as follows: Section 4.2 discusses the motivation and

reviews related literature, presenting the paper's main contributions; Section 3.3 introduces the methodology used to model the household disposable income distribution and decompose changes in this distribution over time; Section 3.4 presents the context and results of the illustrative application done to Portugal between 2007 and 2013; Section 3.5 concludes and discusses some policy implications.

3.2 Motivation, related literature and main contributions

Various strategies have been used to analyse changes in the distribution of income over time. Traditional approaches compute one particular inequality summary index in two different moments in time and then use decomposition methods to break down the observed changes into the contribution of a number of components, such as sources of income or population groups. These are typically based on the methodologies proposed in the seminal works of Reynolds & Smolensky (1977), Shorrocks (1980), Shorrocks (1982), Shorrocks (1984) and Lerman & Yitzhaki (1985). Approaches like these, while useful and widely used, have a number of shortcomings. First, they do not allow for an analysis of the full income distribution, being limited to inequality summary measures. Second, they are typically restricted to a fairly small number of components and cannot account for the interactions between the effects of the different components. Third, when measuring the redistributive effect of the tax and transfer system, they are not able to disentangle the pure effect of policy changes from the effect of automatic stabilisers.

The shortcomings of traditional approaches have been tackled in two main strands of literature. The first strand has focused on refining the analysis of the market income distribution, with a special focus on labour earnings (which is typically the main component of market income) starting with the works by Juhn et al. (1993) and DiNardo et al. (1996). Both papers focus on modelling the individual wage distribution and are a generalisation of the Oaxaca-Blinder decomposition (Oaxaca (1973) and Blinder (1973)), which provides a decomposition of differences in wage means for particular population groups into price and endowment effects. Juhn et al. (1993) complement the parametric approach of Oaxaca-Blinder with a specific way of computing the distribution of residuals. DiNardo et al. (1996) develop a semi-parametric procedure that improves the estimation of counterfactual wage distributions by finding the appropriate weights that render comparison between samples easier by making one sample "more like" the other sample in some particular respect. A step further was

taken by Bourgignon et al. (2008) who extended the previous approaches in essentially two ways: by considering the household as a unit of measure instead of the individual; by incorporating the role of differences in household composition (including fertility behavior) and in the occupational structure of household members. Although capable of identifying important sources of differences between market income distributions, this work did not include an analysis of how differences in tax and transfer systems could contribute to differences in the entire household disposable income. Assessing the contribution of the tax and transfer system to changes in the household disposable income distribution has been the focus of the second strand of literature, which essentially relies on the use of tax-benefit microsimulation models (for a general assessment see for example Bourgignon & Spadaro (2006) and Bargain (2014)). These models depart from a sample of individuals obtained from a household survey, containing information on their market income and socio-demographic characteristics, and then plug the prevailing rules of the tax-benefit system to simulate the values of taxes and benefits corresponding to each individual. This enables the construction of counterfactual scenarios, where different instruments of the system are changed one at a time, keeping market income constant, which allows for a disentanglement of the effects of discretionary policy changes from the effects of changes in the underlying economic environment in which the system operates.

Each of these strategies, while interesting and useful in its own right, is unable to give by itself a full picture of the anatomy and drivers of changes in the household disposable income distribution. In this paper, we develop a new framework that tackles this limitation bringing existing approaches together, allowing for a thorough analysis of the characteristics and determinants of changes in the full household disposable income distribution (or functionals such as inequality measures) between any two moments in time. We build on the approach developed in Sologon et al. (2018). The authors combine the strategy in Bourgignon et al. (2008) to model the household market income distribution with the EUROMOD microsimulation model to compute the value of taxes and benefits, and this way obtain a full representation of the entire household disposable income distribution. From this representation they construct a methodological apparatus that is capable of identifying multiple sources of differences in income distributions across countries. They apply this apparatus to a comparison of the UK and Ireland distributions, using 2007 as the reference year. The present work build on this apparatus but adapts it to study changes in income distributions over time for one single country instead of differences in income distributions across countries. In particular, we

are able to not only study changes between two moments in time, but to break down these changes into the contributions of different sub-periods. This is a methodological development, that brings us one step forward in our ability to understand distributional developments, and constitutes one of our two main contributions to the literature. Indeed, to the best of our knowledge, our work is the first one to provide a framework that allows to disentangle in detail and in an unified way the determinants of changes in the market income distribution and the effects of changes in the tax and transfer system. A particularly useful feature of our model is that it builds on the EU-SILC data and uses EUROMOD for the simulation of taxes and benefits. Both the EU-SILC and EUROMOD are available in a harmonised form for all EU countries, and therefore our model can potentially be adapted to study changes in the income distribution over time of any EU country.

Our second main contribution is an empirical one, related to the assessment of the distributional impacts of aggregate crises and fiscal consolidation programs. While the aggregate effects of crises and fiscal consolidation episodes have been extensively investigated in the literature, only more recently have their distributional effects began to be studied in detail, motivated to a large extent by developments following the 2007-2008 crisis (see for e.g. Agnello & Sousa (2012), Ball et al. (2013), Bova et al. (2013), Rawdanowicz et al. (2013)). In general, these studies find that: (i) periods of crisis and fiscal consolidation are typically associated with increases in income inequality; (ii) consolidations undertaken during recessions are particularly harmful; and (iii) spending-based adjustments produce larger distributional effects than taxes-based ones. We contribute to this literature by using our new framework to study one particularly interesting and informative case study, the post 2007-2008 crisis period in Portugal. As discussed in Subsection 3.4.1, this period was marked by profound changes in the Portuguese economy due to both the "direct" impact of the crisis and the effects of post-crisis policy actions, including the EAP signed between the Portuguese government and the Troika, which promoted the implementation of severe austerity measures. The richness and complexity of the post 2007-2008 crisis Portuguese experience make it a particularly suitable choice for an application of our framework. Some studies have already provided valuable evidence on post-crisis distributional developments in Portugal (see for e.g. Avram, Figari, Leventi, Levy, Navicke, Matsaganis, Militaru, Paulus, Rastringina & Sutherland (2013), Rodrigues, Figueiras & Junqueira (2016) and Callan, Doorley & Savage (2018)). Although these studies differ in their methodologies and scope, some common main findings can be identified: (i) in the early stages of the crisis aftermath there was

a decrease in disposable income inequality and an increase in average income, while following the introduction of austerity measures there was an increase in disposable income inequality and a strong decrease in average income; (ii) the burden of the adjustment process fell more heavily on poorer and richer households than on middle-income households, giving rise to an inverted u-shaped effect; (iii) direct tax increases had a progressive effect, cuts to non pension benefits had a regressive effect, the effect of cuts in public wages and employment and in pensions is less clear-cut. Our work extends the existing evidence on the Portuguese case, providing more detailed and new insights into the impacts of the different main channels through which the crisis and the EAP operated on the full income distribution, based on an explicit modelling of each of these channels. This way, we hope to contribute to a deeper understanding of the changes in the income distribution between the pre and post crisis periods, and enable a more informed discussion about the consequences of the crisis and the EAP and the design of crisis-coping policies.

3.3 A method to model the household disposable income distribution and decompose changes over time

In this section we present in detail the method developed in this work, which allows for a modelling of the full household disposable income distribution and an analysis of the anatomy and determinants of changes in this distribution (or functionals such as inequality measures) over time. The method builds on the approach developed in Sologon et al. (2018), adapting it to study changes in income distributions over time for one country instead of differences in income distributions across countries.

We start by modelling three sources of market income (labour, capital and other), estimating separately the probability of receipt and the level. Having obtained estimates for market incomes we then feed these values into EUROMOD to estimate the value of different types of taxes and benefits. Adding benefits to market income and subtracting taxes we obtain an estimated value of disposable income for each household from which we can construct the full household disposable income distribution and compute any functional of interest. Changes in this distribution (or functionals) are then decomposed into the contributions of four main factors: (i) labour market structure; (ii) returns; (iii) demographic composition; and (iv) tax-benefit system. These contributions are estimated by simulating and comparing a sequence of counterfactual distributions obtained by swapping the

characteristics of the economy in each year along the four main dimensions considered.

Below we describe these steps in detail. In Subsection 3.3.1, we provide an overview of the different income components that we model. In Subsection 3.3.2, we present the parametric specifications used to model market incomes. In Subsection 3.3.3, we describe how taxes and benefits are computed using EUROMOD. Finally, in Subsection 3.3.4, we explain how counterfactual distributions are generated and the mechanics of the decomposition exercise.

3.3.1 Household disposable income components

We examine five main components of household disposable income, y_h , distinguishing between market and non-market income. Household market income is given by the sum of household gross labour incomes, y_h^L , household capital incomes, y_h^K , and other household non-benefit pre-tax incomes, y_h^O . Household non-market income corresponds to the difference between household public benefits, y_h^B , and household direct taxes, y_h^T . Household disposable income is then given by:

$$y_h = \underbrace{y_h^L + y_h^K + y_h^O}_{\text{Market}} + \underbrace{y_h^B - y_h^T}_{\text{Non-market}} \quad (3.1)$$

Most of these five components are themselves aggregates of smaller components of income (notably contributions of individuals to overall household income), which we model separately in order to have a representation that is defined at a fine level of disaggregation. We provide the main aspects of this disaggregation below, leaving the details for the next two sections.

Market incomes

For each component of market income, income is estimated at the individual level, and then for each household the incomes of all individual members are added to obtain the household's income. Each component is disaggregated into two sources: *Labour income* into employment (emp) and self-employment (semp) income; *Capital income* into investment (inv) and property (prop) income; and *Other non-benefit pre-tax income* into private pensions (pripem) and a catch-all concept that aggregates all other non-benefit individual incomes (mainly private transfers such as alimonies) (other). For each income source, we first estimate a binary participation indicator equal to one if the individual receives that type of income and zero otherwise and then, for the individuals receiving it, we estimate

the level. For labour income, we first estimate a binary indicator equal to one if the individual is working and zero otherwise and then, for those individuals working, we assign the estimated income from employment and self-employment. We then have:

$$y_h^L = \sum_{i=1}^{n_h} I_{hi}^{lab} (I_{hi}^{emp} y_{hi}^{emp} + I_{hi}^{semp} y_{hi}^{semp}) \quad (3.2)$$

$$y_h^K = \sum_{i=1}^{n_h} (I_{hi}^{inv} y_{hi}^{inv} + I_{hi}^{prop} y_{hi}^{prop}) \quad (3.3)$$

$$y_h^O = \sum_{i=1}^{n_h} (I_{hi}^{pripen} y_{hi}^{pripen} + I_{hi}^{other} y_{hi}^{other}) \quad (3.4)$$

where: n_h is the total number of individuals in household h ; I_{hi}^{lab} is an indicator equal to one if individual i belonging to household h (individual hi from now on) is working; and for $S \in \{\text{emp, semp, inv, prop, pripen, other}\}$, I_{hi}^S is an indicator equal to one if individual hi receives any income from source S , and y_{hi}^S refers to the amount of income received from that source by individual hi .

Non-market incomes

Non-market incomes are obtained by feeding EUROMOD with the individual-level estimates of market incomes, together with the corresponding socio-demographic characteristics. *Benefits* are composed of a range of individual-level replacement incomes (including retirement and survivor pensions and disability, sickness and unemployment benefits), household-level means-tested social assistance (including housing support) and universal (non means-tested) transfers (including child support). For simplicity we will refer to three broad household-level aggregates: public pensions (pens), means-tested benefits (mtb) and non-means-tested benefits (nmtb):

$$y_h^B = y_h^{pens} + y_h^{mtb} + y_h^{nmtb} \quad (3.5)$$

Direct taxes are given by the sum of income taxes (tax) paid at the household level and social security contributions (ssc) paid at the individual level. They are determined by the tax schedule in place as a function of the vector of gross incomes (i.e. market income plus benefits) and household

characteristics and composition:

$$y_h^T = y_h^{tax} + \sum_{i=1}^{n_h} y_{hi}^{ssc} \quad (3.6)$$

3.3.2 Parametric modelling of market incomes

The modelling of market income builds heavily on the method developed in Bourignon et al. (2008), relying on hierarchically structured, parametric, multiple equation specifications for each detailed source of market income. Each income source is represented as a combination of three types of elements: (i) a set of basic household and individual observable characteristics; (ii) a vector of parameters describing how the receipt and level of income vary with the observable characteristics; and (iii) a vector of household-specific residuals, linking the predictions from the model to the observed values of income. We give special attention to the modelling of labour income, in order to be able to capture in detail the rich contribution provided by different aspects of the labour market structure and wage compensation to the evolution of market income.

An important note should be made at this point. In our setting, model parameters are not meant to capture causal relationships between the various endogenous and exogenous variables considered. The parametric relationships are reduced-form projections that aim to describe the empirical associations between basic conditioning variables and various components of income. The objective is to use these estimated projections to pinpoint the key sources of changes in income distributions over time, whether they mainly arise from differences in population characteristics, from how these characteristics determine income differences or from residual heterogeneity.

Participation indicators

The modelling of each market income source starts by the estimation of a participation indicator for each individual, capturing whether the individual is receiving income from that particular source. In addition, in the case of labour income, a labour market participation indicator is considered, to capture whether the individual is working and therefore receiving income from one or both sources of labour income. All these indicators are modelled in an analogous way, using a binary logistic regression model, and therefore we start by giving a general description of this procedure.

Consider any income source s for which we wish to estimate a participation indicator for individual

hi , I_{hi}^s , equal to one if the individual receives any amount of income from that source and zero otherwise. It is assumed that the outcome of this binary variable depends on the value of a continuous latent variable, I_{hi}^{s*} , being equal to one when this value is positive and zero otherwise, i.e. $I_{hi}^s = 1$ if $I_{hi}^{s*} > 0$ and $I_{hi}^s = 0$ otherwise. The latent variable in turn depends linearly on a set of observable characteristics, x_{hi} , and on an error term, ϵ_{hi}^s , such that $I_{hi}^{s*} = x_{hi}\gamma^s + \epsilon_{hi}^s$. We then have $I_{hi}^s = \mathbf{1}[\epsilon_{hi}^s > -x_{hi}\gamma^s]$, where $\mathbf{1}[cond]$ is equal to one if $cond$ is true and zero otherwise. The logistic regression model assumes that ϵ_{hi}^s has a logistic distribution such that the (conditional) probability of earning any income from source s is given by:

$$\Pr(I_{hi}^s = 1|x_{hi}) = \Pr(x_{hi}\gamma^s + \epsilon_{hi}^s > 0) = \Pr(-\epsilon_{hi} < x_{hi}\gamma^s) = \frac{\exp(x_{hi}\gamma^s)}{1 + \exp(x_{hi}\gamma^s)} \quad (3.7)$$

The characteristics included in x_{hi} are: age (and age squared); academic achievement (whether holds a university degree); marital status; number of own children in the household (separating children under 4, children between 4 and 11 and children between 12 and 15); and citizenship. Separate sets of parameters are allowed for men, single women, and women in couple.

This way, we obtain estimates for: I_{hi}^{lab} , I_{hi}^{emp} and I_{hi}^{semp} appearing in equation (3.2); I_{hi}^{inv} and I_{hi}^{prop} appearing in equation (3.3); and I_{hi}^{pricen} and I_{hi}^{other} appearing in equation (3.4).

Levels of labour income sources

We start by modelling the earnings of self-employed workers, the variable y_{hi}^{semp} appearing in Equation (3.2), according to the following log-linear regression model:

$$y_{hi}^{semp} = \exp(x_{hi}\beta^{semp} + v_{hi}^{semp}) \quad (3.8)$$

where v_{hi}^{semp} is a zero-mean residual with homoscedastic variance $\sigma^{2,semp}$ ².

We then model the earnings of salaried employed workers, the variable y_{hi}^{emp} appearing in Equation (3.2). This is given by the multiplication of the individual's hourly wage, w_{hi} , by the individual's total number of hours worked, s_{hi} :

$$y_{hi}^{emp} = w_{hi}s_{hi} \quad (3.9)$$

²The variances of residuals are part of the parameter vector. They are set to unity in logistic regression models.

We model hours worked using a basic linear regression model:

$$s_{hi} = x_{hi}\gamma^{hrs} + \epsilon_{hi}^{hrs} \quad (3.10)$$

where ϵ_{hi}^{hrs} is a zero-mean residual with homoscedastic variance $\sigma^{2,hrs}$.

The final step in the modelling of labour incomes is a specification for wages. Given the central importance of wages in the distribution of household income, we adopt a specification that connects individual characteristics to the whole conditional wage distribution and not only to the conditional mean as in the regressions used for other sources of income. To do so, we assume that wages follow a Singh-Maddala distribution, F_X , represented by:

$$F_{X=z}(w) = \text{SM}(w; a(z), b(z), q(z)) = 1 - \left[1 + \left(\frac{w}{b(z)} \right)^{a(z)} \right]^{-q(z)} \quad (3.11)$$

where the X indicates that the distribution is conditional on a vector of characteristics z . The Singh-Maddala distribution is a flexible unimodal three-parameter distribution that has been shown to provide good fit to wage distributions (Van Kerm, Choe & Seunghee (2016)). The parameter $q(z)$ is a shape parameter for the ‘upper tail’, $a(z)$ is a shape parameter (‘spread’) affecting both tails of the distribution, and $b(z)$ is a scale parameter. Each of these parameters is allowed to vary log-linearly with individual characteristics $\theta(z) = \exp(z\beta^{\theta,emp})$, as in Biewen & Jenkins (2005) or Van Kerm (2013). Individual wage is then given by:

$$w_{hi} = F_{X=z}^{-1}(v_{hi}^{emp}) = b(z)[(1 - v_{hi}^{emp})^{-\frac{1}{q(z)}} - 1]^{\frac{1}{a(z)}} \quad (3.12)$$

where v_{hi}^{emp} is a random term uniformly distributed. The model is estimated for men and women separately. For women, we estimate a participation-corrected model as in Van Kerm (2013).

Besides the previously introduced conditioning variables, x_{hi} , z contains three additional variables that are particularly relevant to the modelling of wages: occupation, occ_{hi} , industry, ind_{hi} , and sector, pub_{hi} , of main job. We model these three variables only for people in salaried employment (i.e. with $I_{hi}^{emp} = 1$), who are the ones receiving a wage.

Occupation is a categorical variable with 8 categories, based on the ISCO-08 classification. The categories considered are: managers; professionals; technicians and associate professionals; clerical

support workers; services and sales workers; craft and related trades workers; plant and machine operators and assemblers; and unskilled³. We model it using a multinomial logistic regression model. A latent variable $I_{hi}^{k,occ*} = x_{hi}\delta^{k,occ} + \epsilon_{hi}^{k,occ}$ is associated to each of the $k \in m^{occ}$ alternative occupations with $\epsilon_{hi}^{k,occ}$ following an extreme value distribution. The observed occupation for individual hi , say j ($I_{hi}^{j,occ} = 1$ and $I_{hi}^{k,occ} = 0$ for $k \neq j$), is such that $I_{hi}^{j,occ*} > I_{hi}^{k,occ*}$. Under an extreme value distribution for the residuals, the probability of being in occupation j is given by:

$$\Pr(I_{hi}^{j,occ} = 1 | x_{hi}) = \frac{\exp(x_{hi}\delta^{j,occ})}{\sum_{k=1}^{m^{occ}} \exp(x_{hi}\delta^{k,occ})} \quad (3.13)$$

with the parameter vector for the first alternative normalized to $\delta^{1,occ} = 0$. When only two choices are available, this is equivalent to the binary logistic model.

Industry of employment can be primary, secondary, or tertiary and is modelled similarly to occupation using a multinomial logistic model, with $m^{ind} = 3$. Sector of employment is either public or private (public sector includes public administration jobs but also army, health and education) and it is modelled using a binary logistic regression model, like the one described for the participation indicators, with one corresponding to being in the public sector. We add occupation as a conditioning variable in the models for industry and sector of employment, which are thus determined by (x_{hi}, occ_{hi}) . Parameters are estimated using maximum likelihood.

Levels of other market income sources

We adopt a much simpler parametrisation for the levels of all other sources of market incomes, a log-linear regression model, similarly to the modelling of self-employment income. For each source p with $p \in \{inv, prop, pripen, other\}$, we have:

$$y_{hi}^p = \exp(x_{hi}\beta^p + v_{hi}^p) \quad (3.14)$$

where v_{hi}^p is a zero-mean residual with homoscedastic variance $\sigma^{2,p}$.

This way, we obtain estimates for: y_{hi}^{inv} and y_{hi}^{prop} appearing in equation (3.3); and y_{hi}^{pripen} and y_{hi}^{other} appearing in equation (3.4).

³The original ISCO classification considers one more category, “skilled agricultural, forestry and fishery workers”, which we merge into the “managers” category. For more information on the ISCO-08 classification see <http://www.ilo.org/public/english/bureau/stat/isco/isco08/index.htm>.

3.3.3 Simulation of benefits, taxes and social security contributions

The final two components of household disposable income are benefits (or public transfers) received, y_h^B , and direct taxes paid, y_h^T . We derive the bulk of these components using EUROMOD, a pan-European tax-benefit static microsimulation engine (see Sutherland & Figari (2013) for a presentation of the model). This large-scale income calculator incorporates the tax-benefit schemes of EU member countries and uses harmonised input datasets, allowing for the estimation of benefit and tax (both direct taxes and social insurance contributions) entitlements as a function of pre-tax pre-benefit income sources, household characteristics and other variables that may influence the benefit eligibility and tax liabilities according to the rules in place (see Figari, Paulus & Sutherland (2015) for a discussion of the modelling of taxes and benefits using microsimulation models). It also makes it possible to implement ‘policy swaps’ in which particular tax or benefit policies from one reference country or year are applied to other countries or years (see for e.g. Levy, Lietz & Sutherland (2007), Bargain & Callan (2010) and Bargain (2012)).

EUROMOD simulates a wide range of benefits including family benefits, housing benefits, social assistance, and other income-related benefits. Not all benefits are however, evaluated by EUROMOD. Two main sources of benefits are not simulated (or are only partially simulated): contributory benefits and retirement and disability pensions, which generally depend on past employment histories or other information (e.g., about the severity of a disability) that is usually not observed in the household survey data that inputs the tax-benefit simulator. For these components of y_h^B , the benefits measured at the individual level are modelled like non-labour incomes (with a logistic regression model for receipt and a log-linear regression model for the amount received), while benefits measured at the household level are modelled similarly except that only one household level equation is specified for each model and the exogenous characteristics x_h are composed of household-level demographic composition and of the individual characteristics of the ‘household head’ (where household head is defined as the individual with the highest individual income or the eldest in the case of equal income). We rely entirely on EUROMOD for the computation of direct taxes, which include income and property taxes and social security contributions.

A few additional variables that are not a part of household income can influence the amount of taxes and benefits, such as mortgages, rents paid, and contributions for private pensions. These variables are also modelled, using the same strategy as for non-labour incomes and benefits not

evaluated by EUROMOD. The estimates obtained do not determine household income directly, but are fed into the tax-benefit microsimulation engine to calculate taxes and benefits of household h .

3.3.4 Counterfactual distributions and decomposition of changes over time

Having explained how we model all sources of income, we can now describe the method used to generate counterfactual distributions and perform the decomposition of changes in the income distribution between any two years.

The Income Generation Process

We start by introducing a generic representation of the household income generation process (IGP):

$$Y = m(X, \Upsilon) \tag{3.15}$$

where Y is household disposable income, X is a vector of exogenous characteristics and Υ is a vector of unobserved heterogeneity (residual) terms (see Matzkin (2003) and Rothe (2010)). The function m describes jointly the relationship between X and Y and the heterogeneity in Y that is not ‘explained’ by X . The derivative of m with respect to its first argument reflects variations in Y across households that can be attributed to differences in observable characteristics while the derivative of m with respect to its second argument reflects variations in Y across households with identical observable characteristics.

The parametric functional forms adopted for the different income components imply a particular parametric shape for m , such that:

$$Y = m^\xi(X, \Upsilon; \xi) \tag{3.16}$$

where m^ξ represents the specific parametric structure adopted for the income generation model and ξ is the vector of parameter values. Equation (3.16) has no ‘structural’ interpretation but it should be viewed as a set of reduced form equations linking household characteristics and income (a relationship that may arise from an unknown, broader structural model) through earnings functions, equations for employment and occupational and industrial structure, equations for non-labour income and replacement incomes and through tax-benefit rules.

We are interested in studying the distribution F of the random variable Y as well as any functional of interest $\theta(F)$ (such as inequality indices). In particular, we want to examine why F or $\theta(F)$ may differ between two periods. This will depend on the (joint) distribution of X and Υ in the population through m^ξ and ξ . Therefore, differences in F and $\theta(F)$ over time will be a result of differences in the distributions of observable characteristics and unobservable residual heterogeneity and differences in the model's parametric structure and parameter values. For tractability reasons, we assume that all years can be represented by a common parametric model of the form m^ξ but that years differ in the values taken by the parameters ξ .

In order to quantify the relative contributions of these factors to changes in F and $\theta(F)$, we define a number of ‘transformations’ that, when applied to the model, allow us to build counterfactual distributions which, when compared to the baseline distribution, capture how sensitive F and $\theta(F)$ are to specific dimensions of the model. The transformations are then calibrated to reflect actual differences between periods in the factors concerned, leading to a decomposition of over time differences into specific factors of interest. We describe the several steps of this process below.

Four transformations of the Income Generation Process

We focus on four ‘transformations’ of the IGP that allow us to capture the relative contributions of four main factors (or subsets thereof): (i) a *labour market structure* transformation; (ii) a *returns* transformation; (iii) a *demographic composition* transformation; and (iv) a *tax-benefit system* transformation. These transformations follow naturally from the characteristics of our model, but it should be noted that they are specific choices among other possibilities that could be explored.

The *labour market structure* transformation consists of changing the values of parameters that define crucial aspects of the labour market structure such as employment probabilities and occupational, industrial and sectoral structures. This involves modifying certain elements of the parameter vector ξ , including the ones characterising employment probabilities (γ^{lab} , γ^{emp}), hours worked (γ^{hrs}) and occupational, industrial and sectoral structures ($\delta^{j,occ}$, $\delta^{f,ind}$, δ^{pub}). This produces an alternative parameter vector, $\tilde{l}(\xi)$, based on which we obtain new outcomes for income, Y^l (which leads to a new counterfactual distribution of income, F^l):

$$Y^l = m^\xi(X, \Upsilon; \tilde{l}(\xi)) \tag{3.17}$$

The *returns* transformation again acts through the parameter vector ξ . Specifically, it involves changing the parameters of the equations characterising the levels of labour earnings $((\beta^{semp}, \sigma^{semp}), (\beta^{a,emp}, \beta^{b,emp}, \beta^{q,emp}))$ and of all other pre-tax incomes $((\beta^{inv}, \sigma^{inv}), (\beta^{prop}, \sigma^{prop}), (\beta^{pripem}, \sigma^{pripem}), (\beta^{other}, \sigma^{other}))$. This produces an alternative parameter vector, $\tilde{r}(\xi)$, based on which we obtain new outcomes for income, Y^r (which leads to a new counterfactual distribution of income, F^r):

$$Y^r = m^\xi(X, \Upsilon; \tilde{r}(\xi)) \quad (3.18)$$

This transformation is analogous, albeit in a multiple equations setup, to the manipulation of the vector of coefficients in Mincerian earnings regressions in order to capture ‘price’ effects (as distinct from ‘composition’ effects) in traditional Oaxaca-Blinder decomposition exercises. It closely resembles the decomposition of Juhn et al. (1993) in the way residual variances are accounted for.

