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

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

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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.

Keywords: income distribution, inequality, decompositions, microsimulation, tax-benefit policies, crisis, austerity, overtime comparison

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

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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 and Smolensky 1977, Shorrocks 1980, Shorrocks 1982, Shorrocks 1984 and Lerman and 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 et al. 1993, DiNardo et al. 1996 and Bourgignon et al. 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 Bourgignon and 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 and Sousa 2012, Ball et al. 2013, Bova et al. 2013, Rawdanowicz et al. 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 2 discusses the motivation and reviews related literature, presenting the paper's main contributions; Section 3 introduces the methodology used to model the household disposable income distribution and decompose changes in this distribution over time; Section 4 presents the context and results of the illustrative application done to Portugal between 2007 and 2013; Section 5 concludes and discusses some policy implications.

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 and Smolensky (1977), Shorrocks (1980), Shorrocks (1982), Shorrocks (1984) and Lerman and 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 conterfactual 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 and 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 conterfactual 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 and 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 Sub-section 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 et al. 2013, Rodrigues et al. 2016b, Callan et al. 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 in 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 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) overt 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 probabillity 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 Sub-section 3.1, we provide an overview of the different income components that we model. In Sub-section 3.2, we present the parametric specifications used to model market incomes. In Sub-section 3.3, we describe how taxes and benefits are computed using EUROMOD. Finally, in Sub-section 3.4, we explain how counterfactual distributions are generated and the mechanics of the decomposition exercise.

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:

$$y_h = \underbrace{y_h^L + y_h^K + y_h^O}_{Market} + \underbrace{y_h^B - y_h^T}_{Non-market} \tag{1}$$

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 (pripen) 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:

$$y_h^L = \sum_{i=1}^{n_h} I_{hi}^{lab} \left(I_{hi}^{emp} y_{hi}^{emp} + I_{hi}^{semp} y_{hi}^{semp} \right) \tag{2}$$

$$y_h^K = \sum_{i=1}^{n_h} \left(I_{hi}^{inv} y_{hi}^{inv} + I_{hi}^{prop} y_{hi}^{prop} \right) \tag{3}$$

$$y_h^O = \sum_{i=1}^{n_h} \left(I_{hi}^{pripen} y_{hi}^{pripen} + I_{hi}^{other} y_{hi}^{other} \right) \tag{4}$$

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 $S \in$\{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):

$$y_h^B = y_h^{pens} + y_h^{mtb} + y_h^{nmtb} \tag{5}$$

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:

$$y_h^T = y_h^{tax} + \sum_{i=1}^{n_h} y_{hi}^{ssc} \tag{6}$$

3.2 Parametric modelling of market incomes

The modelling of market income builds heavily on the method developed in Bourgignon 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 modelilng 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^s_{hi}, 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^{s*}_{hi}, being equal to one when this value is positive and zero otherwise, i.e. $I^s_{hi} = 1$ if $I^{s*}_{hi} > 0$ and $I^s_{hi} = 0$ otherwise. The latent variable in turn depends linearly on a set of observable characteristics, x_{hi}, and on an error term, ϵ^s_{hi}, such that $I^{s*}_{hi} = x_{hi}\gamma^s + \epsilon^s_{hi}$. We then have $I^s_{hi} = \mathbf{1}\left[\epsilon^s_{hi} > -x_{hi}\gamma^s\right]$, where $\mathbf{1}\left[cond\right]$ is equal to one if $cond$ is true and zero otherwise. The logistic regression model assumes that ϵ^s_{hi} has a logistic distribution such that the (conditional) probability of earning any income from source s is given by:

$$\Pr(I^s_{hi} = 1|x_{hi}) = \Pr(x_{hi}\gamma^s + \epsilon^s_{hi} > 0) = \Pr(-\epsilon_{hi} < x_{hi}\gamma^s) = \frac{\exp(x_{hi}\gamma^s)}{1 + \exp(x_{hi}\gamma^s)} \tag{7}$$

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^{lab}_{hi}, I^{emp}_{hi} and I^{semp}_{hi}appearing in equation (2); I^{inv}_{hi} and I^{prop}_{hi}appearing in equation (3); and I^{pripen}_{hi} and I^{other}_{hi}appearing in equation (4).

