Cross-National Differences in Income Inequality: Isolating the Roles of Demography, Market Returns, Policy and Labour Supply*

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Abstract

Isolating the effect of various influences on income inequality is of policy importance. Traditionally, comparison studies explored the changes of inequality through the lens of summary indices. This method however, can be crude because the intertwined nature of the tax policies and the market income distribution creates a complex nonlinear pattern than cannot be fully captured by indices. We propose a unified simulation framework for exploring the drivers of the cross-national differences in the distribution of household disposable income, focusing on the role of tax-benefit systems, employment structures and market returns and demographic structures. Our framework extends the methodology by developing a household income distribution, which incorporates a flexible parametric approach of modelling market incomes, the complexity of tax-benefit rules through micro-simulation (EUROMOD), and the integration of the labour supply behaviours. The result is an

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integrated framework across countries for generating and simulating the distribution of household disposable income under alternative scenarios, thereby enabling the study of the various drivers of the cross-national distributional differences in household disposable income. We apply the method through the analysis of two European countries–the UK and Ireland–that share many similarities, while displaying at the same time sufficient differences to merit understanding more clearly of the factors that have resulted in different levels of inequality. The direct effect of the differences in tax-benefit rules between the two countries accounts for roughly half of the observed difference in income inequality. The Irish tax-benefit system is more redistributive than the UK system due to a higher tax progressivity and more generous average transfer rates. These differences are largely attributable to policy differences, but also to differences in market income distribution. Market income distributional differences reinforce the net redistributive policy effect via the market composition and demographic differences.

Keyords: income inequality, microsimulation, tax and transfer policy, progressivity, redistributive effect

JEL Codes: D31,H23,J21,J22,J31

1 Introduction

Income inequality has been on the rise since the 1980s in most advanced economies and emerging markets, and have caused a significant amount of concerns for future social and economic development. Perhaps even more striking than the increase in the national income inequalities are the differences in income inequality *across* countries. Cross-country differences in income inequality are considerably larger than variations in inequality over time in any country (Bourguignon et al., 2008; Milanovic, 1998, 2005; OECD, 2011; World Bank, 2006; World Economic Forum, 2011). Even among OECD countries, the Gini index ranges from a low of 0.248 in Denmark to a high of 0.378 in the US (OECD, 2011). Brandolini and Smeeding (2010) once said "... attempts to model and understand causal factors and explanations for differences in level and trends in income inequality across nations is the ultimate challenge to which researchers on inequality should all aspire". Despite the growing concerns and the recognition that social inequality may have short-term and long-term implications for social cohesion and growth (Wilkinson and Pickett, 2009), relatively little is known about the sources of the differences in household disposable income inequality across countries (Bourguignon et al., 2008).

To investigate the source of income inequality differences while accommodating the complexity of welfare systems and the large population heterogeneity, we build upon a micro-simulation micro-econometric approach by developing a household income distribution model which incorporates a flexible parametric approach for modelling both market incomes and the complexity of tax-benefit rules as well as short-term labour supply behaviour through micro-simulation techniques. Our paper attempts to fill the gap in the literature by proposing a unified framework where (i) we use comparable data and (ii) extend the methodology developed in Bourguignon et al. (2007) (henceforth BFL) for exploring the nature of cross-national differences in income inequality. Our approach builds on recent progress made in tax-benefit simulations, in labour supply modelling, and in decomposing income distributions (see Bargain (2012); Bargain and Callan (2010); DiNardo et al. (1996); Ferreira (2012); Fortin et al. (2011); Fortin and Lemieux (1997); Herault and Azpitarte (2015); Jenkins and Van Kerm (2005); Juhn et al. (1993); Li and O'Donoghue (2013); O'Donoghue (2001).

The Bourguignon et al. (2008) approach (BFL hereafter) relies on a parametric representation of the link between household income per capita and its components (individual earnings and unearned income—transfers and capital), and household or individual socio-demographic characteristics, complemented by a non-parametric reweighting technique of the demographic profiles following the DFL approach. In essence, this approach extends the Oaxaca-Blinder approach in two ways: first it deals with the entire income distribution, not just mean earnings, and second it builds a parametric income-generation process for the household, not just a parametric earnings process for the individual. It is described as a three-level structural model.