The *demographic composition* transformation consists of changing the values of variables that reflect basic socio-demographic characteristics of the population, such as: age, gender, marital status, education level and number of children. This involves a modification of the distribution of the random variables in X , and obtaining new outcomes for income, Y^d , based on this alternative distribution of X , $\tilde{X}(X)$ (which leads to a new counterfactual distribution of income, F^d):

$$Y^d = m^\xi(\tilde{X}(X), \Upsilon; \xi) \quad (3.19)$$

The fourth and last transformation that we apply is the *tax-benefit system* transformation. This works as a particular transformation of the parameter vector ξ which modifies (i) the regression parameters determining the level and eligibility of benefits that are not (or only partially) simulated by EUROMOD and (ii) the rules and parameters of the tax-benefit calculator for tax liabilities and those benefits that are determined directly by EUROMOD. This produces an alternative parameter vector, $\tilde{tb}(\xi)$, based on which we obtain new outcomes for income, Y^{tb} (which leads to a new counterfactual distribution of income, F^{tb}):

$$Y^{tb} = m^\xi(X, \Upsilon; \tilde{tb}(\xi)) \quad (3.20)$$

For each of the four transformations, we can compute the impact on any distribution functional

of interest, θ . This type of measure is called a ‘partial distributional policy effect’ in Rothe (2012) or simply a ‘policy effect’ in Firpo, Fortin & Lemieux (2009). For transformation k with $k \in \{l, r, d, tb\}$, this impact is given by:

$$\Delta_{\theta}^k(F) = \theta(F^k) - \theta(F) \quad (3.21)$$

Swapping of components of the Income Generation Process between years

The transformations just described can then be used to create counterfactual distributions that allow to answer the question: “*What would the income distribution of year t be if its IGP was the one of year s along one or more of the dimensions considered?*”. This is done by estimating the IGP for each year separately and calibrating transformations so as to replace components of the IGP of year t with components of the IGP of year s . We call this process a ‘swapping’ of components between the IGP of years t and s . Once again this procedure is analogous to standard Oaxaca-Blinder decompositions (swapping regression coefficients across earnings equations for alternative groups) but implemented in a multiple equations model and in an over time instead of cross country framework.

For the *labour market structure* transformation applied to period t , the parameter vector is transformed such that we obtain a new vector composed by: the subset of parameters from period t that are not affected by the transformation ξ^t ; and the subset of parameters that are ‘imported’ from period s through the swapping procedure, ξ^s . The transformed IGP for year t thereby corresponds to a simulated distribution for year t as if it had the labour market structure of year s and all other components of the model unchanged.

The *returns* transformation involves a similar procedure, i.e. an ‘importation’ or swaping of the returns-related year s parameters onto year t ’s IGP. Unlike the labour market structure transformation, however, the returns transformation also involves swapping variance terms, σ^2 . This is achieved as in Juhn et al. (1993), by rescaling the residuals of period t by the ratio $\frac{\sigma_K^s}{\sigma_K^t}$ for each of the five income components K that are affected by the transformation. This procedure scales the distribution of residuals heterogeneity terms, but preserves the rank correlation of the residuals across the different equations of the IGP.

The *demographic* transformation involves modifying the distribution of population characteristics, X , of year t in such a way that it has the distribution of year s . The distribution of X is modified

but the *conditional* distribution of the residuals, Υ given X , must not be affected and remain as it is in t . As shown in DiNardo et al. (1996) and Barsky, Bound, Kerwin & Lupton (2002), this can be achieved semi-parametrically by reweighting population t households by a factor given by:

$$\omega(X) = \frac{\Pr(X|s)}{\Pr(X|t)} = \frac{\Pr(s|X) \Pr(t)}{\Pr(t|X) \Pr(s)} \quad (3.22)$$

The probabilities in equation (3.22) can be estimated by standard techniques for binary responses (see for e.g. Biewen & Juhasz (2012) for a recent application of this approach).

Finally, the calibration of the *tax-benefit system* transformation combines both swapping model parameters as above (for the equations describing the benefits not fully simulated by EUROMOD) and using EUROMOD to apply the tax-benefit rules and parameters of period s onto the market incomes and household characteristics of period t . Such swapping of tax-benefit policy rules and parameters has already been done in other studies for the analysis of trends in income distributions (see Bargain & Callan (2010), Bargain (2012), Herauld & Azpitarte (2016), Paulus & Tasseva (2017)) and cross-country differences (see Dardanoni & Lambert (2002) and Levy et al. (2007)).

Decomposition of changes in the income distribution over time

Finally, we arrive at the main goal of the analysis: the decomposition of the observed differences between the income distributions and corresponding functionals in years t and s into the contributions of a set of determinants. Suppose for example that we compute a certain functional $\theta(F)$ for each of the two years, obtaining $\theta(F^t)$ and $\theta(F^s)$. A decomposition procedure aims at (additively) decomposing the total observed difference, $\theta(F^s) - \theta(F^t)$, into the contributions of each of the individual determinants k of a set K :

$$\Delta_{\theta}(F^t, F^s) = \theta(F^s) - \theta(F^t) = \sum_{k=1}^K \Delta_{\theta}^k(F^t, F^s) \quad (3.23)$$

A common way to build such a decomposition is by applying each determinant sequentially, from the original distribution, F^t , to the target distribution, F^s , and taking the difference between two consecutive steps of the sequence. The effect of each determinant is then defined as:

$$\Delta_{\theta}^k(F^t, F^s) = \theta(F^{t,s(k)}) - \theta(F^{t,s(k-1)}) \quad (3.24)$$

where $F^{t,s(k)}$ is a counterfactual distribution obtained by composing k transformations of the IGP for period t calibrated to the structure of period s (and we define $F^{t,s(0)} = F^t$ and $F^{t,s(K)} = F^s$). Note that the last factor K is a ‘residual’ (or ‘unexplained’) factor that is not modelled and imported explicitly, which collects all residual difference between the target distribution and the counterfactual distribution obtained after all transformations have been applied to the IGP for period t . In the context of our model, we would have five components, four corresponding to each one of the transformations previously described, and one corresponding to the residuals:

$$\Delta_{\theta}^1(F^t, F^s) \equiv \Delta_{\theta}^d(F^t, F^s) = \theta(F_t^d) - \theta(F^t) \quad (3.25)$$

$$\Delta_{\theta}^2(F^t, F^s) \equiv \Delta_{\theta}^{l|d}(F^t, F^s) = \theta(F_t^{l,d}) - \theta(F_t^d) \quad (3.26)$$

$$\Delta_{\theta}^3(F^t, F^s) \equiv \Delta_{\theta}^{r|l,d}(F^t, F^s) = \theta(F_t^{r,l,d}) - \theta(F_t^{l,d}) \quad (3.27)$$

$$\Delta_{\theta}^4(F^t, F^s) \equiv \Delta_{\theta}^{tb|r,l,d}(F^t, F^s) = \theta(F_t^{tb,r,l,d}) - \theta(F_t^{r,l,d}) \quad (3.28)$$

$$\Delta_{\theta}^5(F^t, F^s) \equiv \Delta_{\theta}^{\Upsilon}(F^t, F^s) = \theta(F^s) - \theta(F_t^{tb,r,l,d}) \quad (3.29)$$

where $\Delta_{\theta}^{\Upsilon}(F^t, F^s)$ corresponds to the residuals, capturing all factors that are not accounted for by any of the transformations, namely the distribution of residual heterogeneity terms Υ .

So the total observed difference would be decomposed as:

$$\Delta_{\theta}(F^t, F^s) = \Delta_{\theta}^d(F^t, F^s) + \Delta_{\theta}^{l|d}(F^t, F^s) + \Delta_{\theta}^{r|l,d}(F^t, F^s) + \Delta_{\theta}^{tb|r,l,d}(F^t, F^s) + \Delta_{\theta}^{\Upsilon}(F^t, F^s) \quad (3.30)$$

The drawback of such a sequential decomposition is its path-dependence, i.e. the dependence of the estimated contribution of each factor on the precise sequence of transformations chosen⁴. To tackle this issue, we follow Biewen & Juhasz (2012) and Biewen (2014) and examine ‘direct effects’, which assess the impact of each determinant from the same initial benchmark distribution and therefore avoid composing transformations. Each direct effect is defined as:

$$D_{\theta}^k(F^t, F^s) = \theta(F_t^k) - \theta(F^t) \quad (3.31)$$

⁴Some authors have proposed to calculate the contribution of each factor in all possible sequence of introduction of factors and average across sequences (Devicienti (2010), Chantreuil & Trannoy (2013), Shorrocks (2013)). This approach can however be computationally prohibitive for complex models and does not necessarily improve the economic interpretation of the estimated components.

where F_t^k is the counterfactual distribution obtained by applying one single particular transformation k to the initial distribution F^t .

As Biewen & Juhasz (2012) argue, comparing ‘direct effects’ is a natural way to assess the effects of alternative transformations. However, the sum of all direct effects and residuals does not add up to the overall difference between income distributions. The discrepancy captures the interactions between the different transformations. In the context of our model, we then have six components: the four direct effects of each transformation, the residuals, and an interaction term:

$$D_{\theta}^1(F^t, F^s) \equiv D_{\theta}^d(F^t, F^s) = \theta(F_t^d) - \theta(F^t) \quad (3.32)$$

$$D_{\theta}^2(F^t, F^s) \equiv D_{\theta}^l(F^t, F^s) = \theta(F_t^l) - \theta(F^t) \quad (3.33)$$

$$D_{\theta}^3(F^t, F^s) \equiv D_{\theta}^r(F^t, F^s) = \theta(F_t^r) - \theta(F^t) \quad (3.34)$$

$$D_{\theta}^4(F^t, F^s) \equiv D_{\theta}^{tb}(F^t, F^s) = \theta(F_t^{tb}) - \theta(F^t) \quad (3.35)$$

$$D_{\theta}^5(F^t, F^s) \equiv \Delta_{\theta}^{\Upsilon}(F^t, F^s) = \theta(F^s) - \theta(F_t^{tb,r,l,d}) \quad (3.36)$$

$$D_{\theta}^6(F^t, F^s) \equiv I_{\theta}(F^t, F^s) = \left(\theta(F_t^{tb,r,l,d}) - \theta(F^t) \right) - \left(\sum_{k \in \{d,r,l,tb\}} D_{\theta}^k(F^t, F^s) \right) \quad (3.37)$$

where $I_{\theta}(F^t, F^s)$ captures the difference between the effect of the four transformations combined and the sum of the direct effects, accounting for all two-way and three-way interactions between the four components in the model. These are included in the counterfactual distribution obtained after applying all transformations but not in the counterfactual distributions obtained by applying each transformation at a time (Biewen (2014)).

So the total observed difference is decomposed as:

$$\Delta_{\theta}(F^t, F^s) = D_{\theta}^d(F^t, F^s) + D_{\theta}^l(F^t, F^s) + D_{\theta}^r(F^t, F^s) + D_{\theta}^{tb}(F^t, F^s) + \Delta_{\theta}^{\Upsilon}(F^t, F^s) + I_{\theta}(F^t, F^s) \quad (3.38)$$

3.4 An application to Portugal between 2007 and 2013

We now apply the method presented in the previous section to study the changes in the income distribution in Portugal between 2007 and 2013. This was a particularly intense period for the Portuguese economy, comprising: (i) the “direct” impacts of the 2007-2008 crisis; (ii) the effects of fiscal stimulus measures adopted in 2008 and 2009; and (iii) the effects of fiscal consolidation measures

taken from 2010 onwards, particularly in the context of the EAP.

Subsection 3.4.1 summarises the central features of the Portuguese post-crisis macroeconomic context and policy measures. Subsection 3.4.2 presents the data. Subsection 3.4.3 characterises the evolution of the distribution of household disposable income between 2007 and 2013. Subsection 3.4.4 quantifies the redistributive effect of the tax and transfer system. Subsection 3.4.5 provides the results from the decomposition exercise, identifying the main factors behind the changes previously described. And finally, Subsection 3.4.6 summarises and discusses the main findings.

3.4.1 The 2007-2008 crisis and the Economic Adjustment Program

The financial and economic turmoil that emerged in the global economy following the outbreak of the 2007-2008 crisis in the US first hit Portugal through the banking sector. Starting in 2008, the crisis uncovered the fragilities of two private banks, Banco Português de Negócios (BPN) and Banco Privado Português (BPP), caused by years of bad management. On the grounds of avoiding a potentially serious financial crisis, the Portuguese government, led by then prime-minister Jose Socrates, decided to give the two banks a bailout. This put a significant strain on the country's public finances, in a context where the public deficit and debt to GDP ratio were already high. At the same time, the government incurred in some fiscal stimulus measures to cushion the effect of the global economic crisis in the Portuguese economy, which combined with cyclical revenue losses and expenditure increases further contributed to a deterioration of the country's fiscal stance. Financial markets became anxious about the health of Portuguese public finances and the economy in general and the Republic's risk premium on government bonds started to increase. This gave rise to a wave of downgrades of the country's credit rating, starting with the cut by Moody's of the sovereign bond rating down from Aa2 to A1, in July 2010. The concerns about the long-term (un)sustainability of public finances and the pressure from financial markets regarding the Republic's rating led the government to withdraw the stimulus measures that had been implemented and introduce budget consolidation measures, aimed at producing a smaller deficit and a sustainable path of debt growth. On September 2010, the government introduced an austerity package, including several tax hikes and expenditure cuts. These measures were not enough to ease the tensions and calm financial markets, which culminated in a political crisis that led to the prime-minister's resignation in March 2011 and the announcement in April 2011 that the country, facing a status of bankruptcy, would be requesting

financial assistance from international institutions. On May 2011 a Memorandum of Understanding was signed by the resigning prime-minister and the so-called Troika, composed by the International Monetary Fund, the European Central Bank and the European Commission. The Memorandum defined the terms of the bailout package, in particular a set of austerity measures to be taken in the context of an EAP aimed at promoting the return of the economy to a balanced economic and fiscal situation. A new government headed by prime-minister Pedro Passos Coelho came into functions in June 2011. This government not only implemented the measures included in the EAP but also introduced additional ones, considering that it would accelerate the country's return to a crisis-free state. The austerity policy lasted until the end of Mr. Coelho's government, in November 2015, with the bulk of the measures being taken during the years 2012 and 2013.

The stimulus packages adopted in the early stages of the crisis were part of a European wide strategy. Indeed, at the end of 2008 the European Commission adopted the European Economic Recovery Plan (EERP), aimed at restoring consumer and business confidence, restart lending and stimulate investment, create jobs and help the unemployed back into work, in all EU's economies. The Portuguese government was swift in responding to these requests, taking significant actions early on. These included an increase of government guarantees on bank deposits, the nationalisation of BPN and the Investment and Employment Initiative (IEI), which consisted of a plan to modernize secondary school buildings; boost economic activity and exports; strengthen social protection; raise employment; and promote renewable energies and energy efficiency. Beyond the stimulus efforts required by the EERP, the Portuguese government took some additional measures, in an anticipation of elections by the end of 2009. Among these, there was a pay rise for public employees of 2.9 percent, which was the first one after several years of a salary freeze, and a decrease in the standard VAT rate. Furthermore, measures were taken to strengthen unemployment insurance and social assistance schemes, including an increase in the duration and amount of unemployment benefits and an easing of the qualifying conditions for social assistance reciprocity.

The consolidation measures taken from 2010 onwards were sizeable and spread through a broad range of areas⁵. On the expenditure side, reductions and restrictions on family benefits and social assistance were introduced, including child benefits and minimum income. These measures mostly

⁵For a detailed description of the measures see for e.g. the Euromod country reports for Portugal between 2009 and 2014, Rodrigues & Junqueira (2012), Rodrigues, Junqueira & Figueiras (2013), Rodrigues, Junqueira & Figueiras (2015), Rodrigues, Junqueira & Figueiras (2016) and also Vaughan-Whitehead (2015).

affected lower income households, who were the main recipients of these benefits. Unemployment insurance and assistance was also greatly weakened, through a reduction in the duration, hardening of eligibility conditions, and cut in the rates. Furthermore, there were massive cuts in public sector pay and a freezing of promotions in public careers. The evolution of wages and salaries between 1995 and 2013 is illustrated in Figure 3.1, for the economy as a whole and for the private and public sectors separately. It is clear that the period between 2009 and 2013 marked a dramatic decrease in Portuguese workers remunerations, particularly for those in the public sector. The cuts and restrictions in labour pay mostly affected middle to upper income earners, which embody a large share of civil servants. Besides cuts in wages, there were also cuts and freezes in pensions and changes in pension indexation rules determining a lower paced updating which, as in the case of wages, mostly affected middle to upper income earners. On the revenue side, there were increases in the rates of both direct and indirect taxes and the introduction of an additional income tax rate for top earners. Furthermore, there was a decrease in the amount of tax benefits allowed to be deducted from tax liabilities. Besides measures directly aimed at reducing the public deficit, there were also a set of measures introduced with the goal of increasing flexibility in the labour market. In particular, there was a weakening of collective bargaining agreements, cuts in the amounts of severance payments, and changes in the legislation to simplify layoff procedures. Furthermore, there was an induced retirement of workers (mainly in the public sector but also in the private one), through specific legislative provisions, with the objective of reducing the number of civil servants. This was reinforced by the introduction of a rule of only one admission for every two exits for public sector employees. Finally, one should also mention that the status of public sector employees suffered significant changes. In particular, fixed-term precarious contracts developed over long-term contracts, and many activities previously done by public sector employees were outsourced, often through the use of short-term contracts that implied a loss of rights and access to social insurance.

The joint effects of the crisis and austerity measures taken from 2010 onwards led to a substantial worsening of the Portuguese macroeconomic and labour market context between 2008 and 2014, including a severe drop in economic activity and soaring unemployment. There was a recession in four out of the seven years, with real GDP growth being -3% in 2009, -1.8% in 2011, -4% in 2012 and -1.1% in 2013. As can be seen in Figure 3.2, the unemployment rate rose steadily between 2008 and 2013, from 8% to 16%. Furthermore, the fiscal position deteriorated considerably, with the deficit

Figure 3.1 – Wages and salaries



Source: Taken from Rodrigues, Junqueira & Figueiras (2016), originally in de Portugal (2014)
 Legend: In blue, overall economy; In black, public sector; In grey, private sector

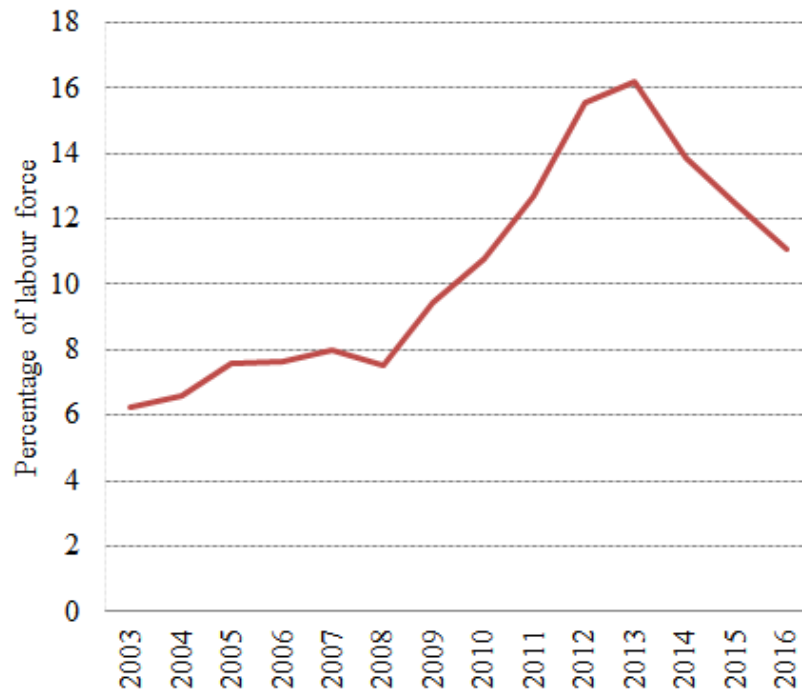
reaching -10% in 2009, -11% in 2010 and exhibiting high values until 2014 and the debt to GDP ratio increasing from around 70% in 2007 to 130% in 2014, as illustrated in Figure 3.3.

3.4.2 Data

Our database is taken from the European Union Statistics of Income and Living Conditions (EU-SILC) survey for Portugal, for the years 2007, 2009 and 2013. The EU-SILC is a nationally representative household survey, which contains detailed information about income as well as about the socio-economic characteristics of households and their members. It is currently the key source of official statistics on income distribution for most European countries, including Portugal.

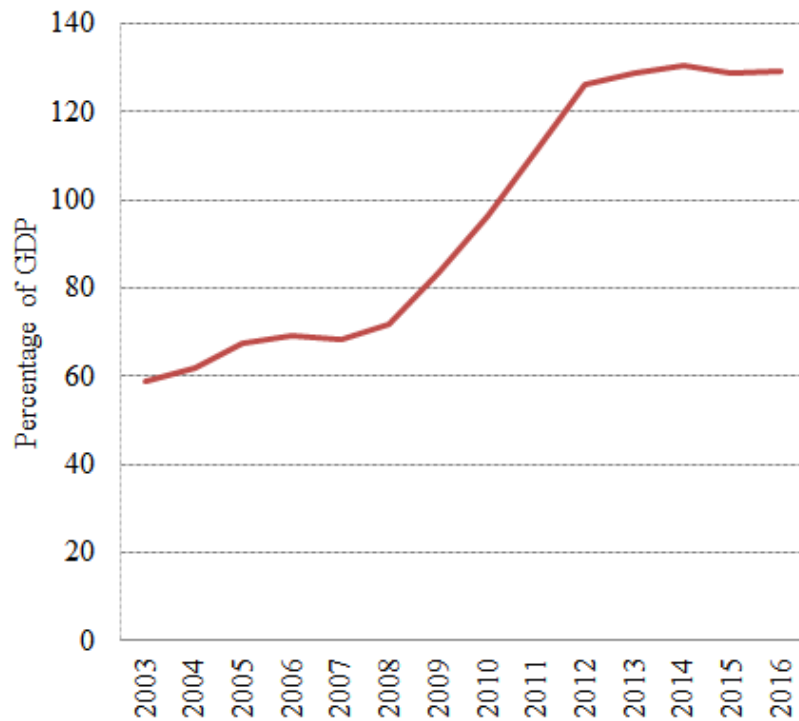
Given that a central component of our model is the tax-benefit microsimulation engine EUROMOD, we use the EUROMOD input data versions of the EU-SILC datasets, which have been standardized for common definitions of income variables and household characteristics. The definition of disposable household income in EUROMOD includes the sum across all household members of market incomes and public pensions plus cash benefit minus taxes and social insurance contributions. Cash benefits, taxes and social insurance contributions are not reported by survey respondents but are calculated by EUROMOD. EUROMOD assumes away any tax evasion and assumes full take-up of benefits.

Figure 3.2 – Unemployment rate



Source: OECD data

Figure 3.3 – Debt to GDP ratio



Source: PORDATA

However, in some countries with high non-take-up rates (including Portugal) it applies a correction to the data so as to match external statistics on take-up proportions. The correction consists in randomly imputing ‘non take-up’ and therefore assigning zero benefits to a fraction of the sample households. This is done separately for different sources of benefits. All income measures are expressed in ‘single adult equivalent’ by dividing total household income by the square root of household size and attributing that value to each member of the household. Furthermore, all income measures are CPI adjusted. Sample sizes are 11,772 individuals (5,122 households) in 2007, 13,334 individuals (6,600 households) in 2009, and 17,195 individuals (7,706 households) in 2013.

Table 3.1 shows a number of population socio-economic characteristics for each of the three years, based on the samples in our database. We can see that there were some significant changes over the period. In terms of socio-demographic characteristics, there was a considerable increase in the share of people with tertiary education among the population aged 25-64, by more than 6 p.p, with the increase being almost entirely concentrated in the period between 2009 and 2013. This may be the result of a composition effect, reflecting the exit from the labour market of lower skilled workers who were the most affected by employment losses following the crisis. There was also a slight ageing of the population, with the share of people aged 65+ increasing by more than 2 p.p. This is likely to also be mostly due to a composition effect, reflecting the exit of many young adults from the country to look for better employment opportunities abroad as described in Justino (2016). Looking at the labour market structure, one can see a sharp decrease in the share of working people, of 8 p.p., as one would expect given the severe job losses induced by the crisis. Most of this decrease occurred between 2009 and 2013. There was also a significant increase in the share of employee workers, of 6 p.p., which is likely to reflect relatively stronger employment losses for the self-employed, who are typically more vulnerable to market fluctuations, having more difficulty in keeping their businesses alive when an aggregate crisis hits. The distribution of workers across types of occupation also experienced some changes, with the main ones being the increase in the share of professionals and the decrease in the share of craft workers. The share of workers in the public sector also increased slightly, by almost 5 p.p.. Finally, considering other market factors, there was a significant increase in the share of people with capital income, of 9 p.p..

Table 3.1 – Population socio-economic characteristics (shares of total population)

	2007	2009	2013
Socio-demographic characteristics			
Tertiary Education	0.129	0.134	0.193
People 16-65	0.673	0.673	0.657
People >65	0.165	0.169	0.187
Child 0-3	0.031	0.032	0.034
Child 4-11	0.085	0.085	0.080
Child 12-15	0.046	0.042	0.041
Married	0.594	0.579	0.559
Citizen	0.973	0.976	0.981
Male	0.478	0.478	0.469
Labour market factors			
In-work	0.586	0.562	0.507
Employee	0.861	0.874	0.920
Occupation			
Managers	0.100	0.083	0.084
Professionals	0.094	0.100	0.165
Technicians	0.097	0.096	0.120
Clerks	0.101	0.101	0.088
Services	0.162	0.174	0.179
Craft	0.218	0.222	0.143
Plant	0.086	0.094	0.099
Unskilled	0.140	0.130	0.122
Industry			
Agriculture	0.042	0.032	0.027
Industry	0.188	0.170	0.176
Services	0.770	0.798	0.796
Public sector	0.184	0.194	0.231
Other market factors			
With private pensions	0.006	0.005	0.012
With capital income	0.117	0.112	0.208
With other income	0.021	0.016	0.033

Notes: The estimates are weighted. The shares for education refer to age-group 25-64; for married, sex to age ≥ 16 ; for in-work to ages 16 to 80; for employees, occupation, industry and sector to those in work aged [16, 80); for citizen to the entire sample. The shares for private pensions refer to ages ≥ 45 , for capital age ≥ 16 .