Levels of labour income sources

We start by modelling the earnings of self-employed workers, the variable y^{semp}_{hi} appearing in Equation (2), according to the following log-linear regression model:

$$y^{semp}_{hi} = \exp(x_{hi}\beta^{semp} + \upsilon^{semp}_{hi}) \tag{8}$$

where v_{hi}^{semp} is a zero-mean residual with homoscedastic variance $\sigma^{2,semp}$.[1]

We then model the earnings of salaried employed workers, the variable y_{hi}^{emp} appearing in Equation (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}:

$$y_{hi}^{emp} = w_{hi} s_{hi} \tag{9}$$

We model hours worked using a basic linear regression model:

$$s_{hi} = x_{hi}\gamma^{hrs} + \epsilon_{hi}^{hrs} \tag{10}$$

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:

$$F_{X=z}(w) = \text{SM}(w; a(z), b(z), q(\text{z})) = 1 - \left[1 + \left(\frac{w}{b(z)}\right)^{a(z)}\right]^{-q(z)} \tag{11}$$

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 et al. 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 and Jenkins (2005) or Van Kerm (2013). Individual wage is then given by:

$$w_{hi} = F_{X=z}^{-1}(v_{hi}^{emp}) = b(z)[(1 - v_{hi}^{emp})^{-\frac{1}{q(z)}} - 1]^{\frac{1}{a(z)}} \tag{12}$$

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

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

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 unskilled [2]. 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:

$$\Pr(I_{hi}^{j,occ} = 1|x_{hi}) = \frac{\exp(x_{hi}\delta^{j,occ})}{\sum_{k=1}^{m^{occ}} \exp(x_{hi}\delta^{k,occ})} \tag{13}$$

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:

$$y_{hi}^{p} = \exp(x_{hi}\beta^{p} + \upsilon_{hi}^{p}) \tag{14}$$

[2]The 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.

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); and y_{hi}^{pripen} and y_{hi}^{other}appearing in equation (4).

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 and 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 et al. (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 et al. (2007), Bargain and 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.

3.4 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):

$$Y = m(X, \Upsilon) \tag{15}$$

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:

$$Y = m^{\xi}(X, \Upsilon; \xi) \tag{16}$$

where m^{ξ} represents the specific parametric structure adopted for the income generation model and ξ is the vector of parameter values. Equation (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):

$$Y^l = m^{\xi}(X, \Upsilon; \tilde{l}(\xi)) \tag{17}$$

The *returns* transformation again acts through the parameter vector ξ. Specifcally, 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 (($\beta^{inv}, \sigma^{inv}$), ($\beta^{prop}, \sigma^{prop}$), ($\beta^{pripen}, \sigma^{pripen}$), ($\beta^{other}, \sigma^{other}$)). 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):

$$Y^r = m^{\xi}(X, \Upsilon; \tilde{r}(\xi)) \tag{18}$$

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) :

$$Y^d = m^{\xi}(\tilde{X}(X), \Upsilon; \xi) \tag{19}$$

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}):

$$Y^{tb} = m^{\xi}(X, \Upsilon; \tilde{tb}(\xi)) \tag{20}$$

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 et al. (2009). For transformation k with $k \in$\{l, r, d, tb\}, this impact is given by:

$$\Delta_{\theta}^{k}(F) = \theta(F^k) - \theta(F) \tag{21}$$

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 $\frac{\sigma_s^K}{\sigma_t^K}$ 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 et al. (2002), this can be achieved semi-pametrically by reweighting population t households by a factor given by:

$$\omega(X) = \frac{\Pr(X|s)}{\Pr(X|t)} = \frac{\Pr(s|X)}{\Pr(t|X)} \frac{\Pr(t)}{\Pr(s)} \tag{22}$$

The probabilities in equation (22) can be estimated by standard techniques for binary responses (see for e.g. Biewen and 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 and Callan (2010), Bargain (2012), Herault and Azpitarte (2016), Paulus and Tasseva (2017)) and cross-country differences (see Dardanoni and 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:

$$\Delta_\theta(F^t, F^s) = \theta(F^s) - \theta(F^t) = \sum_{k=1}^{K} \Delta_\theta^k(F^t, F^s) \tag{23}$$