At the first level, the household income-generation model in the BFL approach aggregates earnings sources across individual members with joint household unearned income (which bundles transfers and capital income). Individual earnings result from different activities. The allocation of individuals across activities (i.e. labour force participation and the occupational structure—inactivity, formal employment in industry, informal employment in industry, formal employment in services or informal employment in services) is represented through a multinomial logit model which links the occupation choice with a vector of individual and household specific characteristics. The earnings functions are typical Mincerian models which link individual earnings with a vector of individual characteristics (including the various activities). The estimation of the structural model results in 2 sets of parameters estimates for the occupational-choice and earnings models and 2 sets of individual residual terms —random variables distributed according to some pre-specified law. At the second level, the model estimates conditional distributions of the number of children in the household, years of schooling and total household non-labour income on a vector of demographic characteristics using multinomial logit models for the former two and tobit for the latter. At the third level, the demographic composition is approximated via reweighting techniques.

This paper further extends the BFL model in three directions. First, we incorporate a more flexible parametric approach in modelling the distribution of household income. We parametrically model the presence of an income source, the level and distribution of the income source, the occupational and industrial structure, and labour market participation components. Second, we incorporate the complexity of the tax-benefit rules via a large-scale pan-European tax-benefit static micro-simulation engine EUROMOD (Sutherland and Figari, 2013). Using cross-country comparable data, the income distribution model has a common specification for each country so as to permit the simulation of counterfactual distributions holding components constant across countries. Third, we allow for labour supply behavioural responses, which incorporates the tax incentives into the labour supply and income distribution.

For the purpose of demonstrating the potential for decomposing inter-country differences in disposable income, we select Ireland and the UK as they share many similarities. For countries at very different stages of development there may be very significant endogeneity between different institutions between for example tax-transfer and labour market institutions. Ireland and UK have always formed a common travel area and labour market, they share a language and border and whose welfare states have evolved contemporaneously, influenced by similar drivers and philosophies. Nevertheless there are sufficient differences to merit understanding more clearly of the factors that have resulted in different levels of inequality. We select year 2007, which the latest year before the economic crisis in both countries.

In the next section (section 2) we focus on the theoretical derivation of the method. Section 3 describes the data. This is followed by the result discussions in the section 4. Section 5 concludes.

2 Methodology

We build upon a micro-simulation micro-econometric approach extending the approach originally developed in Bourguignon et al. (2008) (BFL) and taking advantage of recent progress made in tax-benefit simulations and income distribution decomposition techniques. This approach helps us identify the sources of the cross-country differences in inequality (as summarized by any index). The contribution of tax-benefit systems and labour market structures to the differences in inequality is assessed using (a sequence of) simulated counterfactual distributions of household disposable incomes that would prevail in each country, if these factors were swapped between countries.

Overall, the decomposition infrastructure is composed of five modules. The market composition module (assuming no labour supply responses) models labour market composition factors (e.g. participation, occupation/industry/sector structure) and non-labour composition factors (e.g. the presence of non-labour income sources). The returns module models labour market income sources (the wage rate and self-employment income), private pensions, and other non-labour income sources. The semi-parametric demographic module estimates the weights used for accounting for the effect of various demographic characteristics. The tax-benefit module models the country-specific tax-benefit rules, complemented by a pre-Euromod data standardization module which standardizes the country datasets for the tax-benefit swaps. The labour supply responses module allows for indirect effects to the main components swaps.

The contribution of tax-benefit systems, market composition (and their sub-components — in-work, employment/self-employment structure, occupation/industry/sector structure, others), returns (and their sub-components — labour market income, private pensions, others) and demographic structures to the differences in inequality is assessed using (a sequence of) simulated counterfactual distributions of household disposable incomes that would prevail in each country, if these factors (or their sub-components) were swapped between countries. Furthermore, the redistributive character of tax-benefit systems does not depend only on the design of tax and benefit schedules, but also on the distribution of market income and their interactions. In order to understand the cross-national differences in the distribution and redistribution of income, we also decompose the differences in the net redistributive measures and their drivers: tax progressivity, average tax rate, benefit regressivity and the average benefit rates.

2.1 Basic setup

We are interested in studying the distribution F of household equivalised annual disposable income among individuals in a given population. We aim to understand the structure of some index measure $\theta(F)$—say, the Gini coefficient—and why this index differs from the index observed in another country $\theta(G)$.