Table 3.2 – Summary measures of equivalised household disposable income distribution

	Levels			Changes		
	2007	2009	2013	2007-2009	2009-2013	2007-2013
Mean	958	991	907	3.44%	-8.48%	-5.32%
Median	771	814	766	5.58%	-5.90%	-0.65%
Gini	35.7	32.6	33.6	-3.1	1.0	-2.1

Notes: The values for the mean and median are monthly and in euros

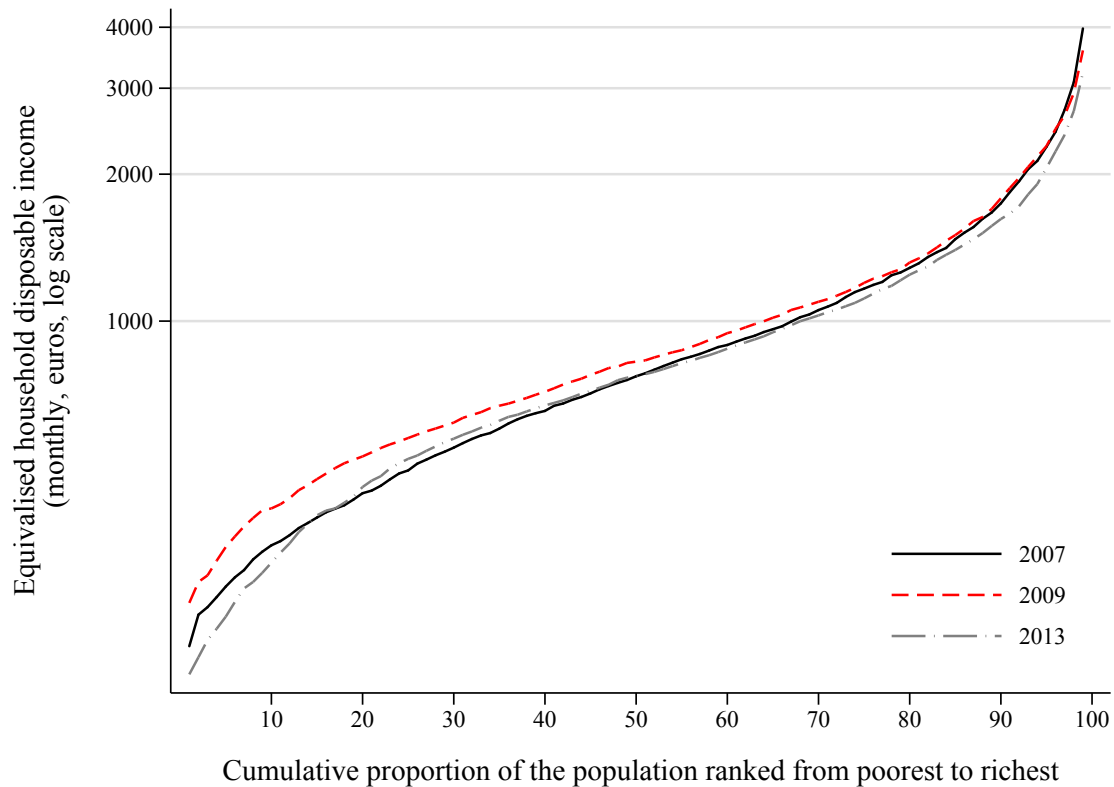
3.4.3 Changes in the income distribution between 2007 and 2013

We start by characterising the changes in the distribution of household disposable income in Portugal between 2007 and 2013, considering both the period 2007-2013 as a whole and the sub-periods 2007-2009 and 2009-2013. All three distributions (2007, 2009 and 2013) were obtained according to the methodology presented in Subsections 3.3.1 to 3.3.3.

Table 3.2 shows the mean and median monthly income and Gini index associated with each of these distributions. Starting with the evolution of mean and median income between 2007 and 2013, we find a decrease in both, of 5.3% and 0.7% respectively. Furthermore, it can be seen that this overall evolution encompassed two very distinct periods. Between 2007 and 2009 there was actually an increase in both average and median income, of 3.4% and 5.6% respectively, but this was more than compensated by a decrease between 2009 and 2013, of 8.5% and 5.9% respectively. A similar pattern occurred in terms of inequality, as measured by the Gini index. The overall decrease observed between 2007 and 2013, of 2.1 Gini points, was the result of a significant decrease between 2007 and 2009, of 3.1 Gini points, and an increase between 2009 and 2013, of 1 Gini point.

These indicators, although useful to obtain a summary of changes in the income distribution, are not enough to understand the anatomy of these changes, i.e. the detailed developments for different income groups. For that, we need to consider the full distributions, which are given in Figure 3.4 in the form of Pen's parades. When comparing the 2007 and 2013 distributions, it can be seen that almost all quantiles experienced an income decrease, particularly those at the very bottom and top of the distribution. Only the quantiles between the 20th and the 40th percentile experienced some increase. When comparing these two distributions with the 2009 distribution, it is clear that almost all quantiles were better off in 2009 than in both 2007 and 2013, with the sole exception of the very

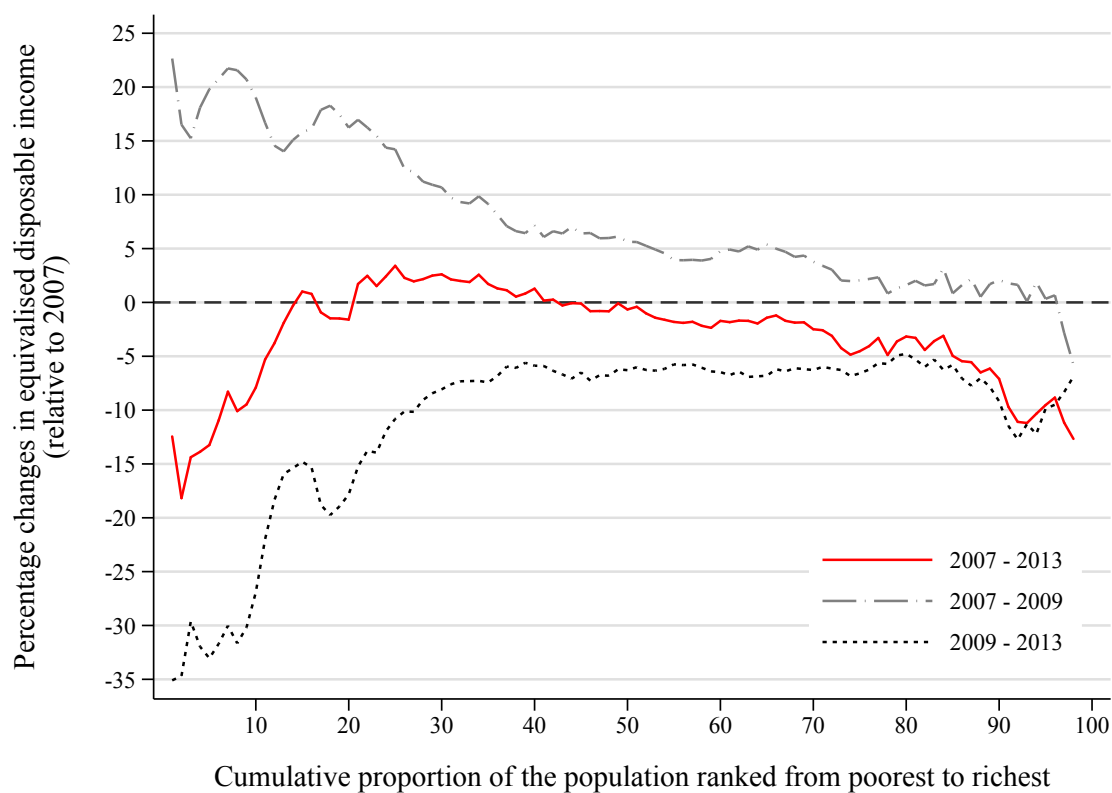
Figure 3.4 – Distribution of equivalised household disposable income (Pen's parades)



top ones, whose income was slightly higher in 2007. The biggest differences can be found at the bottom half of the distribution, for quantiles up to the 50th percentile, who had a strikingly more favourable situation in 2009.

These considerations are made clearer in Figure 3.5, which shows the pairwise differences between the three distributions shown in Figure 3.4, as a percentage of the 2007 distribution. For each percentile, the change between 2007 and 2013 is equal to the sum of the change between 2007 and 2009 and the change between 2009 and 2013. Therefore, for each percentile, the change over the whole period can be decomposed into the contributions of each of the two sub-periods. We can clearly see that the 2007-2013 period comprised two very distinct sub-periods in what concerns the evolution of incomes across the disposable income distribution. The years between 2007 and 2009 brought increases in the income of almost all percentiles, particularly those at the bottom of the distribution, with the poorest 30% experiencing increases between 10% and 25%. This is in sharp contrast with the years between 2009 and 2013, where there were income losses across the entire distribution,

Figure 3.5 – Changes in the distribution of equivalised household disposable income



particularly for households at the bottom, with those below the 30th percentile exhibiting losses between 10% and 35%. Looking at the 2007-2013 period as a whole, we see that the income increases observed between 2007 and 2009 were completely offset by the income decreases observed between 2009 and 2013 for almost all percentiles, particularly for lower and middle-upper income households. For the middle of the distribution, between percentiles 20 and 60, the household income situation was left relatively unchanged.

Considering the evidence presented in Figures 3.4 and 3.5, together with the context described in Subsection 3.4.1, it seems reasonable to conclude that: the adoption of fiscal stimulus measures in the early stages of the crisis determined income gains for households across the entire income distribution, particularly those in the bottom half; the combined effects of the crisis and the austerity measures taken from 2010 onwards determined substantial income losses for households in all percentiles, especially for households at the bottom 30 percentiles and, to a smaller extent, those at the very top; overall, taking the combined effects of the crisis, and the fiscal stimulus/consolidations measures,

households at the bottom and top of the distribution suffered non-negligible income losses, while those at the middle experienced relatively small changes.

3.4.4 The redistributive effect of the tax and transfer system

An important determinant of the disposable income distribution is the redistributive action of the tax and transfer system, which typically cushions developments in the market income distribution. In Table 3.3 we provide some summary indicators of the effect of the system as a whole as well as the partial effects of taxes and transfers. Specifically, we present measures of: absolute redistribution, given by the Reynolds-Smolensky index; relative redistribution, which is equal to absolute redistribution as a share of the Gini of market income; size effect, measured by average tax (transfer) rates, defined as the ratio between the total amount of taxes (transfers) paid (received) and the total pre-tax (transfer) income; and progressivity/regressivity effect, measured by the Kakwani index⁶.

Table 3.3 – The redistributive effect of the tax and transfer system

	Levels			Changes		
	2007	2009	2013	2007-2009	2009-2013	2007-2013
Gini Market Income	52.0	51.7	55.6	-0.3	3.9	3.6
Gini Gross Income (market + transfers)	40.6	37.4	40.5	-3.2	3.1	-0.1
Transfer Regressivity (K)	92.5	91.7	96.3	-0.8	4.6	3.8
Average Transfer Rate	20.3	25.3	30.0	5.0	4.7	9.7
Absolute Transfer Redistribution (RS)	11.4	14.3	15.2	2.9	0.9	3.8
Relative Transfer Redistribution	21.9%	27.7%	27.3%	5.7 p.p.	-0.3 p.p.	5.4 p.p.
Gini Post Tax Income (gross - income taxes)	36.4	33.4	35.3	-3.0	1.9	-1.1
Tax Progressivity (K)	37.8	40.8	35.0	3.0	-5.8	-2.8
Average Tax Rate	10.1	8.8	13.0	-1.3	4.2	2.9
Absolute Tax Redistribution (RS)	4.2	3.9	5.2	-0.3	1.3	1.0
Relative Tax Redistribution	8.1%	7.5%	9.4%	-0.5 p.p.	1.8 p.p.	1.3 p.p.
Gini Disposable Income (post tax - ssc)	35.7	32.6	33.6	-3.1	1.0	-2.1
Absolute Total Redistribution (RS)	16.3	19.1	22.0	2.8	2.9	5.7
Relative Total Redistribution	31.3%	36.9%	39.6%	5.6 p.p.	2.6 p.p.	8.2 p.p.

Notes: K = Kakwani; RS = Reynolds-Smolensky.

The analysis of these indicators suggests several findings. First, in terms of overall redistribution,

⁶Note that in the case of transfers, higher regressivity means more transfers being *received* by lower income households, while in the case of taxes higher regressivity means more taxes being *paid* by lower income households. Therefore, an increase in transfer regressivity increases redistribution while an increase in tax progressivity (and therefore a decrease in tax regressivity) increases redistribution.

we can see that the tax and transfer system as a whole was a crucial determinant of the level of disposable income inequality in Portugal in the period under analysis. Indeed, in each of the three years considered, the Gini of disposable income is substantially smaller than the Gini of market income, with the reduction representing slightly more than one third of market income inequality, on average. Furthermore, considering the evolution of redistribution, it is clear that the system was crucial at taming the rise in market income inequality that occurred between 2007 and 2013, with redistribution increasing in both the 2007-2009 and the 2009-2013 sub-periods, by approximately 3 Gini points in each, such that there was a total increase of almost 6 Gini points. However, the increase in redistribution occurred in very distinct ways in each of the sub-periods. Whereas between 2007 and 2009 the system reinforced the decrease in market income inequality, leading to a non-negligible decrease in disposable income inequality, between 2009 and 2013 the system only partially cushioned the increase in market income inequality, such that disposable income inequality also increased.

Second, considering the redistributive effects of each part of the system, one can see that the bulk of redistribution was due to transfers, whose effect was approximately three times higher than the one of taxes in each year, on average. Transfers were particularly determinant in the 2007-2009 period, when almost all of the increase in total redistribution was due to an increase in the contribution of transfers, with taxes having a slight negative contribution and social security contributions a slight positive contribution. This was not the case in the 2009-2013 period, where the increase in total redistribution was a result of a rise in the redistributive power of all instruments, but taxes were the one with the biggest contribution. Considering the 2007-2013 period as a whole, the rise in redistribution was due to a large extent to transfers, whose contribution was almost the double of the ones by taxes and social security contributions combined.

Third, looking at the drivers of the redistributive action of transfers and taxes, separating between a progressivity and a size effect, one can see that these evolved in distinct ways. For the 2007-2013 period as a whole, the rise in transfers' redistribution was due to an increase in both regressivity and size while the rise in taxes' redistribution reflected an increase in size but a decrease in progressivity. Considering the size effect in each sub-period separately, the transfer rate increased in both sub-periods, while the tax rate decreased between 2007 and 2009 and increased between 2009 and 2013. As for the progressivity effect, the evolution in the two sub-periods was markedly different: while for transfers it decreased between 2007 and 2009 and then increased between 2009 and 2013, for taxes it increased in

the first sub-period and the decreased in the second one.

3.4.5 Drivers of changes in the income distribution between 2007 and 2013

We now present the results from decomposing the changes presented in Subsection 3.4.3 into the contributions of the main factors considered in our model, as described in Subsection 3.3.4. We therefore move from a purely descriptive analysis of the evolution of the income distribution, focused on the ‘what’, to a thorough understanding of its driving forces, focused on the ‘why’.

Decomposing changes in incomes

Figure 3.6 shows the contribution of each factor to the total changes in income distributions shown in Figure 3.5. Analogously to the results presented in Figure 3.5, for each percentile in each graph the change in the period 2007-2013 is equal to the sum of the changes in the periods 2007-2009 and 2009-2013. Furthermore, for each percentile, and each period, the total change in the income distribution given in Figure 3.5 is equal to the sum of the factor contributions given in Figure 3.6.

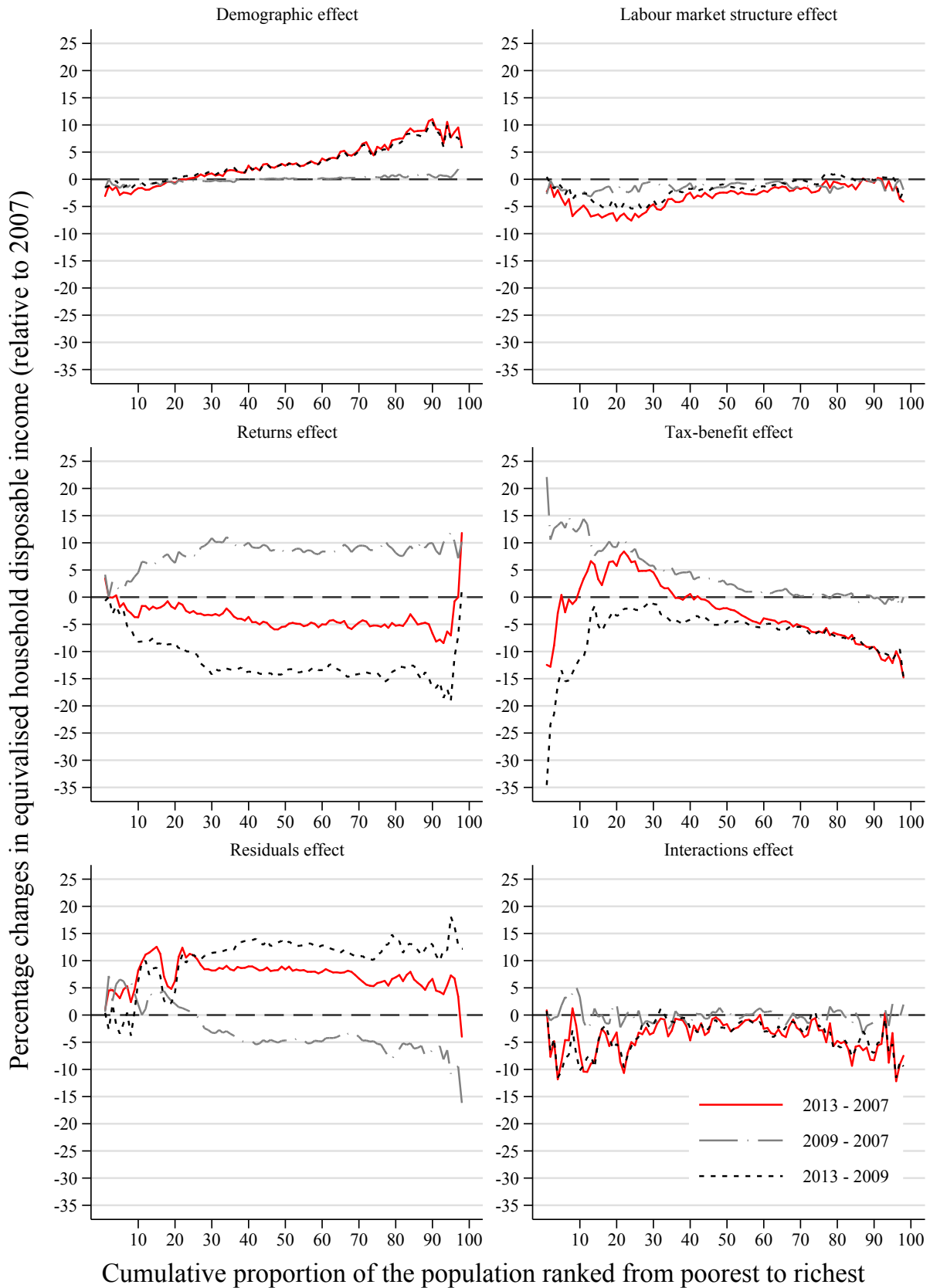
Starting with the 2007-2009 period, three main conclusions can be drawn. First, changes in the labour market structure did not significantly impact households’ incomes, except for poorer households, for whom it determined minor income losses. This is in line with the evidence presented in Table 3.1 and the events described in Subsection 3.4.1. Indeed, between 2007 and 2009, the decrease in the share of in-work households and the increase in the unemployment rate were relatively small. Furthermore, there was some increase in the share of employees and public sector workers, which indicates that self-employed and private sector workers, who are typically more concentrated at the bottom half of the distribution, were the ones most hit by the (yet modest) employment losses. These results are likely to be the combination of three main aspects: the fact that the crisis hit the economy the hardest only from mid-2009 onwards; the effectiveness of stimulus measures in preventing large employment losses in the immediate aftermath of the crisis; the role of automatic stabilisers in cushioning income losses for those who did lose their job⁷. Second, changes in returns determined significant income

⁷It should be noted that the contributions of changes in the demographic, labour market and returns factors include the effect of automatic stabilisers, i.e., changes in disposable income that occurred due to changes in the amount of taxes and transfers resulting from the evolution of factors determining market incomes and not from discretionary changes in tax-benefit rules. Therefore, the results presented include some cushioning effect of the tax and transfer system, which is likely to be particularly important for the labour market structure factor, as unemployment benefits certainly tamed income losses due to unemployment. An assessment of the impact of these stabilisers on inequality and redistribution is given in the next Subsection.

gains, particularly for households at the middle and top of the distribution. This is likely to reflect the increases in wages and salaries that occurred in 2008 and 2009, as described in Subsection 3.4.1, and illustrated in Figure 3.1. Third, changes in the tax-benefit system determined important income gains for households at the bottom half of the distribution, particularly for the lowest income ones. This is in line with the reinforcement of the social protection system in the context of the fiscal stimulus package adopted between 2008 and early 2010, as described in Subsection 3.4.1. Since benefits are more concentrated on poorer households, it is not surprising that these measures mostly benefited households at the lower end of the distribution.

Moving to the 2009-2013 period, results are markedly different. First, changes in the labour market structure had a somewhat stronger effect, determining income losses for households at the bottom and middle of the distribution, which is consistent with the previously described fall in the share of in-work households and sharp rise in the unemployment rate. These results are likely to be the combination of two main aspects: the “direct” recessive impacts of the crisis, which started to be felt in 2009; the contractionary effects of austerity measures taken from 2010 onwards. Note however that the losses were not as pronounced as one could expect given the sharp rise in unemployment. This is likely to be the result of a strong role of automatic stabilisers in cushioning disposable income from the effects of falls in market income due to employment losses, particularly through unemployment benefits. Second, changes in returns were again a crucial determinant, but this time implied significant losses across the whole income distribution, particularly for middle-income households. This is in line with the evidence presented on the decrease in wages and salaries from 2010 onwards, particularly in the public sector. Indeed, cuts in civil servants’ pay were one of the central aspects of the EAP, and it is therefore not surprising that returns end up being a key determinant of income losses in this period. Third, changes in the tax-benefit system were also crucial but, as for returns, had dramatically different effects when compared to the 2007-2009 period, implying a reduction in the incomes of all quantiles, particularly for lower ones and to a smaller extent for upper ones. Again, this is consistent with the developments that occurred in the context of the austerity packages adopted from 2010 onwards. Indeed, it is not surprising that the substantial weakening of benefits determined important losses for the bottom of the income distribution. The increases in taxes, in turn, affected relatively more higher income households, which is likely to be behind the observed income losses for this group. Furthermore, the significant cuts in pensions are also probable to be reflected in the observed changes,

Figure 3.6 – Decomposition of changes in the distribution of equivalised household disposable income



having affected mostly households at the middle and top of the distribution. Fourth, changes in the demographic composition also had a non-negligible effect, determining income gains for households at the middle and top of the distribution. This is consistent with the increase in the share of population with tertiary education and some ageing of the population shown in Table 3.1, as both highly educated and older workers are typically more concentrated at higher quantiles of the income distribution. As previously discussed, both these features may result from a composition effect, reflecting the exit from the labour market of lower skilled workers, who were the most affected by employment losses, and the increase in emigration of younger workers. Finally, it should be mentioned that the residuals component is extremely high, contributing positively to the income changes of most quantiles. This indicates that there are important factors not captured by the model, which had a crucial role at mitigating the negative impacts of the crisis and austerity measures.

Considering the 2007-2013 period as a whole, it is now evident that the observed changes are a mixed result of the somewhat contrasting developments in each of the sub-periods. Changes in the labour market structure contributed to income losses for households at the 40 lowest percentiles, reflecting the increase in unemployment that occurred over the whole period, particularly between 2009 and 2013. Changes in returns determined income losses across the whole income distribution, particularly for middle-upper income households. The substantial cuts in wages and salaries that occurred from 2010 onwards as part of the austerity packages more than compensated the gains induced by the stimulus measures and increases in the pay of civil servants that occurred in the immediate aftermath of the crisis. Changes in the tax-benefit system benefited households between the 10th and 30th percentile, but brought income losses for all other percentiles, particularly those at the very bottom and at the top of the distribution. For these households, the losses suffered in the second sub-period following the important cuts in benefits and pensions and tax increases more than compensated the gains obtained in the first sub-period from the increase in benefits led by a reinforcement of social protection mechanisms in the context of the fiscal stimulus program. Finally, the income gains led by changes in the demographic composition were fully determined by the gains in the second sub-period, reflecting an increase in the share of highly educated and older workers, in a context where lower-skilled and younger workers may have exited the labour market due to important employment losses and emigration.

Decomposing changes in inequality and redistribution

Having investigated the contribution of the different factors to the evolution of households' incomes, we now turn to the analysis of how these factors contributed to the changes in market and disposable income inequality and absolute redistribution presented in Table 3.3. Results are given in Table 3.4. To better understand the drivers of the contributions of the labour market structure and returns factors, we provide some detail into their main components. As before, for each indicator, the total change in one period is equal to the sum of the contributions by all factors and the changes in the 2007-2013 period are equal to the sum of the changes in the 2007-2009 and 2009-2013 periods.

As previously discussed, the 2007-2009 period was characterised by a small decrease in market income inequality but a significant decrease in disposable income inequality, thanks to a rise in redistribution. The factors that more significantly contributed for changes in disposable income inequality were returns and the tax-benefit system, in line with the results in Figure 3.6. However, while returns had a disequalising effect, the tax-benefit system had an equalising effect. The effect of returns can be fully linked to changes in labour incomes. Therefore, the increases in wages and salaries promoted by the fiscal stimulus seem to have benefited relatively more higher income households, even though they expanded incomes across the whole income distribution. Changes in the tax-benefit system in turn, were mostly due to an increase in benefits that affected relatively more lower income households, which is consistent with the increase in the size and redistributive action of transfers illustrated in Table 3.3. Although changes in the tax-benefit system were the biggest contributor for redistribution, changes in both the labour market structure and returns were also important. This points to a meaningful role of automatic stabilisers, such that the existing tax-benefit system was able to counteract some of the market led increase in inequality. Despite the relevant information given by the factors accounted for in the model, it is important to note that the residuals component is the main determinant of the evolution of both market and disposable income inequality, indicating that factors not included in the model had a crucial equalising effect.