A common way to build such a decomposition is by applying each determinant sequentially, one after the other, 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:

$$\Delta_\theta^k(F^t, F^s) = \theta(F^{t,s(k)}) - \theta(F^{t,s(k-1)}) \tag{24}$$

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:

$$\Delta_\theta^1(F^t, F^s) \equiv \Delta_\theta^d(F^t, F^s) = \theta(F_t^d) - \theta(F^t) \tag{25}$$

$$\Delta_\theta^2(F^t, F^s) \equiv \Delta_\theta^{l|d}(F^t, F^s) = \theta(F_t^{l,d}) - \theta(F_t^d) \tag{26}$$

$$\Delta_\theta^3(F^t, F^s) \equiv \Delta_\theta^{r|l,d}(F^t, F^s) = \theta(F_t^{r,l,d}) - \theta(F_t^{l,d}) \tag{27}$$

$$\Delta_\theta^4(F^t, F^s) \equiv \Delta_\theta^{tb|r,l,d}(F^t, F^s) = \theta(F_t^{tb,r,l,d}) - \theta(F_t^{r,l,d}) \tag{28}$$

$$\Delta_\theta^5(F^t, F^s) \equiv \Delta_\theta^{\Upsilon}(F^t, F^s) = \theta(F^s) - \theta(F_t^{tb,r,l,d}) \tag{29}$$

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:

$$\Delta_\theta(F^t, F^s) = \Delta_\theta^d(F^t, F^s) + \Delta_\theta^{l|d}(F^t, F^s) + \Delta_\theta^{r|l,d}(F^t, F^s) + \Delta_\theta^{tb|r,l,d}(F^t, F^s) + \Delta_\theta^{\Upsilon}(F^t, F^s) \tag{30}$$

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 chosen[3]. To tackle this issue, we follow Biewen and 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:

$$D_\theta^k(F^t, F^s) = \theta(F_t^k) - \theta(F^t) \tag{31}$$

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

As Biewen and 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 discrepency 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:

[3]Some 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 and 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.

$$D_\theta^1(F^t, F^s) \equiv D_\theta^d(F^t, F^s) = \theta(F_t^d) - \theta(F^t) \tag{32}$$

$$D_\theta^2(F^t, F^s) \equiv D_\theta^l(F^t, F^s) = \theta(F_t^l) - \theta(F^t) \tag{33}$$

$$D_\theta^3(F^t, F^s) \equiv D_\theta^r(F^t, F^s) = \theta(F_t^r) - \theta(F^t) \tag{34}$$

$$D_\theta^4(F^t, F^s) \equiv D_\theta^{tb}(F^t, F^s) = \theta(F_t^{tb}) - \theta(F^t) \tag{35}$$

$$D_\theta^5(F^t, F^s) \equiv \Delta_\theta^\Upsilon(F^t, F^s) = \theta(F^s) - \theta(F_t^{tb,r,l,d}) \tag{36}$$

$$D_\theta^6(F^t, F^s) \equiv I_\theta(F^t, F^s) = \left(\theta(F_t^{tb,r,l,d}) - \theta(F^t)\right) - \left(\sum_{k\in\{d,r,l,tb\}} D_\theta^k(F^t, F^s)\right) \tag{37}$$

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:

$$\Delta_\theta(F^t, F^s) = D_\theta^d(F^t, F^s) + D_\theta^l(F^t, F^s) + D_\theta^r(F^t, F^s) + D_\theta^{tb}(F^t, F^s) + \Delta_\theta^\Upsilon(F^t, F^s) + I_\theta(F^t, F^s) \tag{38}$$

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 contex of the EAP.

Sub-section 4.1 summarises the central features of the Portuguese post-crisis macroeconomic context and policy measures. Sub-section 4.2 presents the data. Sub-section 4.3 characterises the evolution of the distribution of household disposable income between 2007 and 2013. Sub-section4.4 quantifies the redistributive effect of the tax and transfer system. Sub-section 4.5 provides the results from the decomposition exercise, identifying the main factors behind the changes previously described. And finally, Sub-section 4.6 summarises and discusses the main findings.