Household equivalised disposable income is the variable upon which most official social indicators are calculated (see, e.g., OECD, 2011). It includes market incomes (both labour and capital income), pensions, unemployment benefits and other social transfers, minus direct taxes paid. All these sources are pooled across all individuals belonging to a given household. Athough income components are aggregated at the level of the household, it is the distribution across persons that is generally examined. Total household income is standardised by some equivalence scale to reflect the difference in needs across households of different sizes and account for possible economies of scale in larger households, and each individual in the household is assumed to enjoy such level of equivalised income.

More formally, we are interested in the variable EY which represents a household's annual 'single adult equivalent' disposable income: $EY = \frac{Y}{e(N_a,N_c)}$ where Y is the household's total disposable income and $e(N_a, N_c)$ is an equivalence scale which converts a household composed of N_a adults and N_c dependent children into an equivalent number of 'single adults' to account for differences in needs and economies of scale in household consumption.

Total household disposable income Y is the sum of market incomes (from labour and capital) of all adult members of the household, of all pension payment received (both private and public), of all additional social transfers in cash (unemployment benefits and other social transfers), of private inter-household transfers minus direct taxes paid on those incomes:

$$Y = Y^M + Y^P + Y^O + B - T$$

with

$$Y^M = Y^{L1} + Y^{L2} + Y^K$$

where Y^{L1} and Y^{L2} are the labour incomes of two adults (Y^{L2} can be zero for single adult households and we consider for notational convenience that only there are no more than two adults who contribute to household labour market incomes), and Y^K is total household capital income, Y^P is total household private pension income, Y^O pools all other sources of incomes (e.g., private transfers, labour incomes of additional adults or of dependent children), B

is the total amount of social transfers received (unemployment, sickness or disability benefits, housing allowances, family allowances, minimum income protection, excluding pensions), and T is the total amount of direct taxes paid.

Taxes and benefits can be expressed as functions of the tax-benefit schedules in place in the country which take as arguments all different income sources (before tax) and additional non-income characteristics of the household:

$$B = b\left(Y^M, Y^P, Y^O, X\right)$$

and

$$T = t\left(Y^M, Y^P, Y^O, B, X\right)$$

where X is a vector of household characteristics—including its size and composition $N_a$and N_c—and of individual characteristics of its members, such as their age or education level, their employment status, etc. For reasons that will become clear below, we also consider that X includes some key determinants of earnings and other market incomes which may not directly determine taxes and transfers.

2.2 A general model for the distribution of disposable household income

The random variable of interest EY is a (non-linear) combination of five core random variables for incomes Y^{L1}, Y^{L2}, Y^K, Y^P, Y^O and one generic multivariate random variable X of d household characteristics. Tax-benefit parameters and the shape of equivalence scale determine the particular way in which these random variables combine to form EY.

So, F, the distribution of EY in the population is a function of the joint distribution of the core income source with the distribution of household characteristics and of the deterministic tax and benefit schedules and equivalence scale.

$$F(y) = \Psi(J, t, b, e)$$

where J is the $(d + 6)$-variate joint distribution of income sources and characteristics, and t, b and e are the tax-benefit and equivalence scale parameters.

Step 1. Models for core income sources and household characteristics

The general approach to build our detailed representation of the distribution of income is to consider general non-separable models of the form

$$Y^s = m^s(X, \epsilon^s) \tag{1}$$

for each of the five core income sources, $s\in \{L1, L2, K, P, O\}$. This is as in Matzkin (2003) (or Rothe (2010) in the context of income) for each of the separate source. In this equation, X can be interpreted as a vector of 'regressors' and ϵ^s is an unobserved heterogenity component. Equation (1) has no 'structural' interpretation but should be viewed as a reduced form equation linking household characteristics and income—a relationship that may arise from a broader structural model. The function m^s describes jointly the relationship between household characteristics and income and the heterogeneity in Y^s that is not 'explained' by X: the derivative of m^s with respect to its first argument reflects variations in Y^s across households that can be attributed to differences in observable household characteristics while the derivative of m^s with respect to its second argument reflects variations in Y^s across households of identical observable characteristics. At this stage this model is fully non-parametric since we do not restrict the shape of m^s.