Table 3.4 – Decomposition of changes in inequality and redistribution

	2007-2009	2009-2013	2007-2013
Gini Market Income			
Total change	-0.3	3.9	3.6
Labour market structure	0.5	1.5	2.0
In-work	0.8	2.1	2.9
Employed/Self-employed	-0.3	-0.2	-0.5
Occupation/Industry/Sector	-0.1	0.0	-0.2
Has non-labour income	0.1	-0.5	-0.4
Other + Interactions	0.0	0.2	0.2
Returns	4.6	-0.7	4.0
Labour income	4.7	-0.7	4.0
Private pensions	0.0	0.0	0.0
Other + Interactions	-0.1	0.0	-0.1
Tax-benefit system	-0.1	-0.2	-0.3
Demographic structure	0.4	1.6	1.9
Interactions	0.4	1.4	1.9
Residuals	-6.2	0.4	-5.8
Gini Disposable Income			
Total change	-3.1	1.0	-2.1
Labour market structure	0.1	0.6	0.6
In-work	0.4	0.7	1.0
Employed/Self-employed	-0.3	-0.2	-0.5
Occupation/Industry/Sector	-0.1	0.0	-0.1
Has non-labour income	0.1	-0.2	-0.1
Other + Interactions	0.0	0.2	0.2
Returns	4.2	-1.4	2.7
Labour income	4.2	-1.4	2.8
Private pensions	0.0	0.0	0.0
Other + Interactions	0.0	-0.1	-0.1
Tax-benefit system	-1.7	-1.4	-3.1
Demographic structure	0.2	1.5	1.7
Interactions	0.4	0.7	1.1
Residuals	-6.3	1.0	-5.2
Total Redistribution			
Total change	2.8	2.9	5.7
Labour market structure	0.4	0.9	1.3
In-work	0.4	1.4	1.9
Employed/Self-employed	0.0	0.0	0.0
Occupation/Industry/Sector	0.0	-0.1	-0.1
Has non-labour income	0.0	-0.4	-0.3
Other + Interactions	0.0	-0.1	-0.1
Returns	0.5	0.8	1.2
Labour income	0.6	0.7	1.2
Private pensions	0.0	0.0	0.0
Other + Interactions	-0.1	0.1	0.0
Tax-benefit system	1.6	1.2	2.8
Demographic structure	0.1	0.0	0.2
Interactions	0.0	0.7	0.8
Residuals	0.1	-0.6	-0.5

The evolution of inequality, redistribution and the contributions of the different factors was markedly different in the 2009-2013 period. Both market and disposable income inequality increased but the rise in the former was more pronounced than the rise in the later, thanks to the cushioning effect of the tax and transfer system. The main contributors to the rise in market income inequality were changes in the labour market structure and demographic composition. The disequalising effect of the labour market structure is consistent with the evidence presented in Figure 3.6, where this factor was shown to contribute to income losses for households at the bottom of the income distribution, reflecting relatively more pronounced employment losses. Similarly, the disequalising effect of the demographic composition is also in line with the effect of changes in this factor on the incomes of the different quantiles, as they were shown to contribute to income gains at the middle and top of the distribution, reflecting an increase in the share of highly educated and older workers. Furthermore, returns had an equalising effect, which is also consistent with the more pronounced income losses suffered by middle and top income households due to the evolution of this factor, reflecting the fact that cuts in wages and salaries induced by austerity measures were stronger for these households. Looking at the change in disposable income inequality and redistribution, we see that automatic stabilisers once again played an important role, mitigating the disequalising effect of changes in the labour market structure and reinforcing the equalising effect of changes in returns. Discretionary tax-benefit policies also had an equalising effect, with redistribution due to changes in the tax and transfer system increasing in a non-negligible way. Although at first this may seem somewhat surprising given the severity of the austerity measures, it can be easily rationalised when recalling that an important part of these measures were cuts in pensions and increases in taxes, which penalised relatively more middle and top income households. This is in line with results presented in Table 3.3, which show that taxes were the main driver of redistribution in this period. Cuts in benefits were also substantial, and more detrimental for lower income households, but this seems to have been less determinant for the evolution of disposable income inequality.

Finally, we can interpret the results for the whole 2007-2013 period, in light of the conclusions drawn for each of the sub-periods. Market income inequality rose substantially reflecting: a disequalising effect of changes in the labour market structure in both sub-periods, but particularly in the second one, due to employment losses that penalised more heavily households at the bottom of the income distribution; a disequalising effect of changes in returns, due to increases in wages and salaries in the

first sub-period that mostly benefited households at the middle and top of the income distribution; a disequalising effect of changes in the demographic composition, due to a rise in the share of highly educated and older workers, reflecting strong employment losses for low-skilled and emigration of younger workers. Disposable income inequality, however, decreased due to a substantial increase in redistribution reflecting: a significant effect of automatic stabilisers, which cushioned the impacts of changes in the labour market structure and returns; a substantial equalising impact of discretionary changes in tax-benefit policies, which in the first sub-period mostly benefited households at the bottom of the distribution due to increases in benefits and in the second sub-period hurt relatively more households in the middle and top of the distribution due to cuts in pensions and increases in the tax burden.

3.4.6 Summary and discussion of main findings

Results illustrate the complexity of the Portuguese post 2007-2008 crisis story and clearly show that it embodies very contrasting developments over two sub-periods: 2007 to 2009, when the crisis had not yet hit the country in full force and stimulus measures were adopted; 2010 to 2013, when the crisis had its most profound recessive effects and the country was subject to severe austerity measures, particularly in the context of the EAP signed by the government and the Troika in 2011.

The years between 2007 and 2009 were characterised by income gains for households across the entire disposable income distribution, particularly for those at the bottom half. These gains were led by two main factors: an increase in returns from labour, which benefited more households at the middle and top of the distribution; an increase in government transfers, which benefited more households at the bottom of the distribution. These increases occurred in the context of an expansionary fiscal policy, which raised wages and strengthened social protection mechanisms through eased access, extended duration and increased amounts. Also noteworthy is the fact that disposable incomes were not substantially affected by changes in the labour market structure, which is likely to result from a combination of three aspects: the fact that the crisis hit the economy the hardest from mid-2009 onwards; the effectiveness of stimulus measures in preventing large employment losses in the immediate aftermath of the crisis; the role of automatic stabilisers in cushioning income losses for those who did lose their job. In terms of inequality developments, this period was one of a slight decrease in market income inequality and a pronounced decrease in disposable income inequality, such that redistribution

increased significantly. The biggest part of this increase was due to the discretionary increases in benefits, but automatic stabilisers also played an important role.

The years between 2010 and 2013 brought markedly different distributional developments. There were significant income losses across the entire distribution, particularly for households at the bottom, and to a smaller extent those at the top. These losses were led by three main factors: a decrease in returns from labour, which hurt relatively more households at the middle and top of the distribution; changes in the tax-benefit system, which affected more households at the very bottom and top of the distribution; changes in the labour market structure, which hurt lower-income households. For middle-high income households, losses were somewhat compensated by gains brought by changes in the demographic composition. These developments occurred in the context of the significant recessive effects of the crisis, which began to be felt in mid-2009, and severe austerity measures, which started in 2010 and were reinforced from 2011 onwards as part of the EAP. The fall in returns from labour is likely to reflect the unprecedented cuts in wages and salaries that occurred from 2010 onwards, particularly in the public sector. The losses arising from changes in the tax-benefit system are in line with the drastic cuts in benefits and pensions and increases in the tax burden. As for the losses due to changes in the labour market structure, these are certainly linked to the rise in unemployment, which is likely to reflect not only the “direct” recessive impacts of the crisis but also the contractionary effects of austerity measures. These losses, however, were not as pronounced as one could expect given the sharp rise in unemployment, which attests the importance of automatic stabilisers in cushioning disposable income from the effects of falls in labour income, particularly through unemployment benefits. Finally, the gains from changes in the demographic composition are consistent with an increase in the shares of highly educated and older workers, which are likely to result from a composition effect, reflecting the exit from the labour market of many low skilled workers and the increase in emigration of younger workers. These developments implied a pronounced increase in market income inequality, mostly driven by the losses at the bottom of the distribution due to changes in the labour market structure and the gains at the middle and top due to changes in the demographic composition. This was somewhat counteracted by an equalising role of changes in returns. Redistribution again increased significantly, such that although disposable income inequality also rose it did so in a less pronounced way. The most important determinants of redistribution were automatic stabilisers, but discretionary tax-benefit policies also played a significant role, as cuts in

pensions and increases in taxes penalised middle and high income households relatively more, which more than compensated the impacts of cuts in benefits on low income households.

Considering the period between 2007 and 2013 as a whole, results naturally reflect the joint effects of the contrasting developments in the two sub-periods. Overall, the income losses that occurred between 2010 and 2013 were stronger than the gains obtained between 2007 and 2009 for households at the very bottom and top of the income distribution. For those in the middle, losses and gains more or less cancelled out such that they did not experience significant income changes. Market income inequality increased significantly, but disposable income inequality decreased, as the noteworthy fall between 2007 and 2009 more than compensated the mild rise between 2010 and 2013. Redistribution increased considerably due to important equalising effects of both automatic stabilisers and discretionary tax-benefit policies in each of the two sub-periods.

3.5 Concluding remarks

In this paper we developed a new method to model the household disposable income distribution and decompose changes in this distribution (or functionals such as inequality measures) over time into the contributions of four main factors: demographic composition, labour market structure, returns and tax-benefit system. We applied this framework to the study of distributional developments in Portugal between 2007 and 2013, shedding new light on the main determinants of these developments. This is a particularly interesting case study, given the richness of the post 2007-2008 crisis Portuguese experience, which included the “direct” impacts of the crisis, the effects of stimulus measures taken in the immediate aftermath of the crisis, and the consequences of austerity measures taken between 2010 and 2014. Results illustrate the complexity of the Portuguese experience and clearly show that it embodied markedly different developments over two periods: 2007 to 2009, when the crisis had not yet hit the country in full force and stimulus measures were adopted; 2010 to 2013, when the crisis had its most profound recessive effects and the country was subject to severe austerity measures, particularly in the context of the EAP signed by the government and the Troika in 2011.

The fiscal stimulus measures adopted in the immediate aftermath of the crisis determined significant income gains, and were particularly beneficial for households at the bottom of the income distribution. They had an equalising effect, implying a slight decrease in market income inequality and a significant

decrease in disposable income inequality. Automatic stabilisers also played a role, by preventing (the yet small) employment losses from translating into significant decreases in disposable income. The effects of the crisis felt from 2009 onwards together with the austerity measures that began in 2010 took a toll on the incomes of households across the entire income distribution, particularly those at the bottom and at the top. Furthermore, they had a disequalising effect, implying a significant increase in market income inequality and a mild increase in disposable income inequality. Taking the period between 2007 and 2013 as a whole, the income losses between 2010 and 2013 were stronger than the gains between 2007 and 2009 for households at the very bottom and top of the income distribution. For those in the middle, losses and gains more or less cancelled out such that they did not experience significant income changes. Market income inequality increased significantly, but disposable income inequality decreased, as the noteworthy fall between 2007 and 2009 more than compensated the rise between 2010 and 2013.

Several lessons can be drawn from the post 2007-2008 crisis Portuguese experience. First, aggregate crises are likely to have not only aggregate impacts but also important distributional consequences, hurting relatively more lower income households. Second, implementing fiscal stimulus packages following a crisis can be effective not only at stabilising aggregate outcomes but also at rendering the income distribution more equal. Conversely, the implementation of austerity measures may reinforce income losses induced by the contractionary effects of the crisis and reduce protection of the poorest. Third, beyond the effect of discretionary changes in tax-benefit rules, automatic stabilisers may be crucial at minimising income losses and preventing a rise in income inequality following a crisis. The bottom line is that government policies may significantly impact the heterogeneity of the effects of a crisis on households' incomes, determining important income gains or losses for different income groups. When facing rising unemployment, decreasing aggregate activity and growing budget deficits, following a crisis, governments need to take into careful consideration the distributional impacts of their policy choices, searching for a balance between stabilising aggregate outcomes and shielding households from extreme and unequal income changes.

Chapter 4

Crisis, inequality and social insurance¹

¹I am profoundly grateful to Pablo Winant for his crucial support during the course of this work. His help with the computational aspects of the paper, his encouragement and guidance were more than essential.

Abstract

In this paper I present the ideas, preliminary results and future steps of a long term project aimed at investigating the distributional consequences of aggregate crises and the role of inequality and social insurance in shaping aggregate activity in times of crisis. For that, I develop a theoretical heterogeneous agents incomplete markets DSGE model, with both ex-ante and ex-post household heterogeneity, and one important source of social insurance, unemployment insurance. A first quantitative experiment, aimed at exploring the model's main properties and mechanisms, produces several preliminary results. First, ex-ante heterogeneity matters. Results for economies where there is only ex-post heterogeneity are significantly different from results for economies where there are both types of heterogeneity. Second, the model generates a substantial rise in inequality following a crisis, as a result of an increase in the probabilities of becoming or remaining unemployed. Third, social insurance helps to mitigate the impact of a crisis on aggregate consumption and this effect is stronger for a higher degree of heterogeneity. Finally, a progressive insurance scheme produces a higher mitigation effect than a flat one. By shedding new light on how social insurance policies may shape the impacts of an aggregate crisis, this work contributes to the recent but essential literature on the relevance of considering distributional aspects when targeting macroeconomic objectives.

JEL codes: D31, E12, E32, E62, H53, I38, J38, J65

Keywords: Crisis; Income and wealth distributions; Inequality; Social insurance; Unemployment insurance; Macroeconomic stabilisation; Heterogeneous agents DSGE models

4.1 Introduction

For a long time, a consensus existed in the macroeconomics literature that the study of aggregate phenomena and policies affecting them could largely abstract from any distributional considerations. It was believed that the aggregate economy could be realistically represented using models populated by representative agents, where inequality played no role. Accordingly, macroeconomists mostly focused on studying the functioning and effects of monetary and fiscal policies, disregarding redistributive and insurance mechanisms from their policy toolbox.

Over the last thirty years, this consensus has been abandoned, largely due to a silent revolution in macroeconomic research, which brought a shift from the workhorse representative agent model to models that incorporate one or more sources of household heterogeneity (for a survey on these models see e.g. Krussel & Smith (2006), Guvenen (2011), Heathcote et al. (2009), Quadrini & Rios-Rull (2014), De Nardi (2015), Ahn et al. (2017) and Kaplan & Violante (2018)). The development of these models has enabled the study of how inequality may shape macroeconomic outcomes and a re-evaluation of many aspects of the conventional wisdom based on representative agent models. Furthermore, it has paved the way for the assessment of the potential distributional consequences of macroeconomic phenomena and policies, beyond their aggregate effects.

One particular issue for which the interactions between distributional and aggregate developments may be key is the consequences of aggregate crises and the design of crisis-coping policies. The perils of ignoring these interactions became evident following the 2007-2008 crisis. In the aftermath of the crisis, several European countries adopted austerity measures aimed at promoting fiscal consolidation, without a thorough evaluation of the impact that these measures could have on inequality and how this in turn could feedback into aggregate activity. Although several economists warned about the possibility that an increase in inequality would hold on the recovery (see e.g. Stiglitz (2013) and Cynamon & Fazzari (2016)), standard macroeconomic models did not account for it and policy makers largely bypassed it.

In this paper I present the ideas, preliminary results and future steps of a long term project aimed at investigating the distributional consequences of aggregate crises and the role of inequality and social insurance in shaping aggregate activity in times of crisis. In particular, the project seeks to explore the following three main research questions: (i) can an aggregate crisis have significant distributional

effects, determining an increase in inequality? (ii) can these adverse distributional effects in turn amplify the aggregate effects of the crisis, implying a deeper contraction of economic activity? (iii) can social insurance mitigate this effect by partly cushioning the crisis-induced increase in inequality?

To explore these questions, I develop a theoretical heterogeneous agents incomplete markets DSGE model, with both ex-ante and ex-post household heterogeneity, and one important source of social insurance, unemployment insurance. *Ex ante* heterogeneity arises due to three distinguishing features: (i) differences in labour efficiency, which reflect differences in skills, as in Castaneda, Diaz-Gimenez & Rios-Rull (1998); (ii) differences in the subjective time discount factor, which generates different degrees of "patience" in households' consumption decisions; (iii) differences in access to credit markets, which translates into different borrowing limits. *Ex post* heterogeneity arises due to one source of idiosyncratic risk faced by households in each period, corresponding to changes in their employment status between employed and unemployed, in the tradition of the so-called Aiyagari-Bewley-Huggett-Imrohoroglu models (Aiyagari 1994, Bewley 1986, Imrohoroglu 1989, Hugget 1993). The multiple sources of heterogeneity allow me to meaningfully move from a representative agent world where inequality plays no role, to a more realistic world where households may be affected differently by a crisis and inequality and social insurance may shape the evolution of aggregate activity in a crisis aftermath. There is one representative firm, which produces a single final good using capital and labour inputs. There is no aggregate uncertainty, but two possible deterministic aggregate states, a boom and a crisis, with a crisis being modelled as a drop in Total Factor Productivity (TFP) together with an increase in the probabilities of becoming or remaining unemployed. Finally, there is a government who provides unemployment benefits to the unemployed, financing them through a tax on the labour income of the employed.

The preliminary results presented here are derived from a first quantitative experiment aimed at exploring the model's main properties and mechanisms under different hypothetical crisis scenarios. The analysis is based on a simplified version of the model and constitutes a preliminary and incomplete attempt at investigating the research questions described above. In this quantitative exercise, I consider five alternative scenario economies, which differ along two main dimensions: the existence of household ex-ante heterogeneity and the degree of social insurance provided by the government. Among the several results, four are particularly noteworthy. First, ex-ante heterogeneity matters. Results for economies where there is only ex-post heterogeneity are significantly different from results

for economies where there are both types of heterogeneity. Second, the model generates a substantial rise in inequality following a crisis, as a result of an increase in the probabilities of becoming or remaining unemployed. Third, social insurance helps to mitigate the impact of a crisis on aggregate consumption and this effect is stronger for a higher degree of heterogeneity. Finally, a progressive insurance scheme produces a higher mitigation effect than a flat one.

By shedding new light on how social insurance policies may shape the impacts of an aggregate crisis, this work contributes to the recent but essential literature on the relevance of considering distributional aspects when targeting macroeconomic objectives. As discussed in Lucas (2003) and Heathcote et al. (2009), developments like these are key for the macroeconomics discipline as they set the stage for the study, in a unified way, of the distributional impacts of aggregate policies and the aggregate implications of redistributive policies. Only this way can the possible trade-offs and complementarities between these two types of policies be assessed, such that true welfare-improving policies can be designed and implemented.

The remainder of the paper is organised as follows: Section 4.2 reviews related literature; Section 4.3 presents the theoretical model; Section 4.4 describes the quantitative experiment and gives the corresponding results; Section 5.3 discusses future steps to be taken; Section 5.1 concludes.

4.2 Related literature and main contributions

This work builds upon and contributes to the relatively recent but flourishing literature studying the interactions between household heterogeneity and the macroeconomy, using heterogeneous agents incomplete markets DSGE models. It relates in particular to four main aspects being explored in this literature: (i) the implications of household ex-post and ex-ante heterogeneity for aggregate outcomes; (ii) the impacts of social insurance and redistribution on the macroeconomy; (iii) the distributional consequences of aggregate crises; and (iv) the role of household heterogeneity in shaping the transmission of aggregate crises to aggregate activity.

The study of the implications of household ex-post heterogeneity can be traced back to the works by Bewley (1986), Imrohoroglu (1989), Hugget (1993) and Aiyagari (1994). In these models, the economy is populated by a continuum of households facing uninsurable fluctuations in either their endowments or employment opportunities. In this paper, I closely follow Imrohoroglu (1989) who

considers an idiosyncratic stochastic employment opportunity shock with two states, employed or unemployed, modelled as a first order Markov chain. The inclusion of ex-ante heterogeneity, in addition to ex-post heterogeneity, can be found in subsequent models as those in Castaneda et al. (1998), Krusell & Smith (1998), Mukoyama & Sahin (2006), and Iacoviello (2008). These models consider different sources of multiplicity in household types, including differences in skills, preferences, age, access to credit market, among others. In this work I include a combination of three of these sources, namely differences in skills, discount factors and borrowing limits.

One of the biggest advantages of adding heterogeneity to the previous workhorse representative agent model is the possibility of studying the macroeconomic effects of policies that affect households differently. Among these are social insurance and redistributive policies. Several papers have used heterogeneous agents models to investigate this topic, including Hansen & Imrohoroglu (1992), Beaudry & Pages (2001), Krueger (2006), Alonso-Ortiz & Rogerson (2010), Huggett & Parra (2010), Oh & Reis (2012), McKay (2014), McKay & Reis (2016), Athreya & Schwartzman (2017) and Kekre (2018). In terms of modelling, the unemployment insurance scheme in this paper is closer to Hansen & Imrohoroglu (1992), with the exception that moral hazard is not considered. Despite using a different modelling device, it is also close in spirit to Krueger (2006) and McKay (2014), who consider different degrees of insurance and income taxation, respectively.

Another big advantage of heterogeneous agents DSGE models is to provide an integrated structural framework to study the distributional consequences of aggregate crisis. This topic has been addressed in the empirical microeconomics literature, but with a crisis being modelled as an exogenous decrease in market incomes and the possible influence of general equilibrium effects not being taken into account. By explicitly modelling a crisis "inside" the model and obtaining income and wealth distributions that are a reflection of all the endogenous adjustments that may occur following a crisis (including general equilibrium effects), heterogeneous agents DSGE models provide an important addition to the analysis done in the micro literature. Some papers that have focused on this topic, exploring different mechanisms through which inequality may increase following crisis, are Castaneda et al. (1998), Barlevy & Tsiddon (2006), Glover, Heathcote, Krueger & Rios-Rull (2014) and Krueger, Mitman & Perri (2016*b*). This work is closer to Krueger et al. (2016*b*), as a recession affects the income distribution mainly through the existence of idiosyncratic unemployment risk, which generates heterogeneity in employment losses and consequently in income and wealth.

Finally, the role of household heterogeneity in shaping the transmission of aggregate crises to economic activity has been the focus of a non-negligible amount of studies. Most of these studies model crises through the introduction of an aggregate stochastic shock, such that the economy experiences business cycle variations, constantly changing between good and bad times. Some examples of studies using this approach are Storesletten, Telmer & Yaron (2001), Krusell, Mukoyama, Sahin & Smith (2009), Krueger et al. (2016*b*) and Ravn & Sterk (2017). Here I consider a different approach, similar to the one adopted in Imrohorglu (1989), where there is no aggregate uncertainty, only an unanticipated shock that drives the economy from a boom state to a crisis state in a deterministic way. This allows me reduce substantially the computational burden of solving the model while still doing a meaningful steady-state type of analysis of the effects of an aggregate crisis.

As shown in this section, there is a rich literature on the issues being explored in this paper. Standing on the shoulders of such important works and adding something new to it is not an easy task and admittedly some of the results in this paper are not new. Notwithstanding, the paper attempts to provide two main contributions. The first one is to clarify and stress the role of household *ex-ante* heterogeneity in shaping the macroeconomic effects of an aggregate shock. By showing that this role is important, the paper suggests that policies aimed at tackling structural sources of heterogeneity (due to differences in skills, access to credit markets, or access to information about investment options) may be helpful in stabilising aggregate demand in times of crisis. The second one is to show that differences in the design of social insurance may translate into non-negligible differences in the impacts of a crisis, in particular its degree of progressivity. To my knowledge, this analysis had not been done before.

4.3 The model

In this section I describe the model economy. I start by giving an overview of the model and then turn to a detailed description of each of its components.

4.3.1 A bird's eye view

The economy is populated by households, a representative firm and a government. Households are heterogeneous, exhibiting both *ex ante* and *ex post* heterogeneity. There are three sources of *ex ante*

heterogeneity. The first one is differences in labour efficiency, which reflects differences in skills, as in Castaneda et al. (1998), and implies different returns for the same amount of labour supply units. The second one is differences in the subjective time discount factor, which generates different degrees of "patience" in households' consumption decisions. The third one is differences in access to credit markets, which translates into different borrowing limits. *Ex post* heterogeneity arises due to one source of idiosyncratic risk faced by households in each period, corresponding to changes in their employment status between employed and unemployed, in the tradition of the so-called Aiyagari-Bewley-Huggett-Imrohoroglu models (Aiyagari 1994, Bewley 1986, Imrohoroglu 1989, Hugget 1993). Financial markets are incomplete, such that households cannot buy state-contingent insurance against the idiosyncratic risk. They can only self-insure by holding a single one-period risk-free asset, which is invested in capital. In addition, the government provides social insurance against the idiosyncratic risk by means of unemployment insurance. There are two possible states of the economy, a boom and a crisis. In the crisis state, the level of Total Factor Productivity (TFP) drops to a substantially lower value than in a boom state and the probability of becoming or remaining unemployed increases, and more so for low skilled households than for high skilled ones. This is in line with the evidence in several empirical studies, which show that the vulnerability of low skilled households to employment losses in times of crisis is considerably higher than the one of high skilled households (see e.g. Hoynes, Miller & Schaller (2012) and Bitler & Hoynes (2015)). There is no aggregate uncertainty, only two deterministic states of the aggregate economy, such that there are two invariant (steady-state) asset distributions, one for each value of the aggregate state.

4.3.2 The representative firm

Technology

There is a representative firm which produces one type of good in each period Y_t using a Cobb-Douglas technology, combining capital K_t and labour L_t inputs:

$$Y_t = z_t K_t^\alpha L_t^{1-\alpha} \tag{4.1}$$

where $0 \leq \alpha \leq 1$ is the capital income share and z_t is TFP, which can take on a good (boom) value z^g or a bad (crisis) value z^b , with $z^g > z^b$.

The capital stock evolves according to the following accumulation equation:

$$K_{t+1} = (1 - \delta)K_t + I_t \quad (4.2)$$

where $0 \leq \delta \leq 1$ is the capital depreciation rate and I_t investment in new capital.

Labour-capital input choice problem

The firm rents capital and hires labour from households in perfectly competitive input markets, taking the wage rate w_t and the rental rate of capital r_t as given. It is a price-taker in the output market, and therefore takes the price of the good p_t as given. The good is assumed to be numeraire, such that $p_t = 1$. Since households own the capital stock and make the investment decision, the firm's problem is a static one. In every period, the firm chooses the amount of capital and labour inputs that maximise that period's profits subject to the production technology:

$$\max_{K_t, L_t} Y_t - w_t L_t - r_t K_t$$

s.t.

$$Y_t = z_t K_t^\alpha L_t^{1-\alpha}$$

Given that all markets are perfectly competitive, the FOCs of this problem are such that factor prices are equal to their marginal products:

$$r_t = \alpha z_t \left(\frac{K_t}{L_t} \right)^{\alpha-1} - \delta \quad (4.3)$$

$$w_t = (1 - \alpha) z_t \left(\frac{K_t}{L_t} \right)^\alpha \quad (4.4)$$

4.3.3 Households

Population

There is a continuum of infinitely lived households of two different types indexed by $f \in \mathbb{F} = \{l, h\}$. Household types differ in their skill levels, which translates into differences in the efficiency with which they supply labour ϵ^f , as in Castaneda et al. (1998). Households of type l are low skilled, having a low labour efficiency ϵ^l , while households of type h are high skilled, having a high level of labour

efficiency ϵ^h . The mass of households of type f is μ^f and the total mass of all households is one, such that $\sum_{f \in \mathbb{F}} \mu^f = 1$.

Preferences

Households derive utility in each period t from consumption c_t^f . Lifetime utility, i.e. the expected value of the discounted sum of all period utilities, is given by:

$$E_0 \sum_{t=0}^{\infty} (\beta^f)^t U(c_t^f)$$

where $0 < \beta^f < 1$ is the subjective time discount factor, which is allowed to vary between the two household types, being higher for high skilled households. This implies that high skilled households are more "patient" than low skilled households in their consumption decisions, accumulating a higher level of assets. This assumption translates the idea that high skilled households are able to access and benefit from asset markets more than low skilled households, as they are typically more informed about the different investment possibilities and have more resources to invest, since they receive a higher remuneration from their labour supply. Therefore, the differences in discount factors are not meant to capture an inherent psychological distinction between household types, but a different ability to benefit from asset markets, arising from the heterogeneity in their skill levels. $U(c_t^f)$ is period t instantaneous utility, modeled as a Constant Relative Risk Aversion (CRRA) utility function:

$$U(c_t^f) = \begin{cases} \frac{c_t^{f1-\sigma}}{1-\sigma} & \text{if } \sigma > 0 \text{ and } \sigma \neq 1 \\ \ln(c_t^f) & \text{if } \sigma = 1 \end{cases}$$

where σ measures the degree of relative risk aversion. All households have to comply with a consumption non-negativity constraint $c_t^f \geq 0$.