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 Negocios (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 José 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 recipiency.

The consolidation measures taken from 2010 onwards were sizeable and spread through a broad range of areas[4]. On the expenditure side, reductions and restrictions on family benefits and social assistance were introduced, including child benefits and minimum income. These measures mostly 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 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

[4]For a detailed description of the measures see for e.g. the Euromod country reports for Portugal between 2009 and 2014 (Rodrigues and Junqueira 2012; Rodrigues et al. 2013, 2015, 2016a) and Vaughan-Whitehead (2015).

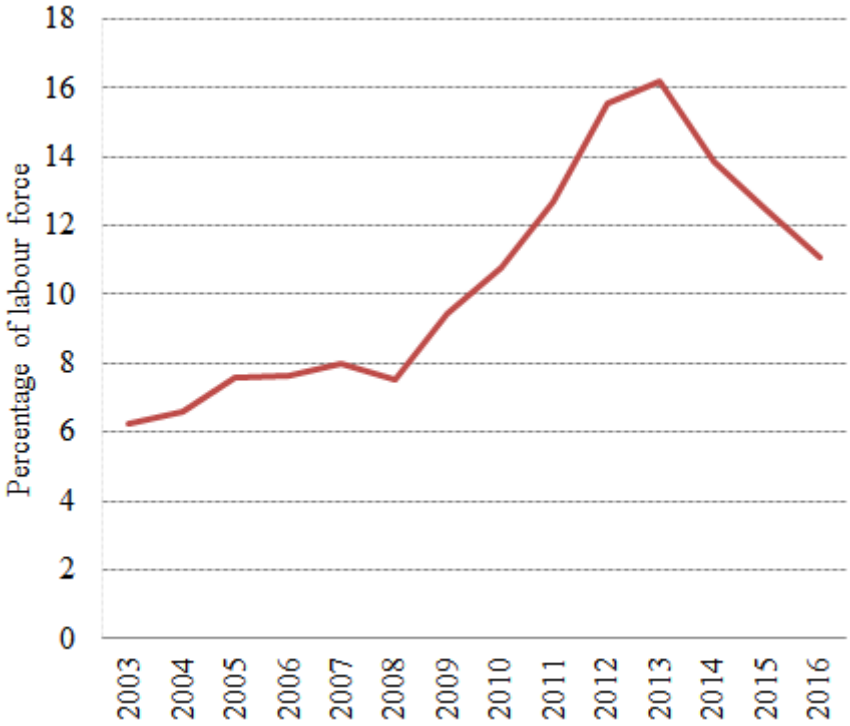
deducted from tax liabilities. Besides measures directly aimed at reducing the public deficit, there were also a set of measures introduced with the goal of increasing flexibility in the labour market. In particular, there was a weakening of collective bargaining agreements, cuts in the amounts of severance 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.

Figure 1: Wages and salaries

Source: Taken from Rodrigues et al. (2016a), originally in de Portugal (2014)
Legend: In blue, overall economy; In black, public sector; In grey, private sector