To build our representation, and without loss of generality, we will assume that ϵ^s is uniformly distributed with CDF U in the population to be uniformly distributed. Matzkin (2003) demonstrates that under the additional assumption that ϵ^s is independent of X and that m^s is strictly increasing in ϵ^s, $m^s(x, \epsilon^s)$ is the same quantile of the distribution of Y conditional on $X = x$ as the quantile of ϵ^s in the distribution U or in other words, that, if ϵ^s is the q^{th} quantile of the distribution U then $m^s(x, \epsilon^s)$ is the q^{th} quantile of the conditional distribution of income source s given household characteristics $X = x$, $m^s(x, \epsilon^s) = F^{-1}_{Y^s|X=x}(Y^s)$.

This means that estimation of equation (1) provides us with a model for $F_{Y^s|X=x}$ and this, combined, with the distribution of observed household characteristics in the population gives us a representation of the joint distribution of income source s and household characteristics:

$$F_{(Y^s,X)}(y, x) = F_{Y^s|X=x}(y)\, h(x)$$

from which the marginal distribution of income source s can be derived by integrating over the distribution of characteristics h:

$$F_{Y^s}(y) = \int_{\Omega_X} F_{Y^s|X=s}(y)\, h(s) = \int_{\Omega_X} F_{(Y^s,X)}(y, s) ds$$

(see, e.g., Chernozhukov et al., 2013; Rothe, 2010).

Step 2. The joint distribution of sources and characteristics

But the distribution function of one source is not enough. Moving from the marginal distribution of sources to their joint distributions involves looking at the joint distribution of ϵ^s.

Of course, the unobserved heterogeneity characteristics are correlated across different sources. Since we assume ϵ^s to be uniformly distribution, it follows that $\epsilon \sim C$ where $\epsilon = (\epsilon^{L1}, \epsilon^{L2}, \epsilon^{K}, \epsilon^{P}, \epsilon^{O})$ is the vector of each source unobserved heterogeneity variable and C is a copula function, that is the 5-variate cumulative distribution function of the (correlated) uniform marginals (see, e.g., Genest and Mackay, 1986; Nelsen, 2006).

Note that we do not need to restrict the joint distribution of unobserved heterogeneity to be independent on X even though we maintain this assumption for their marginal distributions, that is we let the copula function depend on X.

Invoking the Sklar (1959) theorem, we can now express the joint distribution of all sources and household characteristics as

$$J(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, x) = C_{X=x}\left(F_{Y^{L1}}(y^{L1}), F_{Y^{L2}}(y^{L2}), F_{Y^{K}}(y^{K}), F_{Y^{P}}(y^{P}), F_{Y^{O}}(y^{O})\right)$$

Step 3. Taxes and benefits

Endowed with a representation for the joint distribution of core income sources and household characteristics, it is easy to derive the marginal distribution of taxes and benefits by integrating over all possible combination of income source and household characteristics

$$\begin{aligned} F_B(b) &= \int \cdots \int \mathrm{I}\left[b\left(y^{L1}, y^{L2}, y^{K}, y^{P}, yY^{O}, x\right) \le b\right] \; dJ(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, x) \\ &= E(\mathrm{I}\left[b\left(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, x\right) \le b\right]) \end{aligned}$$

(there is a notation for such integration over a distribution J)

and

$$F_T(t) = \int \cdots \int \; \mathrm{I}\left[t\left(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, b\left(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, x\right), x\right) \le t\right] \; dJ(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O},$$

$$F_T(t) = E\left(\mathrm{I}\left[t\left(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, b\left(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, x\right), x\right) \le t\right]\right)$$

But we are more directly interested in the distribution of total household disposable income which is easy to obtain from

$$F_Y = \int \cdots \int \; \mathrm{I}\left[(y^{L1} + y^{L2} + y^{K} + y^{P} + y^{O} + b - t) \le y\right] \; dJ(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, x)$$

Step 4. Equivalence scale adjustments

Finally equivalence scales can be introduced to arrive at the distribution of single-adult equivalent disposable income. Noting that the household composition variables are included in the vector X of household characteristics, we obtain :

$$F_{EY} = \int \cdots \int \; \mathrm{I}\left[(y^{L1} + y^{L2} + y^{K} + y^{P} + y^{O} + b - t)/e(n_a, n_c) \le y\right] \; dJ(y^{L1}, y^{L2}, y^{K}, y^{P}, y^{O}, x)$$

2.3 Constructing counterfactual distributions

To summarize, our general model for the distribution of disposable income has four main components which jointly determine the shape of the distribution in a particular population:

- the distribution h of household characteristics;
- the function m^s for each source which characterizes the joint distribution of source s and household characteristics;
- the copula C_X which captures the correlation between the source-specific unobserved heterogeneity components and determines the joint distribution of all sources and household characteristics;
- the tax-benefit functions b and t which determine households entitlements to social transfers and their tax liabilities, given their characteristics and pre-tax incomes.