Employment idiosyncratic risk

In each period households face a stochastic employment status ε_t with two possible states, employed e and unemployed u , such that the set of states is $\mathbb{E} = \{e, u\}$. I define $e = 1$ and $u = 0$, such that for an employed household $\varepsilon_t = 1$ whereas for an unemployed household $\varepsilon_t = 0$.

When a household of type f draws the employment state, it receives an endowment of $\epsilon^f h$ efficiency

labour units, which it allocates inelastically to the market at the hourly wage w_t . ϵ^f denotes the household-type specific efficiency factor and h denotes the endowment of productive units of time, which is assumed to be the same for all households². If the household draws the unemployed state, it does not receive any endowment of productive time and therefore does not supply any labour, but receives unemployment benefits. I denote the measure of households of type f that draw the employed state by N_t^f . Aggregate employment N_t is the sum over household types of the measures of employed households, i.e. $N_t = \sum_{f \in \mathbb{F}} N_t^f$.

Following Imrohorglu (1989), I model employment status as a first-order Markov chain with a 2×2 transition matrix that differs between states of the aggregate economy. Specifically, the probabilities of becoming or remaining unemployed are higher in a crisis state than in a boom state. In addition, transition probabilities differ across household types as in Castaneda et al. (1998), such that for each state of the economy there are three transition matrices, one for each household type. The probabilities of becoming or remaining unemployed are decreasing functions of the level of efficiency, such that less skilled workers are more likely to become or remain unemployed. For a given state of the economy k and household type f the transition matrix for ϵ_t is $\Pi^{f,k}$. One particular element of the matrix, $\pi_{ij}^{f,k}$, gives the probability of having employment status i in period $t + 1$ conditional on having employment status j in period t and on the economy being in state k , such that $\pi_{ij}^{f,k} = P^f(\epsilon_{t+1} = i | \epsilon_t = j, z_{t+1} = k)$ and $\sum_{i=1}^2 \pi_{ij}^{f,k} = 1$. We have:

$$\Pi^{f,g} = \begin{bmatrix} \pi_{uu}^{f,g} & \pi_{eu}^{f,g} \\ \pi_{ue}^{f,g} & \pi_{ee}^{f,g} \end{bmatrix} \quad \Pi^{f,b} = \begin{bmatrix} \pi_{uu}^{f,b} & \pi_{eu}^{f,b} \\ \pi_{ue}^{f,b} & \pi_{ee}^{f,b} \end{bmatrix}$$

where, e.g., $\pi_{eu}^{f,g} = P^f(\epsilon_{t+1} = e | \epsilon_t = u, z_{t+1} = z^g)$ is the probability that a household of type f will be employed in a boom state in period $t + 1$, given that it was unemployed in period t .

²In this version of the model I do not endogenise the labour supply decision, households simply supply their endowment whenever they have the opportunity to work. I therefore abstract from the possible distortional effects arising from the taxation of labour income. As discussed in Ferriere & Navarro (2018) labour supply responsiveness to tax changes is mostly due to the extensive margin, with the elasticity of hours worked being typically small. Since in my model the extensive margin is exogenously determined (through the employment shock), the only margin I would account for by having an endogenous labour supply would be the intensive one, which would most likely have a negligible impact in the final results. In the future, I plan to include it as a robustness check.

Asset holding and self-insurance

Households can accumulate a risk-free asset a_t belonging to a compact set \mathbb{A} , which allows them to partially self-insure against the employment shock. The asset corresponds to the capital stock and pays a (net) rate of return r_t . Households are allowed to borrow but only up to a limit \bar{a}^f , i.e. $a_t \geq \bar{a}^f$. The borrowing limit can differ between household types, being more stringent for less efficient households, to reflect the fact that households with less resources are typically more constrained in the maximum amount of credit that they can obtain. Specifically, it is assumed to be zero for low skilled households, such that $\bar{a}^l = 0$, and to be the negative of the smallest income that may be earned in a period for high skilled households, such that $\bar{a}^h = -\frac{\lambda^h w \epsilon^h}{1+r}$.

Social insurance and taxes

All households are entitled to unemployment insurance when they are unemployed, which allows them to partially cope with the employment status risk³. A household who becomes unemployed receives unemployment benefits equal to a fraction of the income it would receive if it was employed $\lambda^f w_t \epsilon^f h$ with $0 \leq \lambda^f \leq 1$ being the replacement rate. The replacement rate is allowed to differ between household types, such that the unemployment insurance scheme can be: (i) flat, if $\lambda^h = \lambda^l$; (ii) progressive, if $\lambda^h < \lambda^l$; or (iii) regressive, if $\lambda^h > \lambda^l$. To finance spending with the unemployment insurance scheme, the government collects a labour income tax from all employed households, with $0 \leq \tau \leq 1$ being the tax rate.

Budget constraint and consumption-saving problem

Every household has to comply with a flow budget constraint, such that in each period the household's expenditure with consumption and asset purchase must equal its resources obtained from supplying labour or receiving unemployment insurance and renting its asset holdings. If employed, the household receives the net of taxes labour income given by the wage times the number of efficiency labour units supplied $(1 - \tau) w_t \epsilon^f h$. If unemployed, the household receives unemployment benefits equal to a fraction of the income it would receive when employed $\lambda^f w_t \epsilon^f h$. The budget constraint for a

³Given that transitions in and out of employment are exogenous in the model, the unemployment insurance scheme does not impact a household's incentives to search for and keep a job and therefore problems of moral hazard are ignored. This is a simplifying assumption that renders the model tractable enough to focus on the main research questions I wish to answer with the present work. In the future, it could be relaxed by endogenising the unemployment risk through a search and matching model, for example.

household of type f is then given by:

$$c_t^f + a_{t+1}^f = \varepsilon_t (1 - \tau) w_t \epsilon^f h + (1 - \varepsilon_t) \lambda^f w_t \epsilon^f h + (1 + r_t) a_t^f \quad (4.5)$$

In each period, each household decides on how much to consume and save (or borrow). It does so by choosing the levels of consumption and asset holdings that maximise its lifetime utility subject to a non-negativity consumption constraint, the borrowing constraint and the budget constraint. A household of type f then solves the following decision problem:

$$\max_{c_t^f, a_{t+1}^f} E_0 \left\{ \sum_{t=0}^{\infty} (\beta^f)^t \left(\frac{c_t^f}{1 - \sigma} \right)^{1 - \sigma} \right\}$$

s.t.

$$c_t^f \geq 0$$

$$a_{t+1}^f \geq \bar{a}^f$$

$$c_t^f + a_{t+1}^f = \varepsilon_t (1 - \tau) w_t \epsilon^f h + (1 - \varepsilon_t) \lambda^f w_t \epsilon^f h + (1 + r_t) a_t^f$$

The FOCs for this problem give the standard consumption Euler equation, characterising the evolution of consumption along the optimal path:

$$E_t \left[\beta \left(\frac{c_{t+1}^f}{c_t^f} \right)^{-\sigma} (1 + r_{t+1}) \right] = 1 \quad (4.6)$$

The household's consumption-saving problem is solved over the individual state space characterised by the household's exogenous state (i.e. employment status) and endogenous state (i.e. assets level) $(\varepsilon_t, a_t) \in \mathbb{E} \times \mathbb{A}$. The solution to this problem is a function $a_{t+1}^f(\varepsilon_t, a_t)$ that gives next period's assets, i.e. savings, as a function of the two states. Given the savings decision rule, the consumption function can then be easily found using the budget constraint.

Stationary household wealth distribution

In each period, a household of type f will have a probability of finding itself in one of the many possible combinations of the asset-employment state space. This can be represented by a density function $\Lambda^f(\varepsilon_t, a_t)$, which gives the probabilities corresponding to all possible combinations. This

function will be the same for all type f households, as they face the same consumption-saving problem. By the ergodic theorem, this function will also be the distribution of all type f households over the asset-employment state space, giving the fraction of these households that is in each asset-employment state combination. Since each of these combinations is associated with a value for savings $a_{t+1}^f(\varepsilon_t, a_t)$, obtained by solving the consumption-savings problem, the distribution of assets (or the wealth distribution) is determined by $(a_{t+1}^f(\varepsilon_t, a_t), \Lambda^f(\varepsilon_t, a_t))$.

This distribution will be a function of aggregate prices, which in turn will be a function of the aggregate state of the economy. In an economy with aggregate uncertainty, prices will change over time and therefore so will the wealth distribution. In an economy like the one in this paper, where there is no aggregate uncertainty, prices will be constant and the wealth distribution will be stationary. Note however, that since there are two possible cases for aggregate conditions, boom and crisis, there will be not one but two stationary distributions.

4.3.4 The government

The government follows a balanced budget constraint, such that in each period spending with unemployment benefits B_t is fully financed by the labour income tax revenues T_t . This is achieved by adjusting the tax rate τ until the budget constraint is satisfied in equality:

$$B_t = T_t \Leftrightarrow wh \sum_{f \in \mathbb{F}} \lambda^f \epsilon^f (\mu^f - N_t^f) = \tau wh \sum_{f \in \mathbb{F}} \epsilon^f N_t^f \quad (4.7)$$

4.3.5 Aggregation and market clearing conditions

There are three markets in this economy, the labour, the capital (or assets) market and the goods market, which need to clear at all times. In the labour market, aggregate labour demand corresponds to the representative firm's demand for labour input. Aggregate labour supply corresponds to the sum over household types of the measures of employed households weighted by the number of efficiency labour units supplied, being exogenously determined by the process for the employment status shock. The labour market clearing condition is then given by:

$$L_t = \sum_{f \in \mathbb{F}} \epsilon^f h N_t^f \quad (4.8)$$

In the assets market, aggregate assets demand corresponds to the representative firms's demand for capital input. Aggregate assets supply (or aggregate capital or aggregate savings) corresponds to the total amount of savings over all households in the economy A_t . This is obtained by: (i) multiplying each level of savings by the corresponding household fraction (given by the wealth distribution) by household type to obtain each type's aggregate savings; (ii) computing the sum of of these aggregate savings weighted by each type's share in the economy. The assets market clearing condition is then given by:

$$K_t = A_t \tag{4.9}$$

In the goods market, the aggregate resource constraint must hold such that aggregate output supply, equal to the firm's production, equals aggregate output demand, given by the sum of aggregate consumption C_t and aggregate investment. Aggregate consumption is computed analogously to aggregate savings. The goods market clearing condition is then given by:

$$Y_t = C_t + I_t \tag{4.10}$$

4.3.6 Equilibrium

A stationary competitive equilibrium for this economy is a set of household savings and consumption decision rules $a_{t+1}^f(\varepsilon_t, a_t)$ and $c_t^f(\varepsilon_t, a_t)$, firm's labour and capital input's decisions L_t and K_t , prices r_t and w_t , and a stationary distribution of households over the state variables $\Lambda^f(\varepsilon_t, a_t)$ such that the following conditions are satisfied:

1. The firm chooses its inputs optimally so that factor prices equal their marginal products.
2. Households choose consumption and savings optimally so that the Euler equation and the budget constraint hold and the consumption and borrowing constraints are respected.
3. The government's budget constraint is satisfied.
4. Markets clear.
5. Aggregate variables are constant and the household distribution is stationary.

4.4 A quantitative experiment

In this section, I present the design and results of a first quantitative experiment, aimed at exploring some key properties and mechanisms of the model. The experiment is based on a simplified version of the model, which I describe below. It should be stressed that the exercise presented here constitutes a first and incomplete attempt at investigating the research questions that I wish to explore in the context of a long term project, where many improvements to the current state of the analysis will be introduced. I discuss these in the next section.

4.4.1 Scenario economies

In this quantitative exercise, I consider five alternative scenario economies, which differ along two main dimensions: the existence of household ex-ante heterogeneity and the degree of social insurance provided by the government. For each of these five scenario economies, I solve for the economy in the two possible aggregate states, boom and crisis. The objective of the exercise is to provide a quantitative illustration of the effect that ex-ante heterogeneity and social insurance may have in shaping the distributional and aggregate impacts of a crisis. Table 4.1 provides a scheme of the five possible scenario economies, which are described in detail below.

Table 4.1 – Quantitative analysis scenarios

		Social insurance		
		None	Flat	Progressive
Ex-ante heterogeneity	No	Economy 1	Economy 2	Not applicable
	Yes	Economy 3	Economy 4	Economy 5

Economy 1 - No ex-ante heterogeneity, no social insurance: I start by considering an economy where the only source of heterogeneity is the ex-post idiosyncratic employment shock, such that there is no ex-ante heterogeneity. This corresponds to all households having the same efficiency levels, the same discount factor, and facing the same borrowing constraint. Furthermore, social insurance is "shut off", such that households can only self-insure through savings. This corresponds to setting the unemployment benefits replacement rate equal to zero.

Economy 2 - No ex-ante heterogeneity, flat social insurance: I then move to an economy

where, as in Economy 1, there is no ex-ante heterogeneity but social insurance is "shut on", by setting the replacement rate to a positive value. Therefore, households can now protect themselves against unemployment-driven periods of low income by using both savings and unemployment benefits.

Economy 3 - Ex-ante heterogeneity, no social insurance: next, I consider an economy where the three sources of ex-ante heterogeneity exist, such that now there are two types of households which differ in their efficiency levels, discount factors and borrowing constraints. Specifically: low skilled households have a lower efficiency level and a lower discount factor than high skilled households; low skilled households are not allowed to borrow whereas high skilled households are. As in Economy 1, social insurance is "shut off".

Economy 4 - Ex-ante heterogeneity, flat social insurance: the fourth economy is one where, as in Economy 3, the three sources of ex-ante heterogeneity are active but where social insurance is "shut on", in the form of a flat replacement rate.

Economy 5 - Ex-ante heterogeneity, progressive social insurance: finally, I consider an economy where there is ex-ante heterogeneity and social insurance, as in Economy 4, but the social insurance scheme is progressive, such that the unemployment replacement rate is higher for low skill households than for high skill ones.

4.4.2 Model simplifications and calibration

The quantitative experiment presented in this paper is based on a simplified version of the model. These simplifications were done such that the model was rich enough to perform a meaningful analysis but simple enough to focus on the effects of the key elements and on the main mechanisms. The simplifications are the following:

- The transition probabilities of the employment status shock are the same for the two types, both in the good and bad state. This implies that a crisis leads to the same increase in the probabilities of becoming or remaining unemployed for households of each type. This assumption will be relaxed in the future, with transition probabilities being estimated using micro data, by skill type.

- The government does not collect income taxes to finance its spending with unemployment benefits. It is assumed the the necessary funds are "manna from heaven" as it is often the case for government expenditures in macroeconomic theoretical models. This assumption will be relaxed in the future, with the labour income tax being introduced as explained in subsection 4.3.4.
- The capital depreciation rate is set to zero, so there is no capital depreciation during the production process. This assumption will be relaxed in the future, with the depreciation rate being set to match the empirical long-term aggregate investment to capital ratio.
- Skill types are assumed to have the same fraction of the overall population. This assumption will be relaxed in the future by estimating the share of each skill type using micro data.

The calibration of the model's parameters, taking into account these simplifications, is presented in Table 4.2 for the five different scenario economies in each of the two aggregate states. The calibration is purely theoretical, based on values used in other studies. In the future, most parameters will be empirically calibrated based on both macro and micro data.

Table 4.2 – Parameter calibration

Parameter	Good state					Bad state				
	Eco 1	Eco 2	Eco 3	Eco 4	Eco 5	Eco 1	Eco 2	Eco 3	Eco 4	Eco 5
μ^h, μ^l	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
σ	4	4	4	4	4	4	4	4	4	4
β^h	0,96	0,96	0,97	0,97	0,97	0,96	0,96	0,97	0,97	0,97
β^l	0,96	0,96	0,96	0,96	0,96	0,96	0,96	0,96	0,96	0,96
ϵ^h	1	1	1	1	1	1	1	1	1	1
ϵ^l	1	1	0,5	0,5	0,5	1	1	0,5	0,5	0,5
h	1	1	1	1	1	1	1	1	1	1
α	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33	0,33
δ	0	0	0	0	0	0	0	0	0	0
z	1	1	1	1	1	0,5	0,5	0,5	0,5	0,5
π_{uu}^h, π_{uu}^l	0,7	0,7	0,7	0,7	0,7	0,85	0,85	0,85	0,85	0,85
π_{ue}^h, π_{ue}^l	0,1	0,1	0,1	0,1	0,1	0,25	0,25	0,25	0,25	0,25
λ^h	0	0,27	0	0,27	0,2	0	0,27	0	0,27	0,2
λ^l	0	0,27	0	0,27	0,4	0	0,27	0	0,27	0,4
τ	0	0	0	0	0	0	0	0	0	0

4.4.3 Computational aspects

The model is solved numerically using Dolo, a toolkit for describing, solving, and simulating economic models, and the Julia programming language⁴. Approximate decision rules for the control variables are found using a time-iteration algorithm. The approximation is done using cubic splines, interpolating on regularly spaced assets levels belonging to a compact set defined using a 1000 points cartesian grid, with the lower limit equal to the value of the borrowing constraint and the upper limit set at 120. The approximate decision rules are computed for each of the exogenous states (employed and unemployed) and each of the skill types (high and low).

For each possible case for aggregate conditions, good (boom) and bad (crisis), the economy's equilibrium is computed through the following steps:

1. Initial guess for decision rules: get an initial guess for the household's decision rules, by solving the consumption-savings problem of a representative household of each of the two types over the (ε_t, a_t) space, using calibrated fixed values for the interest rate and the wage level. Compute the corresponding stationary distributions as a histogram with 1000 cells.
2. Aggregate labour supply: compute aggregate labour supply for each household type as the sum of the fraction of households of that type that are in the employed state, multiplied by the type's efficiency level. Compute the whole economy's aggregate labour supply by doing a weighted sum of each household type's aggregate supply, with the weights equal to the share of each type in the total population.
3. Aggregate assets demand: guess possible values for the aggregate assets demand and for each value compute the interest rate and wage level, using the optimality conditions of the representative firm.
4. Aggregate assets supply: for each combination of interest rate and wage level values found in Step 3: (i) solve the consumption-savings problem of each household type as in Step 1 (using the decision rules obtained there as initial guess); (ii) compute the corresponding assets stationary distributions; (iii) compute the aggregate assets supply of each household type, using the respective savings decision rule and stationary distribution; (iv) compute the whole economy

⁴See <http://www.econforge.org/Dolo.jl/latest/index.html> and <https://julialang.org/>.

aggregate assets supply by doing a weighted sum of each household type's aggregate supply, with the weights equal to the share of each type in the total population.

5. Asset market equilibrium and equilibrium prices: find the asset market equilibrium as the value of assets for which the difference between the aggregate demand guessed in Step 3 and the aggregate supply obtained in Step 4 is zero. Compute the corresponding equilibrium interest rate and wage level, using the firm's optimality conditions as in Step 3.
6. Equilibrium consumption and stationary distribution: solve the consumption-savings problems using the equilibrium interest rate and wage level obtained in Step 5, to get the equilibrium decision rules and stationary distributions and sum consumption over households and household types to get aggregate consumption.

4.4.4 Main findings

Some general properties of the model

I start by focusing on some general properties of the model illustrated in Figures 4.1 to 4.3, which present the consumption and savings functions and the wealth distributions for Economy 3. Here I focus on only one economy, as the properties that I wish to illustrate and discuss are common across all economies, but the figures for all the five economies can be found in the Appendix.⁵

In Figure 4.1, the consumption decision rules are shown by skill type and employment status, for each of the aggregate states of the economy. Starting with the good state, consumption of the employed is higher than the one of the unemployed for every level of assets, for both skill types, reflecting the higher income of the employed. Furthermore, consumption of the high skilled is higher than or equal to the consumption of the low skilled in each of the employment states, for every level of assets. When considering the bad state, several results are noteworthy. First, for the same level of assets, consumption is smaller than in the good state, for a household of any skill type - employment status combination. Second, the differences between the four decision rules become much smaller than in the good state. Third, for both employment states, the consumption of a low skilled household may be higher than the consumption of a high skilled one, for high asset levels. This result is completely

⁵Please note that in the case of Economies 1 and 2 the different effects between high and low skilled households do not apply, as there is no ex-ante heterogeneity in these economies. In accordance, in the Figures presented in the Appendix for these economies, the results for high and low skilled households are the same.

due to the higher discount rate of high skilled households, which increases their propensity to save and decreases their propensity to consume, particularly for higher levels of assets and in a context of higher uncertainty.

Figure 4.1 – Consumption decision rules - Economy 3

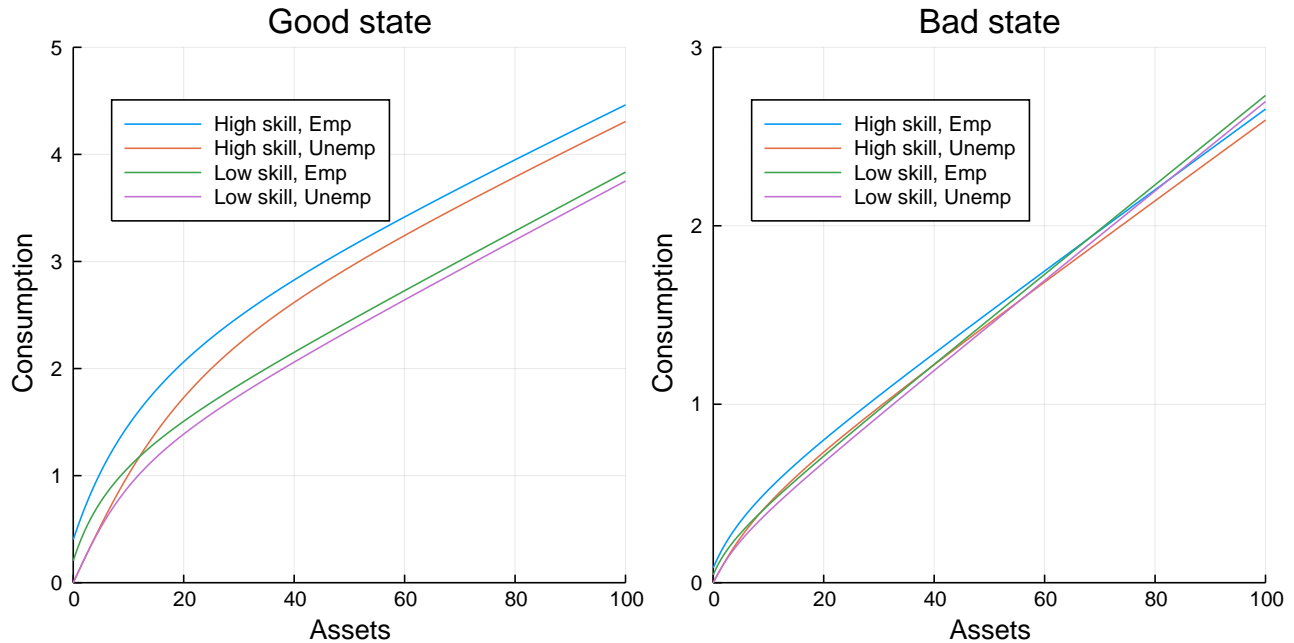
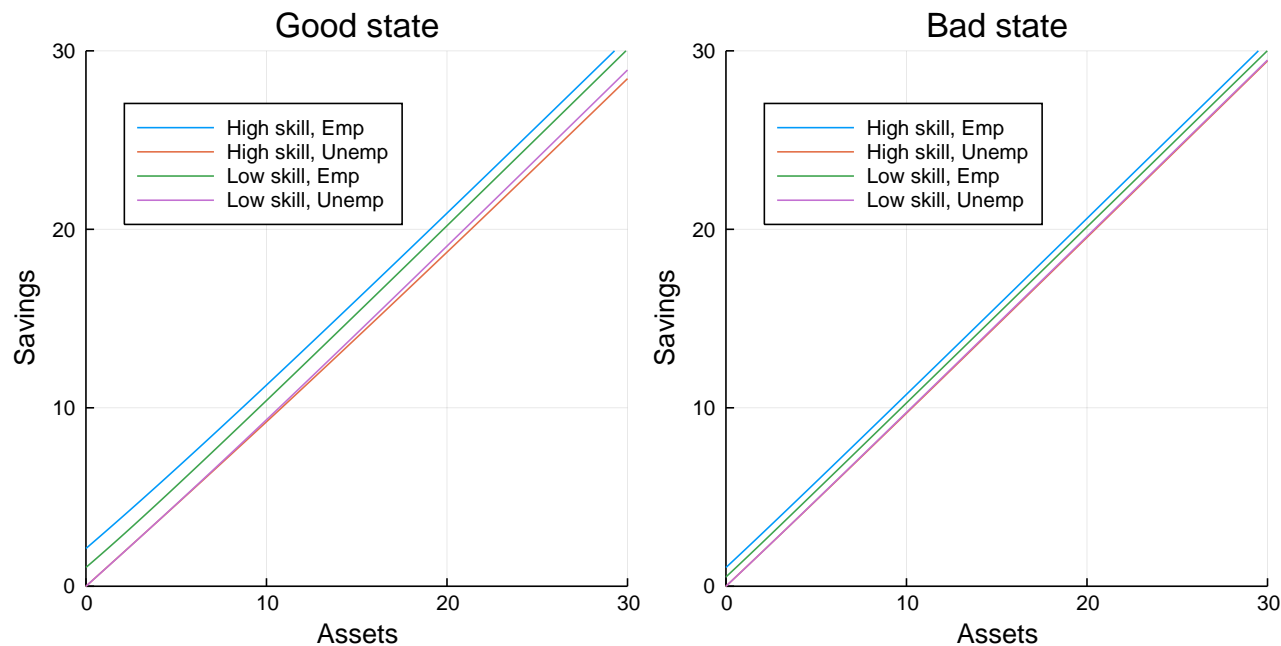


Figure 4.2, is analogous to Figure 4.1 but showing the savings decision rules. Starting with the good state, the same conclusions apply to savings as to consumption. For every level of assets, savings of the employed are higher than the ones of the unemployed for each household type, and savings of the high skilled are higher than or equal to the savings of the low skilled, for each employment status. When considering the bad state, it can be seen that as in the case of consumption the differences between the four decision rules are smaller. However, differently from consumption, this is not associated with a decrease in savings for all households. Instead, it reflects a decrease for employed households but an increase for unemployed households, for both types. This reflects the fact that in a context of crisis, the risk of an unemployed household remaining unemployed increases considerably, which strengthens these households precautionary savings motive, implying higher savings than in the good state.