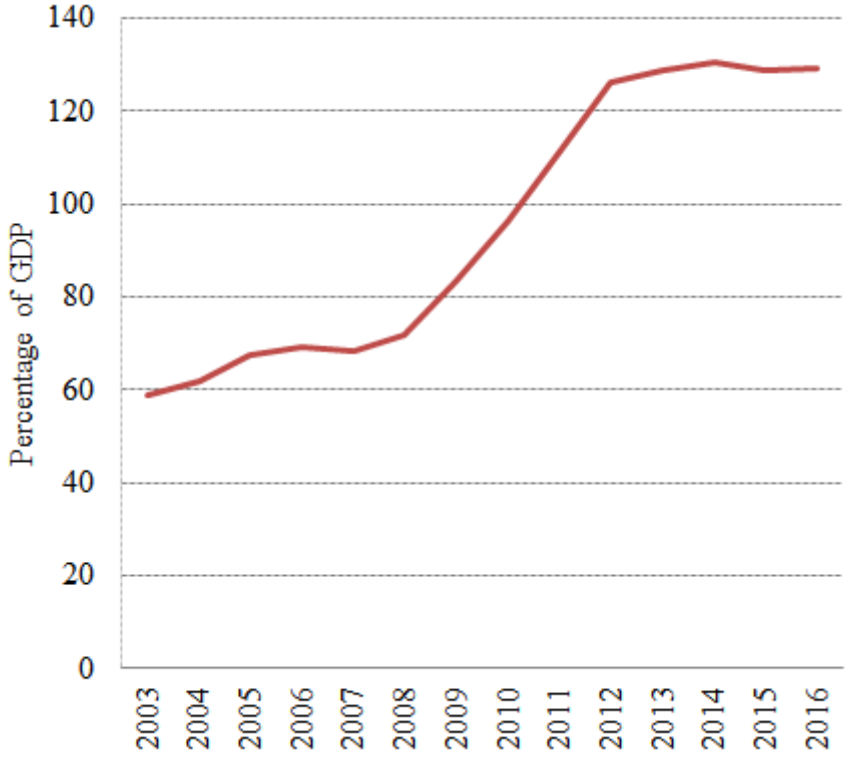
The joint effects of the crisis and austerity measures taken from 2010 onwards led to a substantial worsening of the Portuguese macroeconomic and labour market context between 2008 and 2014, including a severe drop in economic activity and soaring unemployment. There was a recession in four out of the 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 2, the unemployment rate rose steadily between 2008 and 2013, from 8% to 16%. Furthermore, the fiscal position deteriorated considerably, with the deficit 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.

Figure 2: Unemployment rate



Source: OECD data

Figure 3: Debt to GDP ratio



Source: PORDATA

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. 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 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..

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 Sub-sections 3.1 to 3.3.

Table 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 4 in the form of Pen's parades. When comparing the 2007 and 2013 distributions, it can be seen that almost all quintiles 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

Table 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.

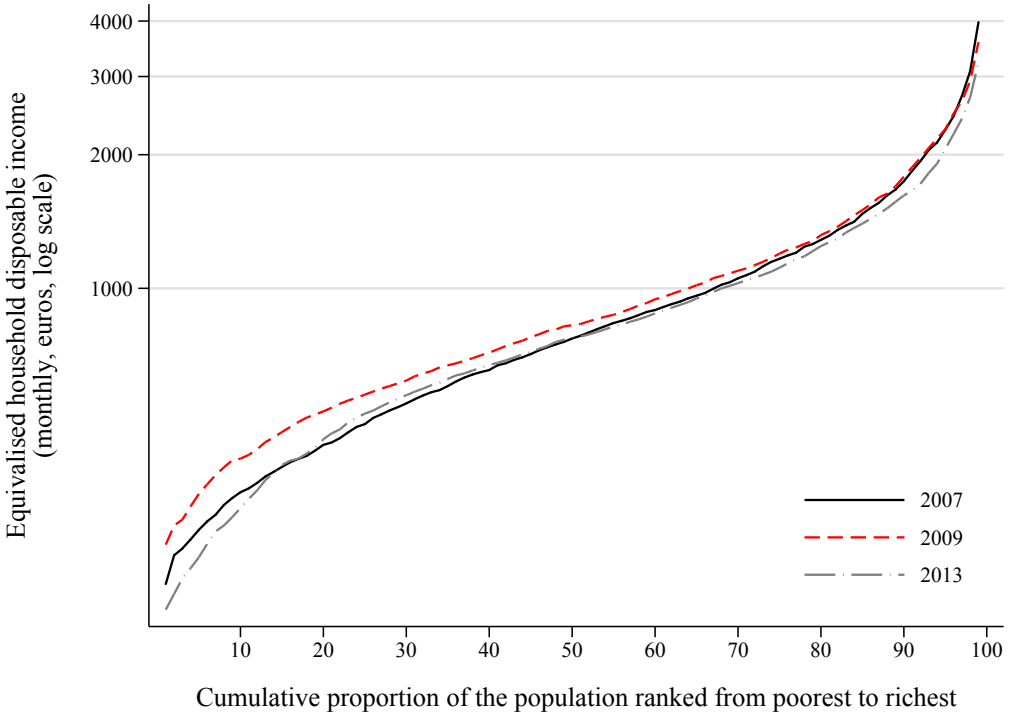
Table 2: Summary measures of equivalised household disposable income distribution

	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

is clear that almost all quantiles were better off in 2009 than in both 2007 and 2013, with the sole exception of the very 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.