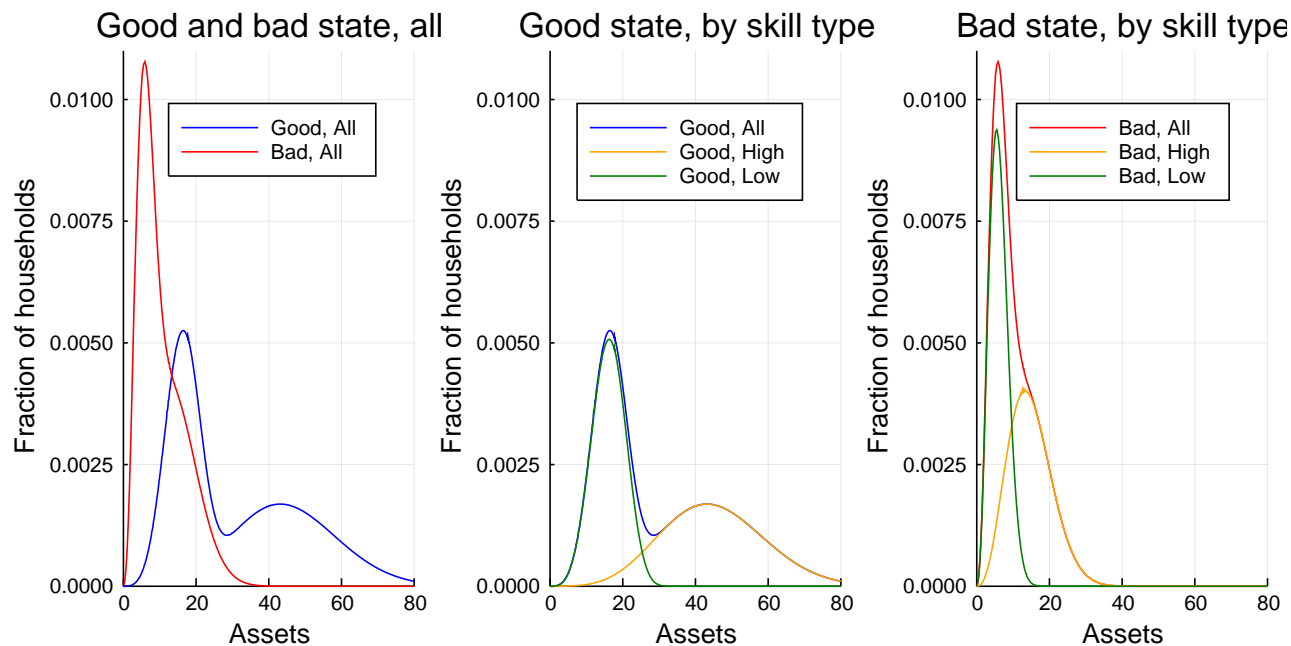
In Figure 4.3, the stationary wealth distributions are presented. The left panel shows the overall distribution in each of the aggregate states, while the middle and right panels split the overall

Figure 4.2 – Savings decision rules - Economy 3



distribution into the contributions of the high and the low skilled, for the good and bad states, respectively. Starting with the left panel, it is clear that in the bad state there is a higher fraction of households with very low levels of wealth and a lower fraction with high levels of wealth than in the good state. As can be seen in the middle panel, the overall good state distribution results from two very different distributions for each skill level: the lower part is mostly determined by the distribution of low skilled households, which is highly concentrated on lower wealth levels; the upper part mostly reflects the distribution of the high skilled, which is more concentrated on higher wealth levels. This reflects both the fact that the high skilled receive higher income from their labour supply, due to their higher efficiency level, and the fact that they are more patient, therefore saving more. The right panel shows that in the bad state, although these differences between skill types are still present, they are much less pronounced, with a higher concentration on low wealth levels occurring for both types. The contraction of the economy and the increase in unemployment transition probabilities affect the income of both types, implying a decrease in wealth accumulation and a shift to the left of the distribution of both types, bringing them closer.

Figure 4.3 – Wealth distributions - Economy 3



The aggregate effects of a crisis and the role of social insurance

I now turn to the study of the aggregate effects of a crisis and the role of social insurance in shaping these effects. Table 4.3 presents the results for the main aggregate variables generated by model for all the five economies, in each of the aggregate states⁶. Panel (a) shows the results for the two economies with no ex-ante heterogeneity, while Panel (b) shows the results for the three economies with ex-ante heterogeneity.

Comparing the results for the good state with the ones for the bad state, it is clear that a crisis induces a sharp contraction of savings and economic activity, and a significant decrease in prices, irrespectively of which economy is considered. The fall in TFP has a direct contractionary effect on output. The increase in the probabilities of remaining or becoming unemployed leads to a rise in the share of unemployed households, which reduces labour supply and consequently the representative firm's labour input, which further contributes to the contraction of aggregate production. The increase in the number of unemployed households and the decrease in prices imply a fall in income, which translates into lower savings and consumption. Prices fall as the drop in productivity implies a

⁶Please note that since the depreciation rate is set to zero the steady-state value of aggregate investment is zero and aggregate income is simply equal to aggregate consumption. Therefore, investment and income are not presented in the Table.

Table 4.3 – Aggregate variables

(a) No ex-ante heterogeneity (Economies 1 and 2)

	Good state					Bad state				
	Savings	Production	Consumption	Interest rate	Wage rate	Savings	Production	Consumption	Interest rate	Wage rate
(1) No insurance	33,04	2,62	2,62	2,61%	2,34	12,12	0,56	0,56	1,54%	1,08
(2) Flat insurance	21,75	2,28	2,41	3,46%	2,04	5,50	0,44	0,58	2,61%	0,83
(2) vs (1)	-34,2%	-12,9%	-7,7%	0,8%	-12,9%	-54,6%	-22,9%	2,6%	1,1%	-22,9%

(b) Ex-ante heterogeneity (Economies 3, 4 and 5)

	Good state					Bad state				
	Savings	Production	Consumption	Interest rate	Wage rate	Savings	Production	Consumption	Interest rate	Wage rate
(3) No insurance	30,64	2,11	2,11	2,2%	2,52	10,46	0,44	0,44	1,4%	1,13
(4) Flat insurance	22,51	1,90	2,02	2,8%	2,27	5,25	0,36	0,47	2,2%	0,90
(5) Progr insurance	22,98	1,92	2,03	2,7%	2,29	5,64	0,36	0,48	2,1%	0,93
(4) vs (3)	-26,5%	-9,9%	-4,6%	0,5%	-9,9%	-49,8%	-20,2%	6,2%	0,8%	-20,2%
(5) vs (3)	-25,0%	-9,2%	-3,8%	0,5%	-9,2%	-46,1%	-18,4%	8,6%	0,7%	-18,4%

reduction in the marginal productivities of capital and labour.

Focusing on the results in Panel (a), three main results can be derived on the aggregate effects of social insurance in a world with no ex-ante heterogeneity. First, social insurance decreases aggregate savings and production relative to the no insurance case, both in the good state and in the bad state, and particularly in the bad state. The existence of insurance decreases households' precautionary saving motive, reducing the need to self-insure through savings against the risk of unemployment in the future. The decrease in aggregate savings translates into a lower capital input for the representative firm, which implies a contraction of production. Second, the introduction of social insurance induces an increase in the interest rate and a decrease in the wage rate. The decrease in capital implies an increase in the marginal productivity of capital and a decrease in the marginal productivity of labour, which translates into a higher price of capital and a lower price of labour, respectively. Third, social insurance cushions the impact of the crisis on aggregate consumption. Indeed, in the bad state consumption is 2.6% higher when there is insurance than when there is not. Unemployment benefits compensate for some of the crisis-induced fall in income for the unemployed, rendering income and consumption higher than in a situation where these households receive no income.

The results in Panel (b) confirm some of the results in Panel (a) and allow for a deeper analysis of the aggregate effects of social insurance. In a world with ex-ante heterogeneity, aggregate savings and production still decrease in comparison with the no insurance case but relatively less than in a

world with only one type of household. Similarly, the differences in prices are smaller relative to the no insurance situation than in Panel (a). The cushioning of the impact of the crisis on consumption is, however, stronger than in the absence of ex-ante heterogeneity and more so when insurance is progressive than flat. Indeed, consumption in the bad state is 6.2% higher when there is flat insurance and 8.6% higher when there is progressive insurance, relative to the no insurance case. Furthermore, the percentage increase in consumption in the bad state induced by insurance is higher than the percentage decrease induced by insurance in the good state. A higher degree of heterogeneity renders the stabilising role of social insurance for aggregate consumption more significant.

The distributional effects of a crisis and the role of social insurance

Finally, I look into the distributional effects of a crisis and the role of social insurance in shaping these effects. Table 4.4 presents the results of several inequality summary measures applied to the model's wealth distributions, specifically: percentile ratios P50 over P20, P90 over P50 and P90 over P20; wealth shares of the poorest 20% and 50% households and of the richest 10% and 5% households⁷. As in Table 4.3, Panel (a) shows the results for the economies with no ex-ante heterogeneity, while Panel (b) shows the results for the economies with ex-ante heterogeneity.

Comparing the results for the good state with the ones for the bad state, it is clear that a crisis induces an increase in inequality, for all economies. All percentile ratios increase, all bottom wealth shares decrease and all top wealth shares increase. This reflects the increase in idiosyncratic risk that results from the higher unemployment transition probabilities.

Focusing on the results in Panel (a) we see that in a world with no ex-ante heterogeneity, introducing social insurance implies an increase in inequality, for both aggregate states. At first, this is a surprising result. Since social insurance helps households to better smooth the income fluctuations induced by the idiosyncratic shock, one would expect a decrease in inequality. Considering the results previously presented, however, it is possible to understand the mechanism behind this result. In the model, including social insurance increases the interest rate and decreases the wage rate. The increase in the interest rate benefits relatively more wealthier households, who benefit more from the increase in the return rate of asset holdings. The decrease in the wage rate penalises the poorest households who are more dependent on their labour income than wealthier ones. Both of these effects lead to an

⁷The Lorenz curves for all economies in each aggregate state are also provided, in the Appendix.

Table 4.4 – Inequality indicators

(a) No ex-ante heterogeneity (Economies 1 and 2)

	Good state							Bad state						
	Percentile ratios			Wealth shares				Percentile ratios			Wealth shares			
	p50/p20	p90/p50	p90/p20	Bot20	Bot50	Top10	Top5	p50/p20	p90/p50	p90/p20	Bot20	Bot50	Top10	Top5
(1) No insurance	1,33	1,38	1,84	12,1%	38,5%	15,0%	8,0%	1,49	1,61	2,40	9,9%	33,7%	17,7%	9,6%
(2) Flat insurance	1,52	1,62	2,46	9,3%	33,5%	17,9%	9,8%	2,00	2,00	4,00	5,4%	26,4%	21,7%	12,4%
(2) vs (1)	14,4%	16,9%	33,8%	-2,8%	-5,0%	2,8%	1,8%	34,0%	24,4%	66,7%	-4,5%	-7,3%	3,9%	2,8%

(b) Ex-ante heterogeneity (Economies 3, 4 and 5)

	Good state							Bad state						
	Percentile ratios			Wealth shares				Percentile ratios			Wealth shares			
	p50/p20	p90/p50	p90/p20	Bot20	Bot50	Top10	Top5	p50/p20	p90/p50	p90/p20	Bot20	Bot50	Top10	Top5
(3) No insurance	1,57	2,43	3,82	7,8%	25,8%	21,2%	11,5%	1,74	2,25	3,90	7,1%	27,0%	22,5%	12,5%
(4) Flat insurance	1,98	3,97	7,86	4,0%	16,2%	27,9%	15,6%	2,49	3,36	8,38	3,0%	16,9%	30,0%	17,0%
(5) Progr insurance	2,45	5,82	14,23	2,2%	9,9%	29,3%	16,3%	3,61	5,13	18,52	1,2%	9,7%	32,1%	18,5%
(4) vs (3)	25,9%	63,3%	105,7%	-3,7%	-9,6%	6,6%	4,1%	43,4%	49,7%	114,6%	-4,1%	-10,0%	7,5%	4,5%
(5) vs (3)	23,5%	46,5%	80,9%	-1,8%	-6,3%	1,5%	0,7%	44,9%	52,5%	120,9%	-1,8%	-7,3%	2,1%	1,5%

increase in inequality.

The results in Panel (b) show that in a world with ex-ante heterogeneity the percentage increase in inequality implied by social insurance is even higher than in a world with only one household type. This reflects the existence of "patient" households, who accumulate more assets, which reinforces the above discussed impact of the rise in the interest rate. However, the increase in inequality is smaller in the case of progressive insurance than in the case of flat insurance and for some inequality measures its is even smaller than in the world with no ex-ante heterogeneity (the decrease in the share of the bottom 20% and the increase in the shares of the top 10% and 5% are smaller). This is in line with the smaller increase in the interest rate and smaller decrease in the wage rate that are obtained in this economy.

4.5 Avenues for future research

As previously discussed, the quantitative experiment presented here is a purely theoretical exercise that constitutes a first step of a long term project. Several additional steps should be taken in the future, to render the model richer and consistent with the data, and to further explore and understand the model's properties and mechanisms.

These steps can be organised into three categories. The first category concerns doing improvements to the version of the model used in the exercise done in this paper. Among these are reversing the model simplifications discussed in subsection 4.4.2, to allow for differentiated transition probabilities for the employment shock, the existence of labour income taxes, a positive capital depreciation rate and different population shares for each skill type. In addition, both macroeconomic and microeconomic datasets should be used to calibrate the model's parameters empirically and verify that the model's aggregate and distributional implications match the salient features of the data.

The second category concerns exploring more in detail some of the results and mechanisms produced by the model. In particular, compute results for income inequality, besides wealth inequality, to further assess the distributional implications of the model and investigate whether the conclusions obtained for wealth inequality also apply to income inequality. Furthermore, explore the connection between the distributional and aggregate impacts of a crisis and further develop on the mechanisms shaping the impact of social insurance on inequality and the aggregate economy. In particular, investigate the surprising result that the introduction of insurance leads to an increase in wealth inequality. Finally, compute the Marginal Propensity to Consume (MPC) of the different household types and investigate the relationship between differences in MPCs and the results for aggregate consumption. Several studies have highlighted that in a heterogeneous agents framework MPCs will be heterogeneous across the income and wealth distributions and this will have important implications for aggregate activity (see e.g. Carroll & Kimball (1996), Carroll (2000), Carroll, Slacalek, Tokuoka & White (2017) and Auclert & Rognlie (2018)). This therefore an aspect that should certainly be included in the analysis. Finally, the numerical constraints and difficulties associated with solving the model need to be further explored, in particular those related to the setting of the borrowing constraint, which has non-negligible implications for the model's convergence properties.

The third category concerns adding new elements to the theoretical model. Among the possible ones, two are likely to be more relevant. The first is considering aggregate shocks, as first introduced in Krusell & Smith (1998) and then further explored in subsequent models (see e.g. , Krueger et al. (2016b) and Challe et al. (2017)). This would allow to go beyond the steady-state type of analysis done in this paper, where the economy moves deterministically and immediately from a good to a bad state, to a business cycle type of analysis, where the economy is stochastic, being constantly hit by good and bad shocks. The second is introducing nominal rigidities as in Heterogeneous Agent

New Keynesian (HANK) models (see e.g. , Challe et al. (2017), Challe (2018) and Kaplan, Moll & Violante (2018)). This feature has been shown to matter for the transmission of aggregate shocks in the context of heterogeneous agents DSGE models and could therefore be an important addition to the current version of the model.

4.6 Concluding remarks

Over the last thirty years, modern macroeconomic modelling has shifted from the workhorse representative agent model to heterogeneous agents models, which incorporate one or more sources of household heterogeneity. The development of these models has prompted a new avenue for research, related to the possible interactions between aggregate and distributional phenomena and the re-evaluation of many aspects of the conventional wisdom, in light of these interactions.

Among the several important topics whose study can be improved by the use of these models is the consequences of aggregate crises and the design of crisis-coping policies. The perils of ignoring the interactions between inequality and the aggregate economy in a crisis context became evident following the 2007-2008 crisis. In the aftermath of the crisis, several European countries adopted austerity measures aimed at promoting fiscal consolidation, without a thorough evaluation of the impact that these measures could have on inequality and how this in turn could feedback into aggregate activity. Although several economists warned about the possibility that an increase in inequality would hold on the recovery, standard macroeconomic models did not account for it and policy makers largely bypassed it.

In this paper I present the ideas, preliminary results and future steps of a long term project aimed at contributing to a better understanding of this subject. Specifically, the project focuses on investigating the distributional consequences of aggregate crises and the role of inequality and social insurance in shaping aggregate activity in times of crisis, trying to answer the question "Does household heterogeneity matter for the effects of aggregate crises and can social insurance play a role in shaping these effects?". To do so, I develop a theoretical heterogeneous agents incomplete markets DSGE model, with both ex-ante and ex-post household heterogeneity, and one important source of social insurance, unemployment insurance.

The preliminary results presented here are derived from a first quantitative experiment aimed at

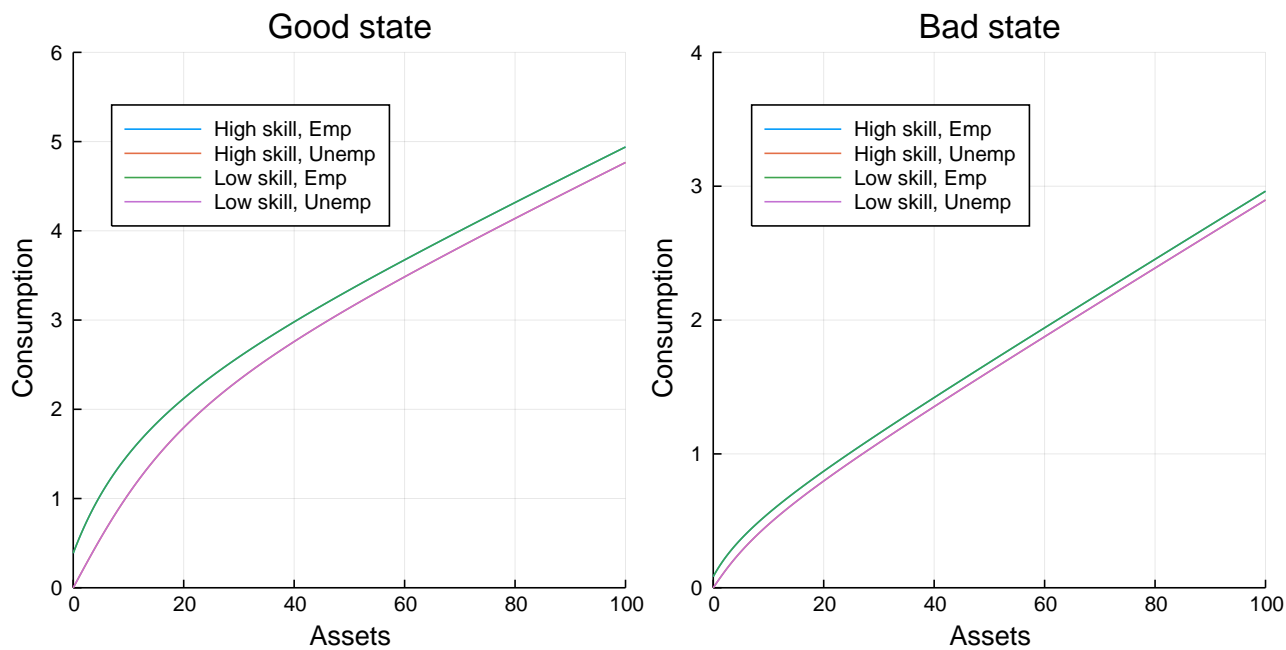
exploring the model's main properties and mechanisms. The analysis is based on a simplified version of the model and constitutes a preliminary and incomplete attempt at investigating the research questions described above. The results show that heterogeneity does matter for the transmission of a crisis to aggregate activity. A crisis will lead to a higher contraction of aggregate consumption in a world where there are both ex-ante and ex-post sources of household heterogeneity than in a world where there is only ex-post heterogeneity. Policies aimed at tackling sources of ex-ante heterogeneity (due to differences in skills, access to credit markets, or access to information about investment options) may therefore be helpful in stabilising aggregate demand following a crisis. Furthermore, a crisis will imply a smaller contraction of aggregate consumption in a world with social insurance than in a world without. This mitigation effect will be higher with a progressive insurance scheme than with a flat one. Therefore, attention should be given to social insurance as an integrant part of the crisis-coping policy mix, beyond the traditional focus given to monetary and fiscal policies.

Several steps should be taken in the future, to render the model richer and consistent with the data, and to further explore and understand the model's properties and mechanisms. Among the most important ones is moving from a purely theoretical analysis to one that uses macroeconomic and microeconomic datasets to calibrate the model's parameters empirically and verify that the model's aggregate and distributional implications match the salient features of the data. Only this way can the results obtained from the model be confidently used as a base for policy analysis. Furthermore, the introduction of nominal rigidities may be crucial, by affecting the way in which prices respond to the crisis and to social insurance, given that these responses have important implications for the results. Finally, the introduction of aggregate shocks would be an insightful addition, as it would allow for the study of the transitional dynamics in a crisis aftermath, beyond the steady-state type of analysis that is done here.

4.7 Appendix

Figure 4.4 – Consumption decision rules

(a) Economy 1 - No ex-ante heterogeneity, No insurance



(b) Economy 2 - No ex-ante heterogeneity, Flat insurance

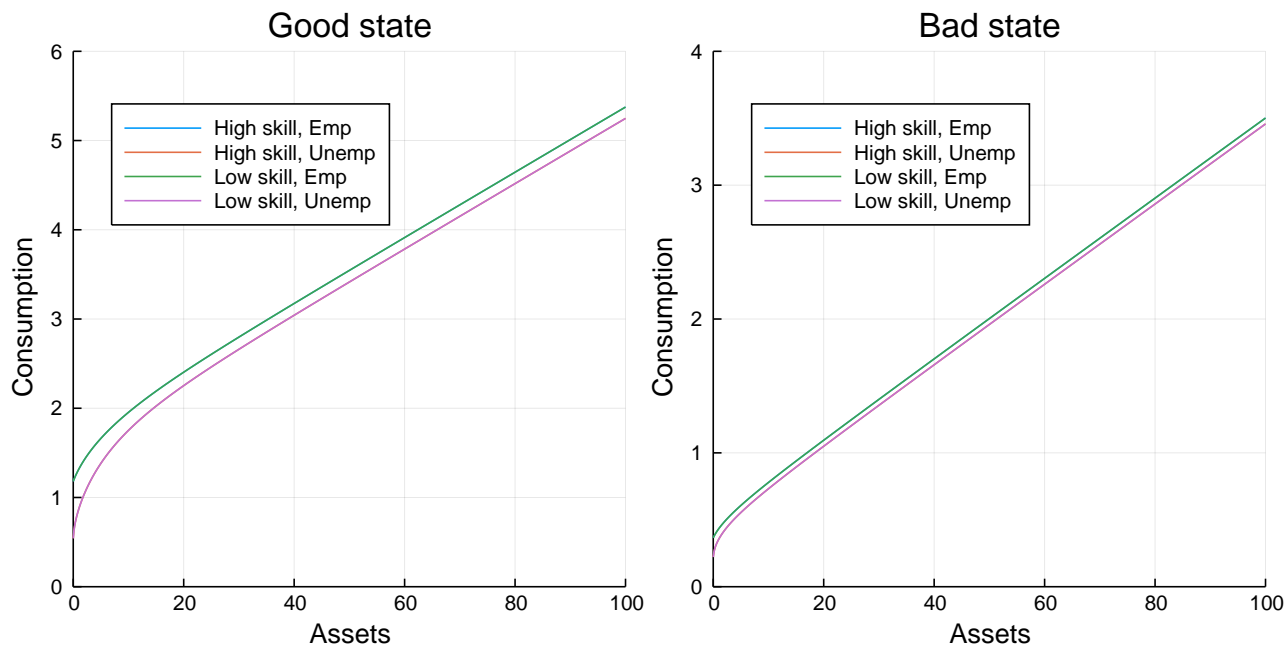
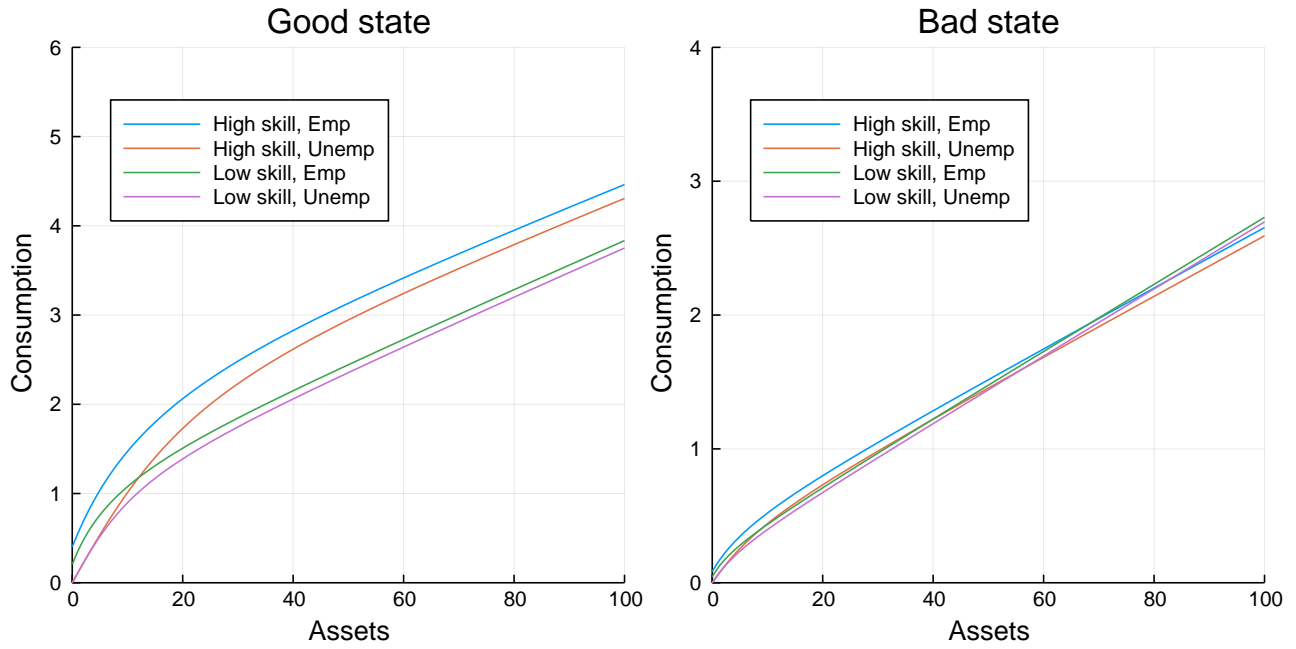


Figure 4.5 – Consumption decision rules (continued)

(a) Economy 3 - Ex-ante heterogeneity, No insurance



(b) Economy 4 - Ex-ante heterogeneity, Flat insurance

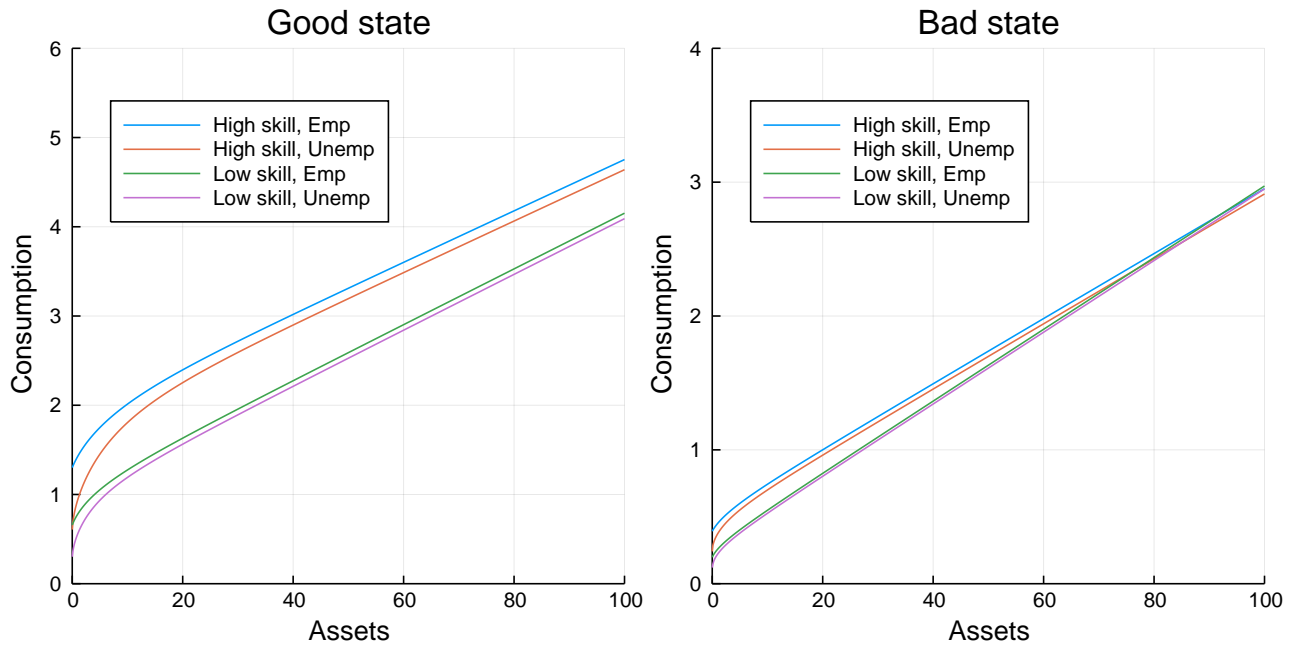


Figure 4.6 – Consumption decision rules (continued)

(a) Economy 5 - Ex-ante heterogeneity, Progressive insurance

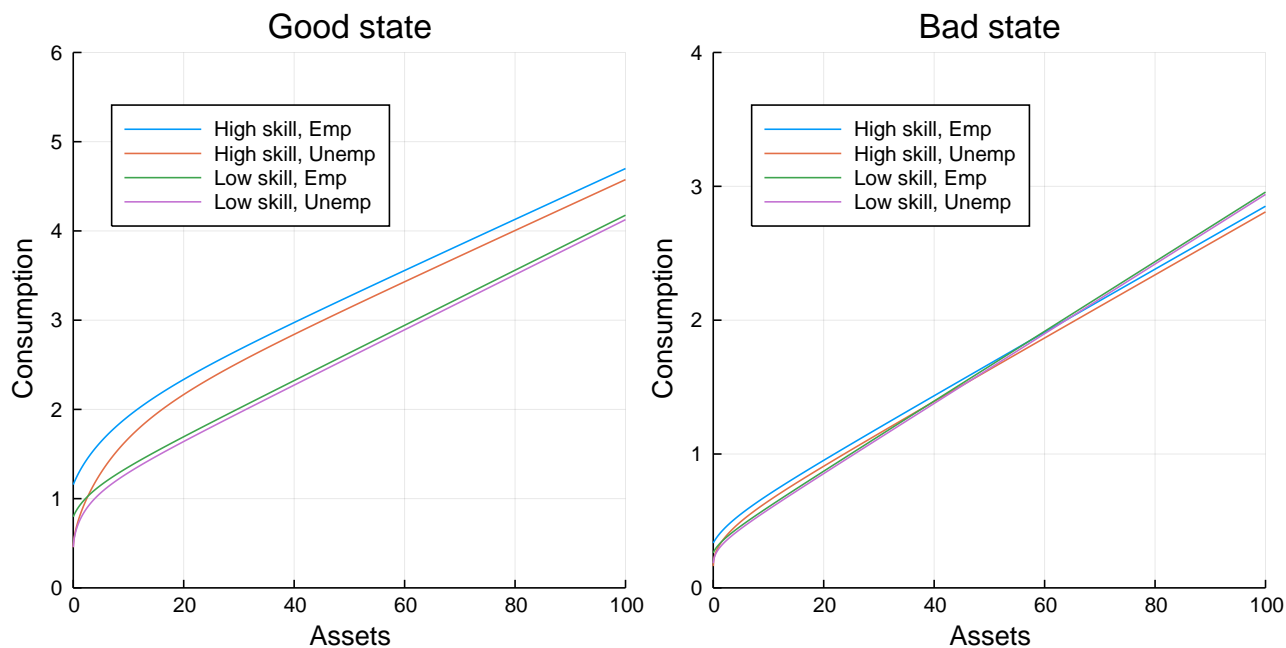


Figure 4.7 – Savings decision rules

(a) Economy 1 - No ex-ante heterogeneity, No insurance

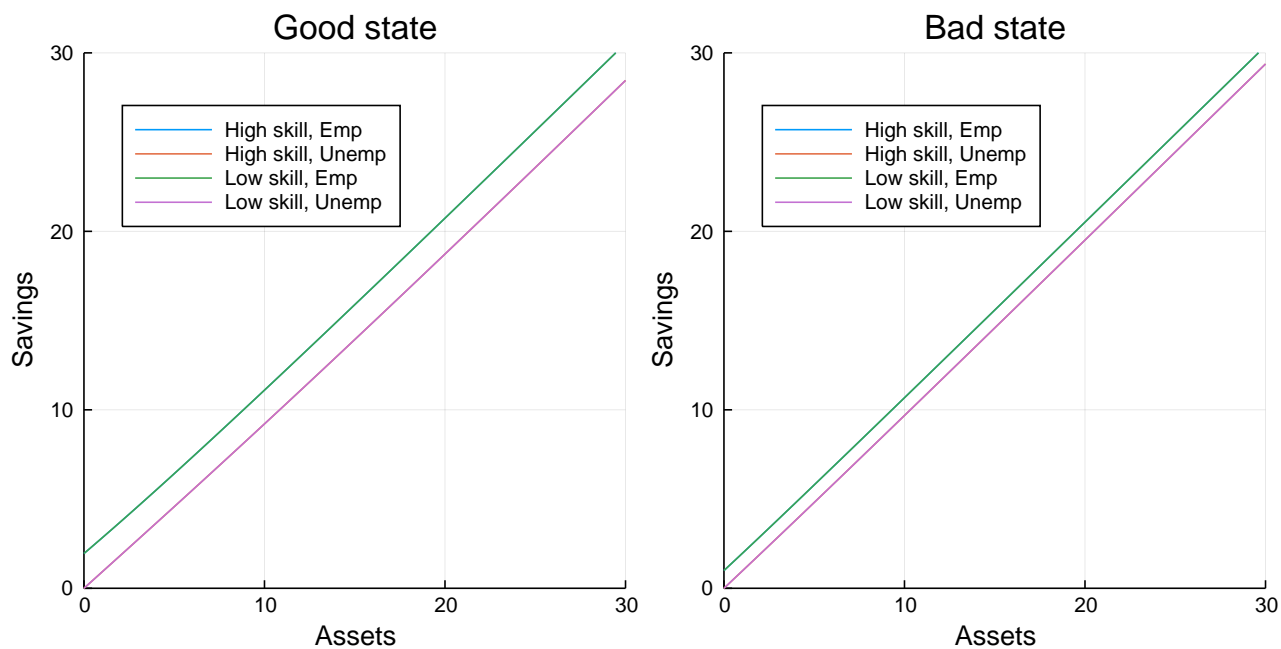
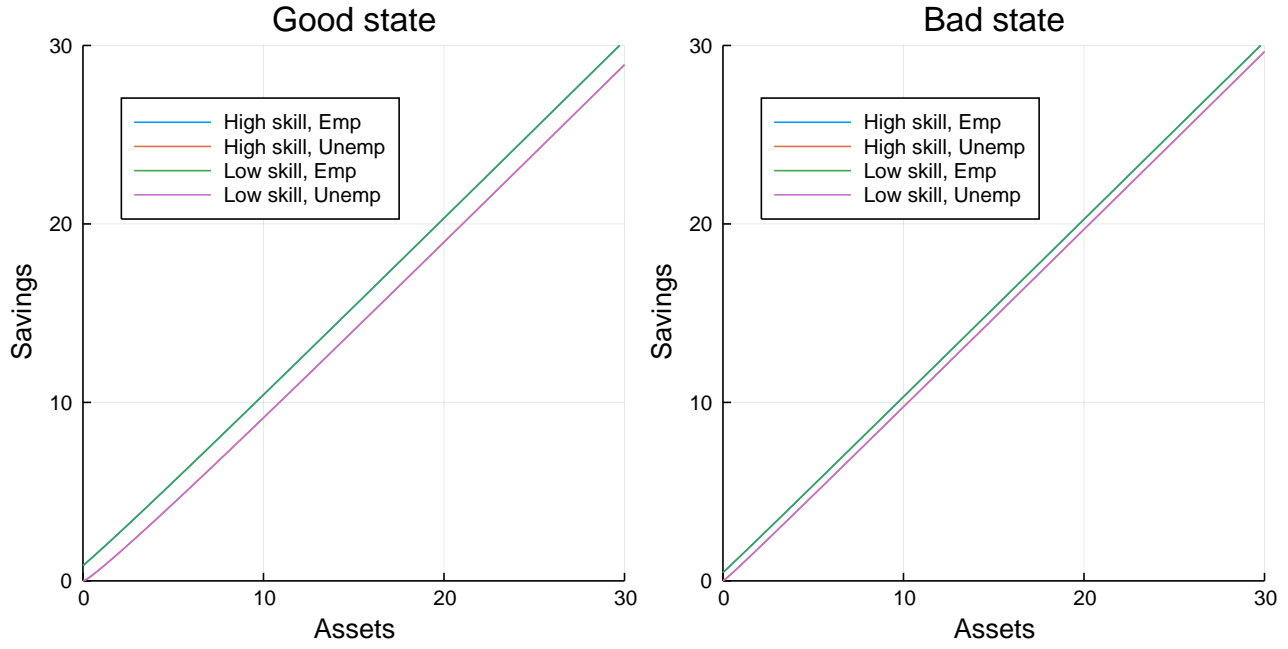


Figure 4.8 – Savings decision rules (continued)

(a) Economy 2 - No ex-ante heterogeneity, Flat insurance



(b) Economy 3 - Ex-ante heterogeneity, No insurance

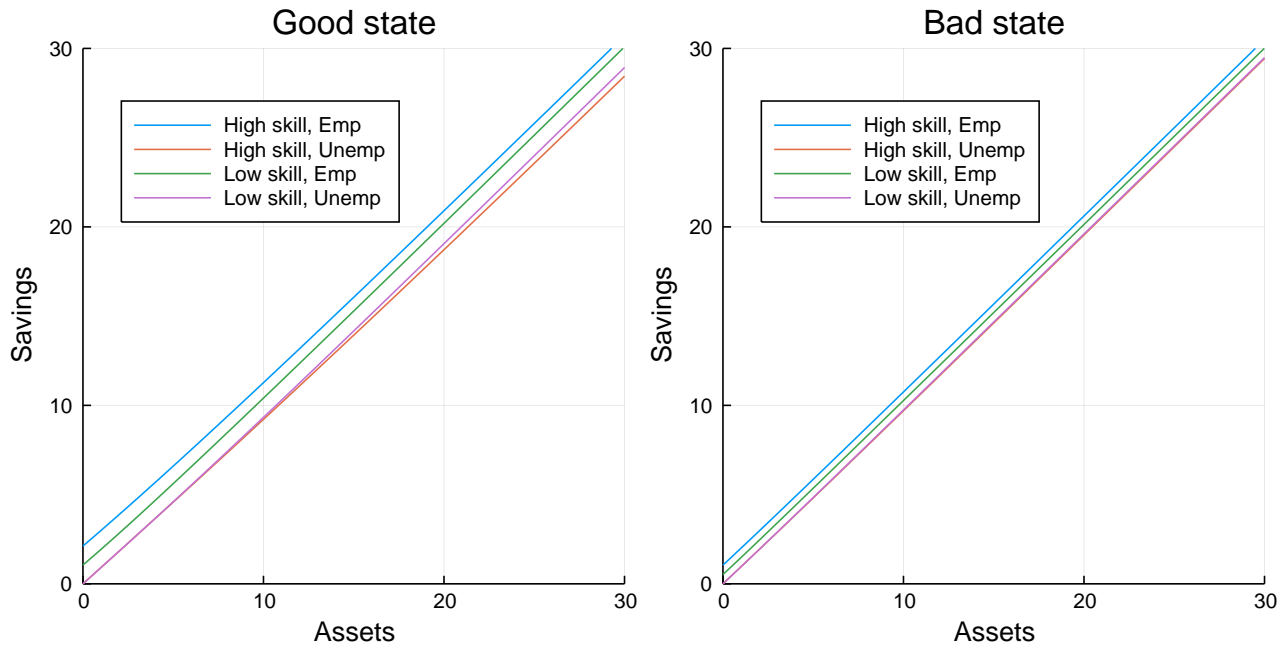
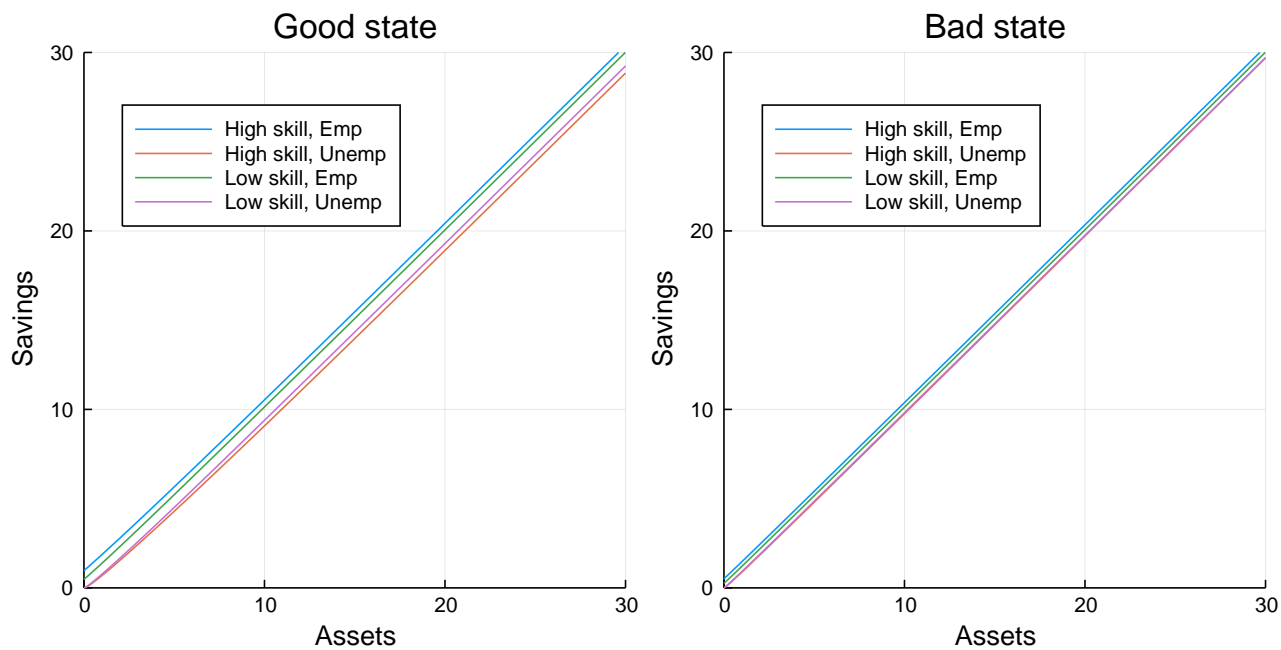


Figure 4.9 – Savings decision rules (continued)

(a) Economy 4 - Ex-ante heterogeneity, Flat insurance



(b) Economy 5 - Ex-ante heterogeneity, Progressive insurance

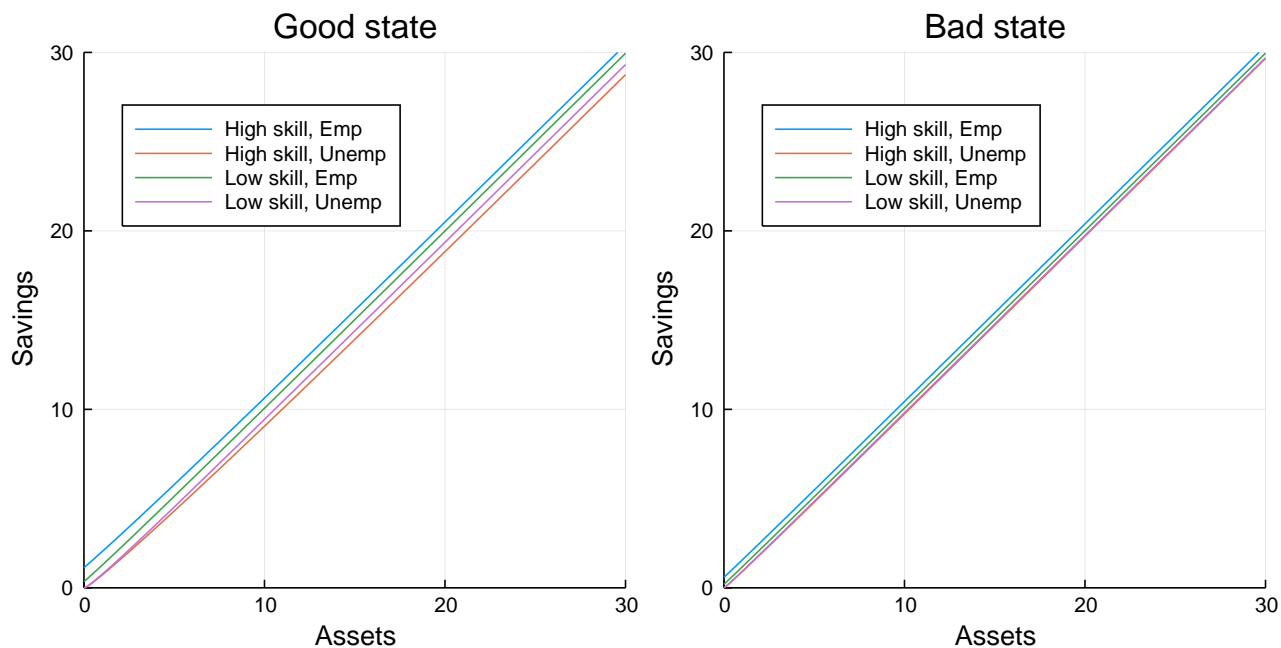
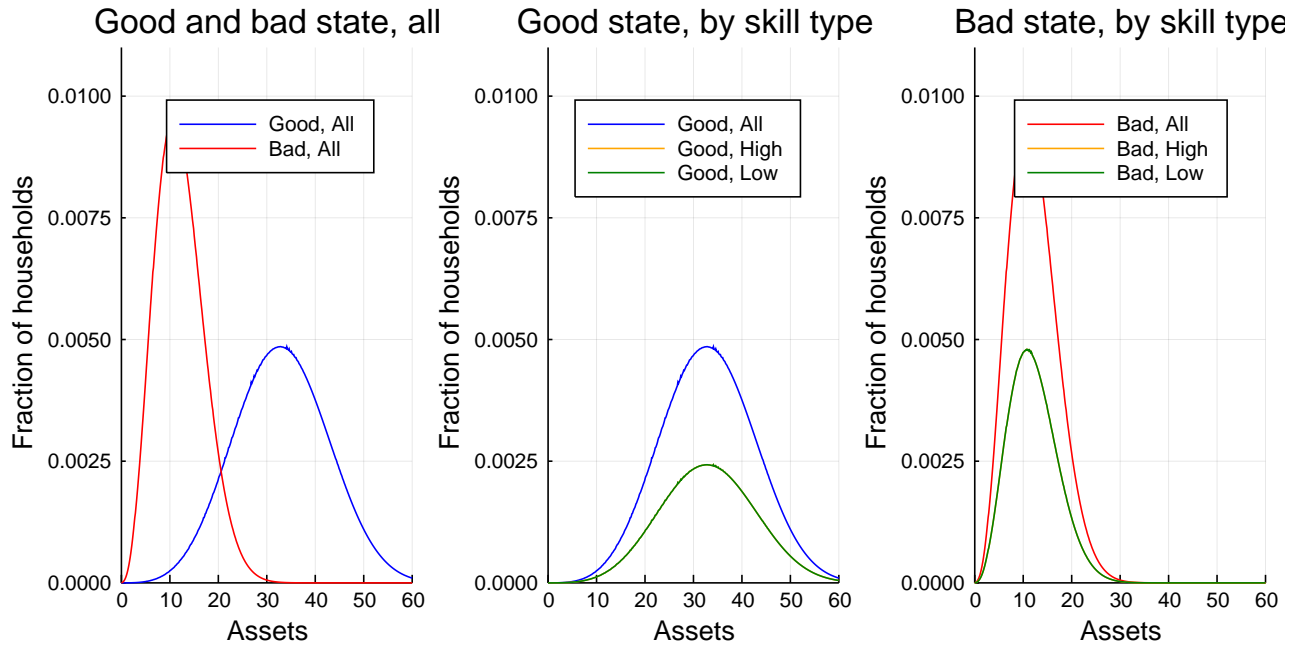


Figure 4.10 – Wealth distributions

(a) Economy 1 - No ex-ante heterogeneity, No insurance



(b) Economy 2 - No ex-ante heterogeneity, Flat insurance

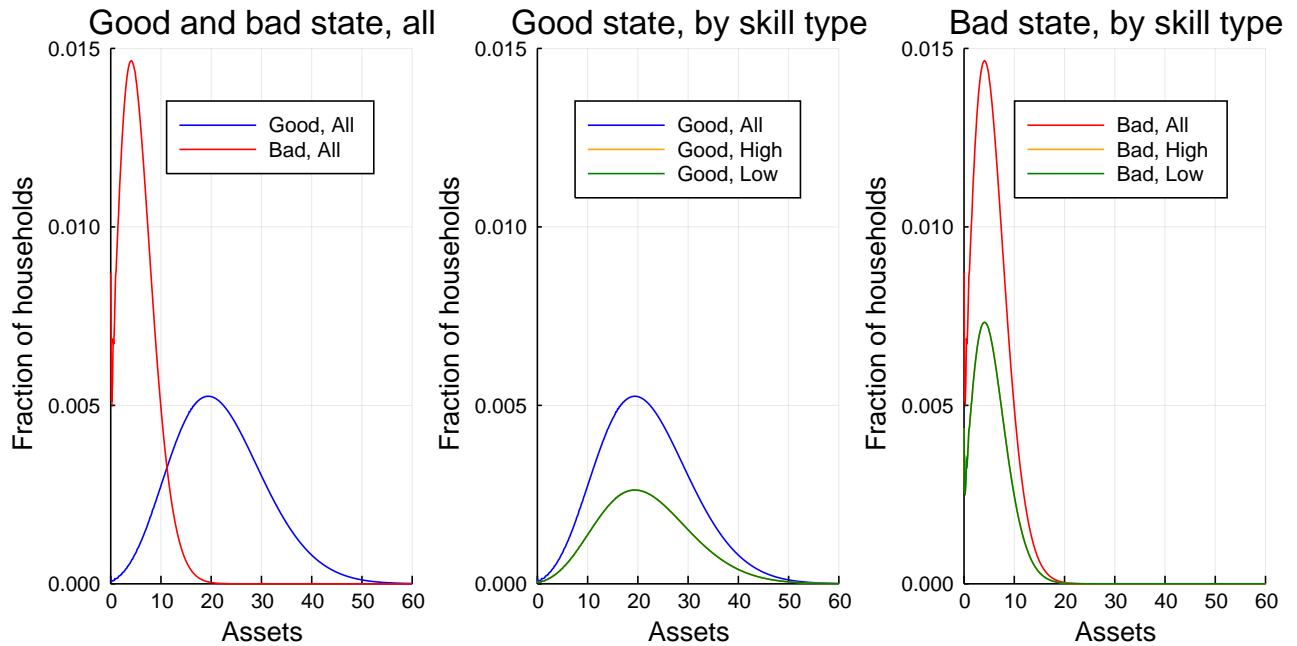
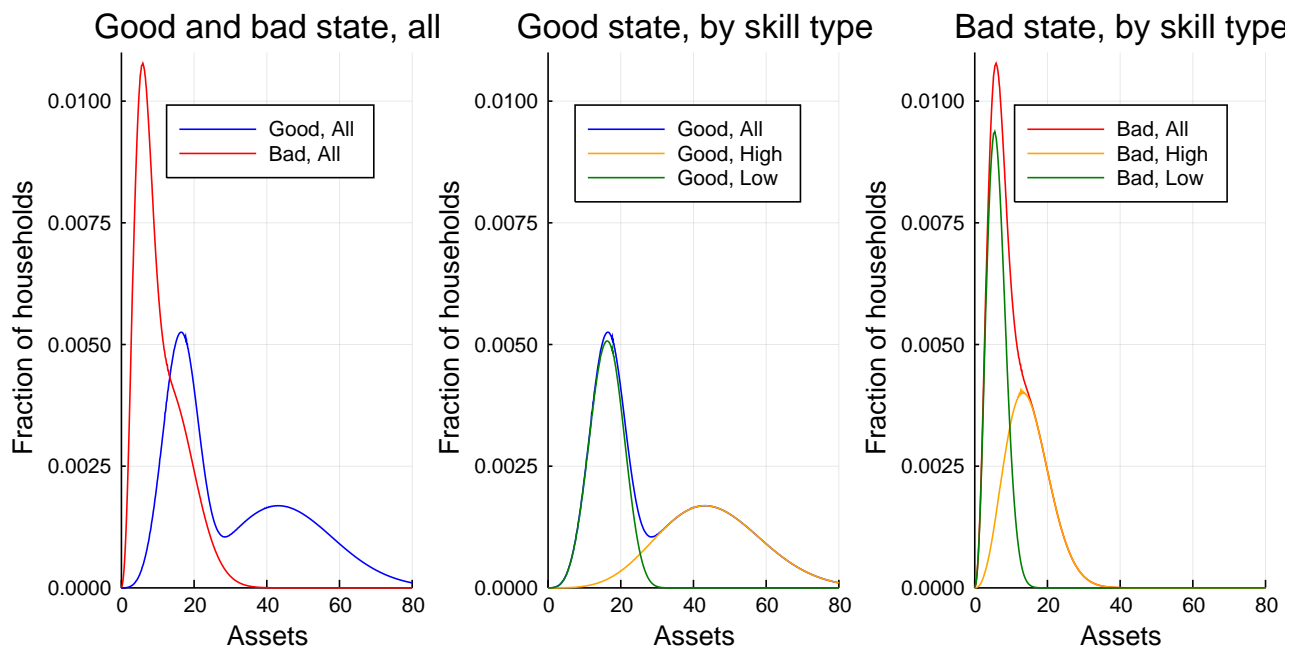


Figure 4.11 – Wealth distributions (continued)