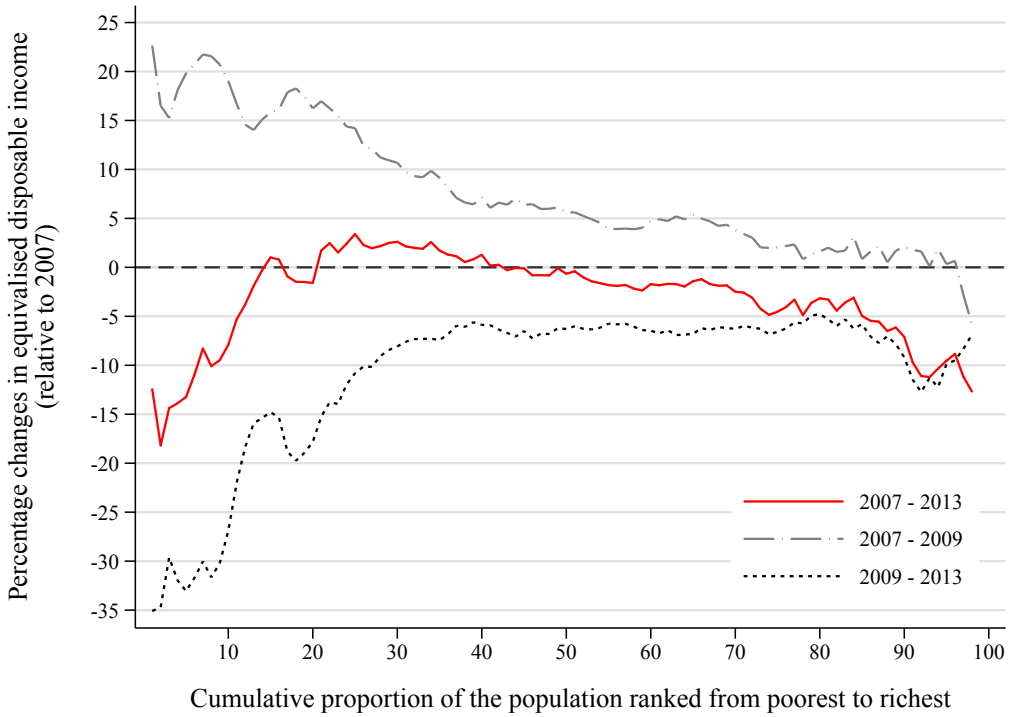
Figure 4: Distribution of equivalised household disposable income (Pen's parades)



These considerations are made clearer in Figure 5, which shows the pairwise differences between the three distributions shown in Figure 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, 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.

Figure 5: Changes in the distribution of equivalised household disposable income



Considering the evidence presented in Figures 4 and 5, together with the context described in Sub-section 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.

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 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 index[5].

Table 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, 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.

[5]Note 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.

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.

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

We now present the results from decomposing the changes presented in Sub-section 4.3 into the contributions of the main factors considered in our model, as described in Sub-section 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