(a) Economy 3 - Ex-ante heterogeneity, No insurance



(b) Economy 4 - Ex-ante heterogeneity, Flat insurance

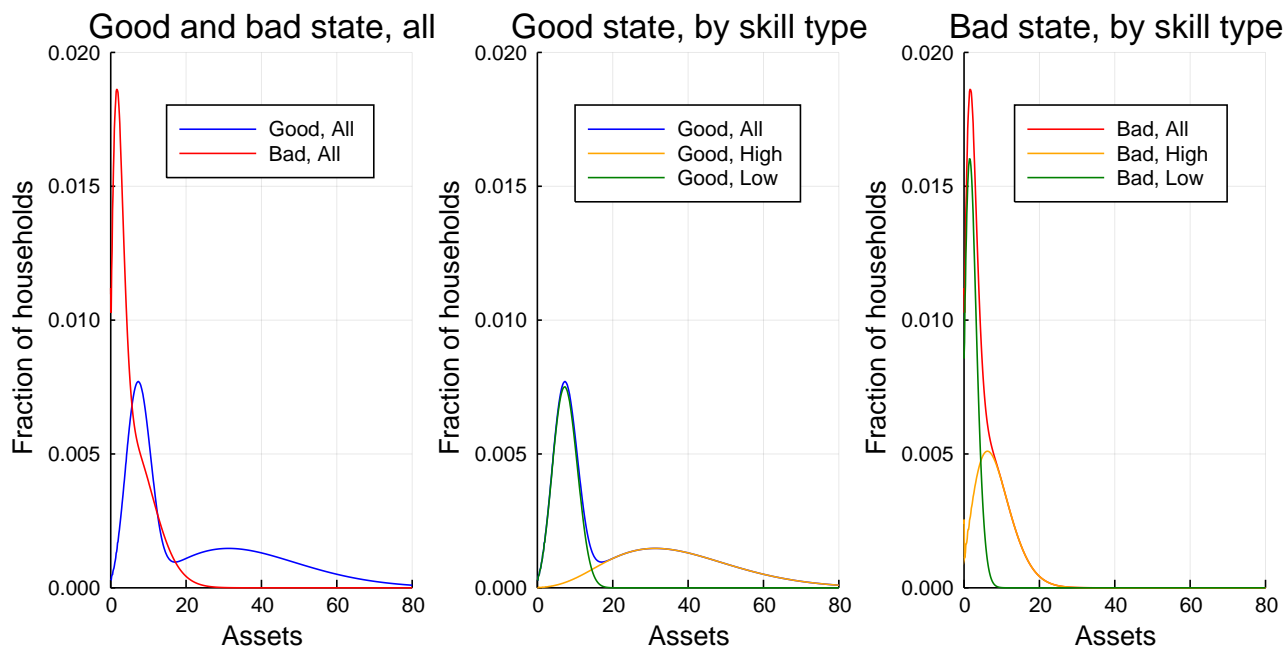


Figure 4.12 – Wealth distributions (continued)

(a) Economy 5 - Ex-ante heterogeneity, Progressive insurance

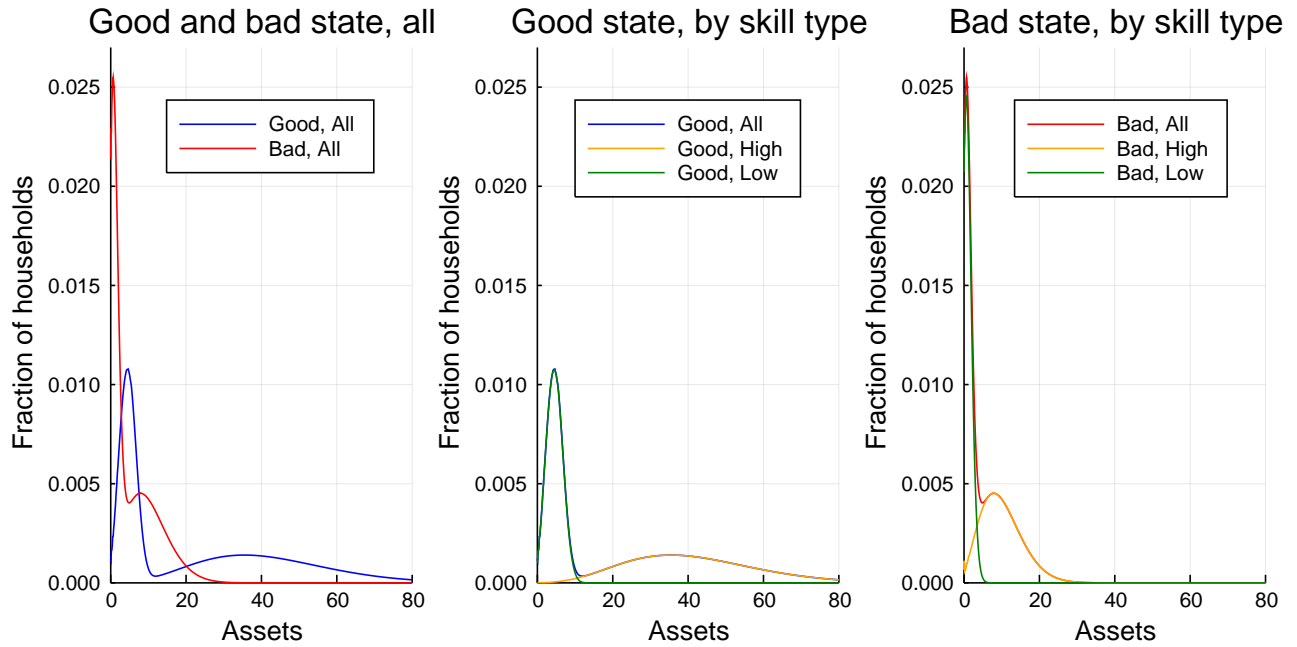


Figure 4.13 – Lorenz curves

(a) Economy 1 - No ex-ante heterogeneity, No insurance

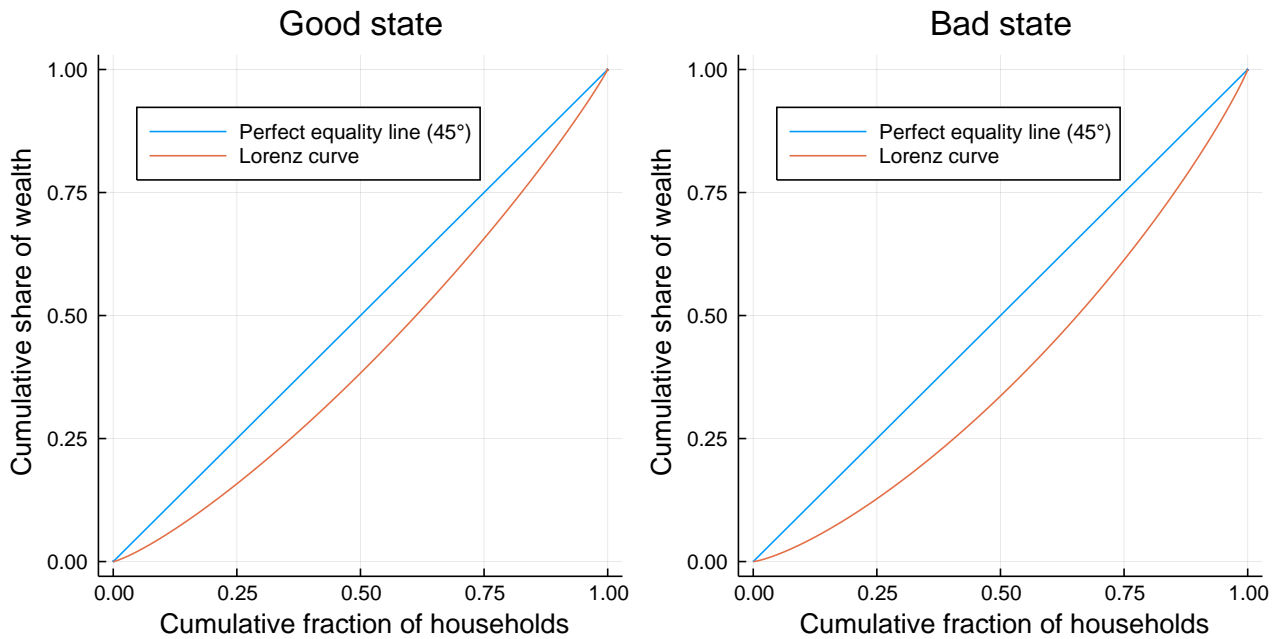
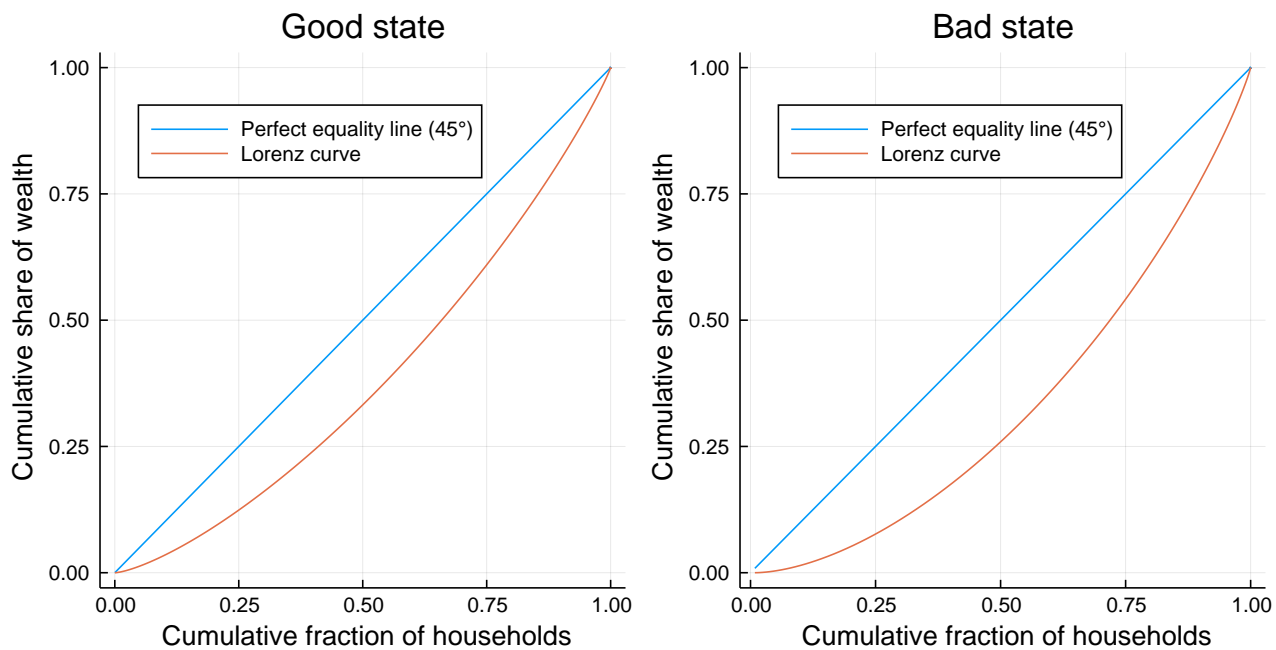


Figure 4.14 – Lorenz curves

(a) Economy 2 - No ex-ante heterogeneity, Flat insurance



(b) Economy 3 - Ex-ante heterogeneity, No insurance

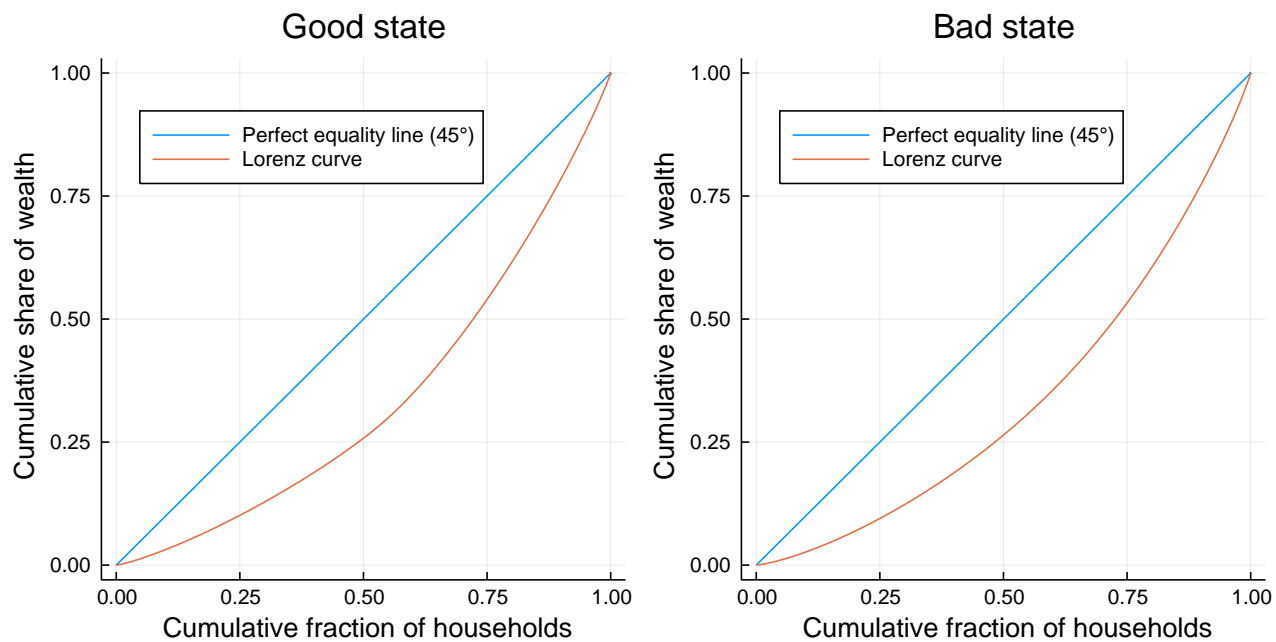
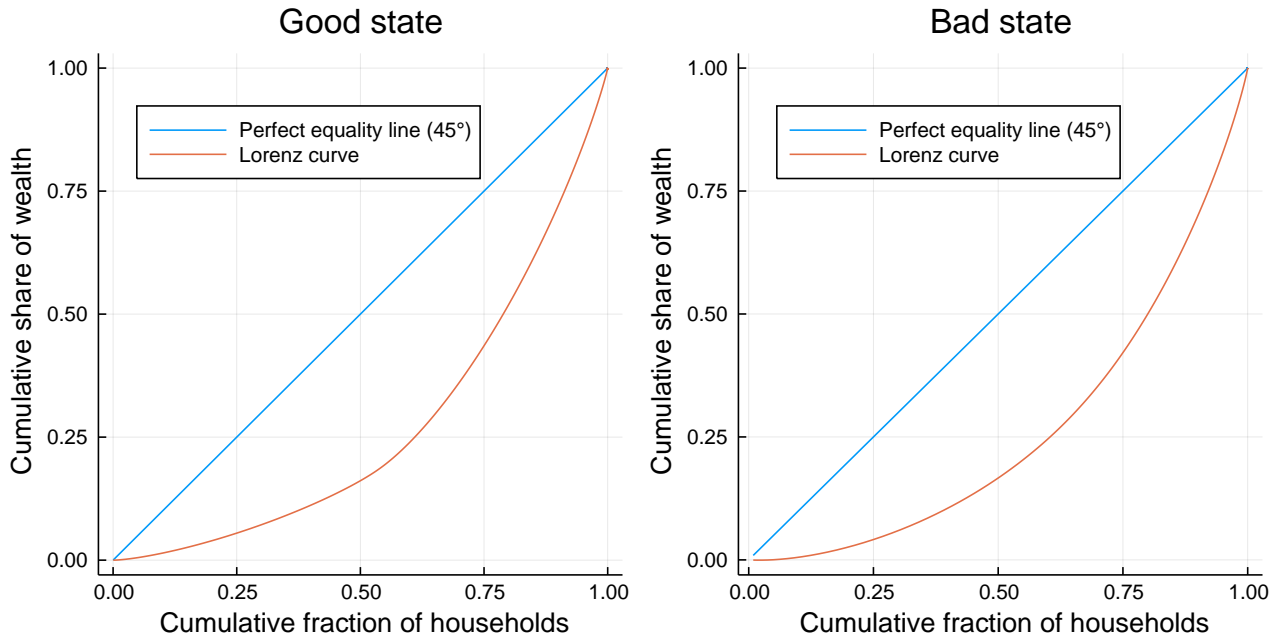
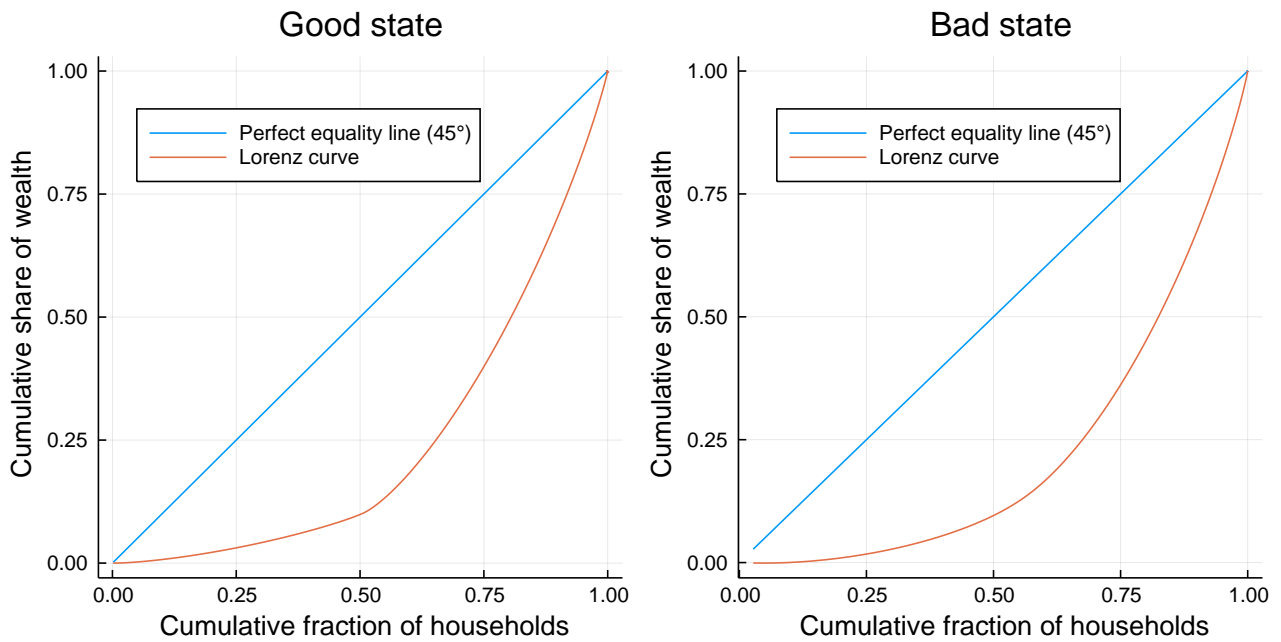


Figure 4.15 – Lorenz curves (continued)

(a) Economy 4 - Ex-ante heterogeneity, Flat insurance



(b) Economy 5 - Ex-ante heterogeneity, Progressive insurance



Chapter 5

General conclusion

5.1 Main conclusions

This thesis has shed new light on the distributional consequences of aggregate crises and the role of the tax and transfer system in stabilising the income distribution and aggregate outcomes in a crisis aftermath. It has done so using a rich set of methods and datasets, both at the micro and macro level, adopting both an empirical and theoretical approach. The combination of different methods at different levels of analysis has allowed for an integrated and comprehensive perspective on the subjects under study, and has highlighted the complementarities between the different approaches.

The first paper has documented in a new and detailed way some key facts about the distributional effects of the 2007-2008 crisis and the cushioning role of the tax and transfer system, in the US. It has shown that the crisis led to a strong and persistent increase in market income inequality, largely driven by dramatic and persistent losses for lower income households, which contrasted with weaker and more transitory losses for higher income ones.

Furthermore, it has shown that the tax and transfer system was key at cushioning these adverse distributional effects, with cash transfers being the most important instrument. Notwithstanding, the system did not fully cushion the increase in inequality and the recovery of household incomes in the crisis aftermath was largely uneven. Five years into the onset of the crisis, disposable income inequality was still above its pre-crisis level, with higher income groups having almost fully recovered to their pre-crisis income levels, while lower income groups were still experiencing non-negligible losses. The system prevented the bottom and the middle of the distribution from growing apart, but not the top from distancing itself relative to both the bottom and the middle.

Importantly, this evolution reflected two very distinct phases. The first one corresponded to the GR years, when redistribution increased significantly fully cushioning the rise in market income inequality. This period coincided with the adoption of multiple stimulus measures, which strengthened the redistributive effect of the tax and transfer system. The second one corresponded to the recovery years, when redistribution decreased and disposable income inequality grew more than market income inequality. This period was marked by a clear reduction of the stimulus effort, with many of the previous measures being gradually phased out or scaled back. These results suggest that tax and transfer policies may have missed the persistence of the distributional effects of the crisis, determining a premature unwind of the measures taken in the immediate crisis aftermath, fueling a rise in inequality.

The second paper has developed a new method to model the household disposable income distribution and decompose changes in this distribution into the contributions of four key factors. Furthermore, it has applied this new framework to the study of distributional developments in the post 2007-2008 crisis period in Portugal, which included the "direct" impacts of the crisis, the effects of stimulus measures taken in the immediate aftermath of the crisis, and the consequences of austerity measures taken after 2010. Results illustrate the complexity of the Portuguese experience and clearly show that it embodied markedly different developments over two periods: 2007 to 2009, when the crisis had not yet hit the country in full force and stimulus measures were adopted; 2010 to 2013, when the crisis had its most profound recessive effects and the country was subject to severe austerity measures, particularly in the context of the EAP signed by the government and the Troika in 2011.

The fiscal stimulus measures adopted in the immediate aftermath of the crisis determined significant income gains, and were particularly beneficial for households at the bottom of the income distribution. They had an equalising effect, implying a slight decrease in market income inequality and a significant decrease in disposable income inequality. Automatic stabilisers also played a role, by preventing (the yet small) employment losses from translating into significant decreases in disposable income.

The effects of the crisis felt from 2009 onwards together with the austerity measures that began in 2010 took a toll on the incomes of households across the entire income distribution, particularly those at the bottom and at the top. Furthermore, they had a disequalising effect, implying a significant increase in market income inequality and a mild increase in disposable income inequality.

Taking the period between 2007 and 2013 as a whole, the income losses between 2010 and 2013 were stronger than the gains between 2007 and 2009 for households at the very bottom and top of the income distribution. For those in the middle, losses and gains more or less cancelled out such that they did not experience significant income changes. Market income inequality increased significantly, but disposable income inequality decreased, as the noteworthy fall between 2007 and 2009 more than compensated the rise between 2010 and 2013.

The third paper has developed a theoretical heterogeneous agents incomplete markets DSGE model, with both ex-ante and ex-post household heterogeneity and unemployment insurance. In addition, it has used the model for a quantitative theoretical experiment, studying the distributional and aggregate effects of a crisis and the role of unemployment insurance in shaping these effects, under several hypothetical crisis scenarios.

Preliminary results show that heterogeneity matters for the impacts of a crisis. In all economies, the existence of ex-post idiosyncratic risk leads to an increase in inequality following a crisis, as a result of an increase in the probabilities of becoming or remaining unemployed. Furthermore, results for economies where there is only ex-post heterogeneity are significantly different from results for economies where there are both types of heterogeneity.

Results also show that social insurance helps to mitigate the impact of a crisis on aggregate consumption and this effect is stronger for a higher degree of heterogeneity. Furthermore, this mitigation effect is stronger when the unemployment insurance scheme is progressive than when it is flat.

5.2 Main lessons and policy implications

Several lessons and policy implications can be drawn from the results obtained in this thesis. First, aggregate crises may have substantial heterogeneous effects across the income distribution, being particularly penalising for lower income groups, and these effects may be considerably persistent. When deciding on crisis-coping actions, policy-makers should not underestimate the need for redistributive policies aimed at correcting crisis-led distributional imbalances, by promoting a more equal sharing of the burden of adjustment to income losses in a crisis context.

Second, the tax and transfer system can crucially impact the evolution of the income distribution following a crisis. A strong tax and transfer system may fully cushion the distributional impacts of a crisis, while a weak one may deepen them. Beyond the normal functioning of automatic stabilisers, discretionary policy choices may have substantial effects.

Third, not only the size but also the design of taxes and transfers matters for the effects of the system as a whole in times of crisis. In particular, for a given size, a more progressive instrument will have a higher stabilising effect than a flat one, both at the distributional and aggregate level. When deciding on changes to the system in a crisis context, policy makers should take into account that choosing a high degree of progressivity may be key.

Fourth, policies aimed at stabilising aggregate outcomes in times of crisis may have significant "collateral" effects on the income distribution. In particular, the implementation of austerity measures may reinforce income losses induced by the contractionary effects of the crisis and impact the

heterogeneity of the effects of a crisis on households' incomes, determining important income gains or losses for different income groups. When facing rising unemployment, decreasing aggregate activity and growing budget deficits, following a crisis, governments need to take into careful consideration the distributional impacts of their policy choices, searching for a balance between stabilising aggregate outcomes and shielding households from extreme and unequal income changes.

Finally, household heterogeneity and social insurance matter for the transmission of an aggregate crisis to aggregate outcomes. A crisis will lead to a higher contraction of aggregate consumption in a world where there are both ex-ante and ex-post sources of household heterogeneity than in a world where there is only ex-post heterogeneity. Policies aimed at tackling sources of ex-ante heterogeneity (due to differences in skills, access to credit markets, or access to information about investment options) may therefore help in stabilising aggregate demand following a crisis. Furthermore, a crisis will imply a smaller contraction of aggregate consumption in a world with social insurance than in a world without. Therefore, attention should be given to social insurance as an integrant part of the crisis-coping policy mix, beyond the traditional focus given to monetary and fiscal policies.

5.3 Some avenues for further research

As previously mentioned, this thesis marks the beginning of a long-term research agenda. Among the many ideas for further research, three are particularly noteworthy. The first one concerns an ongoing project on establishing a link between a microsimulation model and a DSGE model, specifically linking the European Commission's EUROMOD microsimulation model with the QUEST DSGE model. This is a very promising avenue for future research. On the one hand, it allows to incorporate the complexity of the tax and transfer system into a general equilibrium macroeconomic model, which typically has a very simplified representation of taxes and transfers. On the other hand, it takes direct advantage of the richness of the micro level dataset on which the microsimulation model is based to improve the matching of the macroeconomic model to the data. This way, it opens the path for a deeper and more realistic study of the aggregate impacts of changes in different elements of the tax and transfer system.

The second one relates to another ongoing project, which was initially planned to be included as a chapter in this thesis, aimed at investigating empirically the aggregate demand effects of rising income

inequality in times of crisis. It focuses on the 2007-2008 crisis in the US, drawing on state-level panel data from the Current Population Survey (CPS) and the Bureau of Economic Analysis Personal Consumption Expenditures by State, between 2006 and 2015. It involves estimating a state panel fixed effects model, exploring variation in the timing and severity of the crisis across states to assess whether: (i) states where the crisis hit harder experienced more significant increases in income inequality; (ii) states with higher rises in income inequality experienced a more pronounced contraction and a slower recovery of aggregate consumption.

The third one involves deepening the work started in the third paper, improving on some aspects of the current model and exploring possible extensions. In particular, the channels through which social insurance affects aggregate outcomes should be further explored, including an investigation of the MPC generated by the model and its implications for the results. Furthermore, the model should be empirically calibrated, such that the model's aggregate and distributional implications match the salient features of the data. Finally, it would be interesting to consider the introduction of aggregate shocks and nominal rigidities in the model.

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