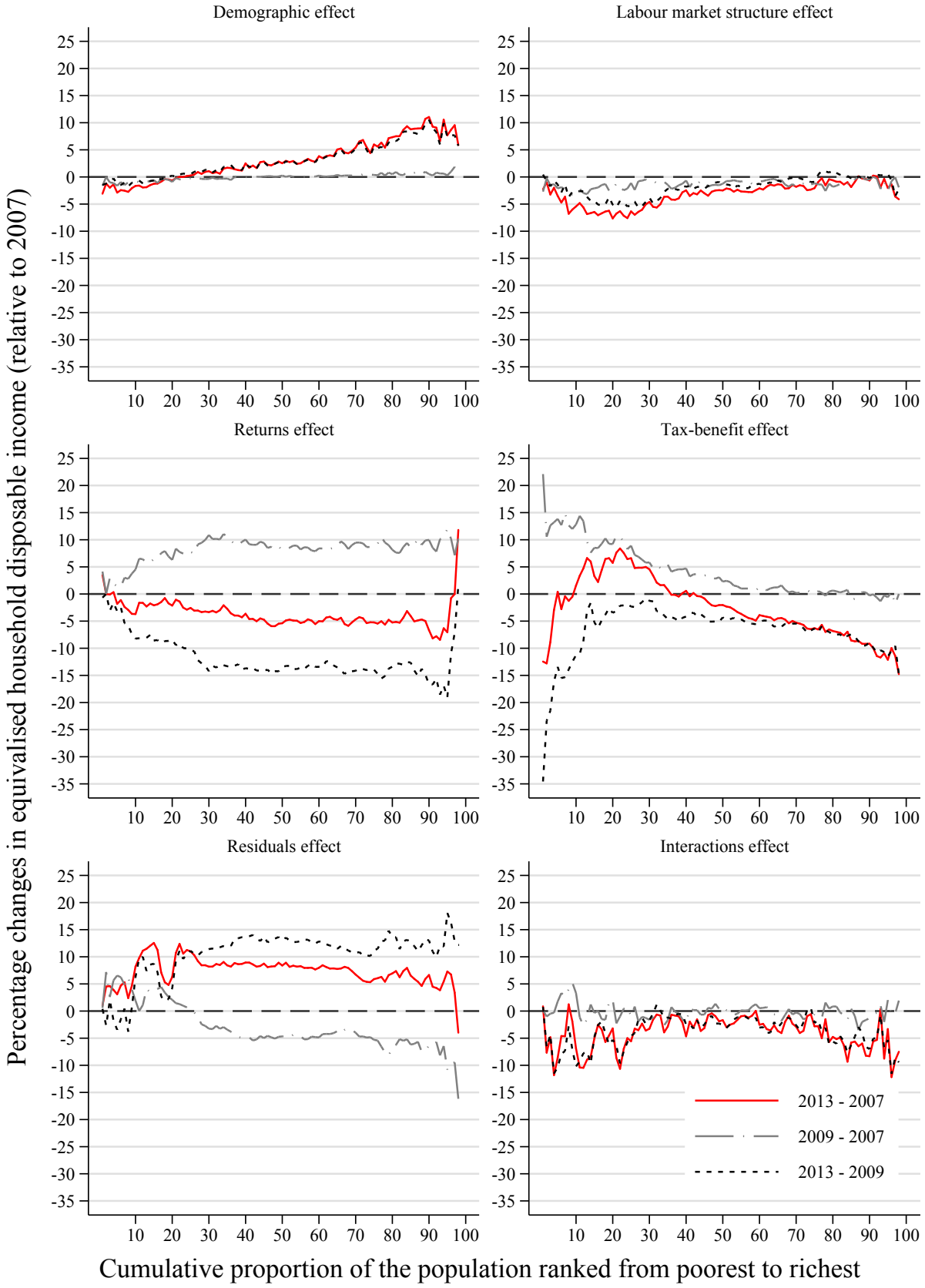
Figure 6 shows the contribution of each factor to the total changes in income distributions shown in Figure 5. Analogously to the results presented in Figure 5, for each percentile in each graph the change in the period 2007-2013 is equal to the sum of the changes in the periods 2007-2009 and 2009-2013. Furthermore, for each percentile, and each period, the total change in the income distribution given in Figure 5 is equal to the sum of the factor contributions given in Figure 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 1 and the events described in Sub-section 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 job[6]. Second, changes in returns determined significant income 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 Sub-section 4.1, and illustrated in Figure 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 Sub-section 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

[6]It 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 ruels. 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 Sub-section.

Figure 6: Decomposition of changes in the distribution of equivalised household disposable income



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, 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 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. Results are given in Table 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 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. 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.

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 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

Table 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

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, 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 disequaling 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.

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 Toika 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.

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, sheding 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 Toika 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.

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