Differences in income distributions across different populations can arise from differences in any of those components. Household characteristics matter and may differ even across similar countries (e.g., educational achievements and human capital accumulation, household demography and composition; REF); differences in the distribution of income sources, in particular of household earnings (but also of pensions, or capital income) are key drivers of differences in income inequality REF; the correlation structure of different sources of market income is important, since, for example the earnings of partners REF, or capital and labour incomes which may be complementary or substitute and therefore re-inforce or mitigate inequality in aggregate incomes; finally, tax and benefit parameters are, by definition, key determinants of income distributions and differ across countries, especially when one looks at countries with different welfare regimes REF.

To examine how much differences in these components between two populations contribute to aggregate differences in, say, inequality measures, it is common to generate counterfactual distributions by isolating one particular factor from country A and transplanting it into country B and examine how much country B's distribution reacts to the operation. That is, we generate a counterfactual distribution $F^*$from a baseline distribution F by replacing one (or some of) of the component(s) of the model for F (e.g., the household characteristics, or the tax-benefit parameters) by the corresponding component(s) from the model for the distribution G observed in country A. How much $\theta(F*)$ differs from $\theta(F)$ and how much $\theta(F*) - \theta(F)$ differs from the total difference $\theta(G) - \theta(F)$ uncovers the importance of the components transplanted in accounting for the aggregate difference in θ. See for example Chernozhukov et al. (2013); Machado and Mata (2005); Rothe (2010, 2012), among many others, for recent notable applications of this principle.

An additional added value of our approach is that we allow for labour supply responses to the swap of each component across countries. Each factor that affects the value of gross income will imply a labour supply response. The "observed" effect of each factor $\theta(F*^{LS}) - \theta(F)$ is composed from a direct effect $\theta(F*) - \theta(F)$ and an indirect effect via the labour supply response $\theta(F*) - \theta(F*^{LS})$,where $\theta(F*^{LS})$, is the counterfactual distribution considering the behavioural response in the labour supply, allowing the distribution to respond to the different incentive structure of the tax benefit system.

It should be noted that swapping of the component is hypothetical in the sense that we do not consider the potential social, cultural, political and many other potential factors that may affect the society once the tax system or another component is changed. The main goal for the exercise is to explore the statistical relations as in many of the current literature (see, e.g., Biewen and Juhasz, 2012; Bourguignon et al., 2008; Chernozhukov et al., 2013; Daly and Valletta, 2006; DiNardo et al., 1996; Hyslop and Mare, 2005; Larrimore, 2014, for leading examples): we estimate and transplant parameters or functional form estimates of the components of the representation of the distribution and generate counterfactual distributions by re-composing the final distribution statistically, leaving all other components constant. In other words, the approach is 'static' in the sense that we do not allow for other components to dynamically 'react' to the transplantation when we calculate the counterfactual distributions. It should be clear that we are not trying here to generate the final income distribution that would be observed if we were to suddenly and exogenously change the component of interest and then let households, policy-makers and the economy react and adjust to the change and therefore modify other components over time. Similarly we are not concerned whether the transplantation that we simulate reflect changes that could be "realistically" imposed in the population. Our aim here is different: we use the magnitude of the model's response to the simulated transplantation to quantify the relative contribution of each of a number of factors of interest to the aggregate difference between two populations. These magnitudes are not meant to represent structural or causal estimates of the impact of real interventions but rather help point out where to look to understand cross-country inequality differences and where importing some interventions could potentially be effective.

2.4 Decomposition approaches

2.4.1 Sequential and Marginal Decompositions

Formally, a decomposition procedure typically aims to (additively) decompose the total difference $\Delta = \theta(G) - \theta(F)$ into a number of factors that capture the contribution of different components of the model:

$$\Delta = \sum_{k=1}^{K} \Delta_k.$$

Very often, a sequential approach is adopted to construct this additive structure: a sequence of counterfactual distributions is constructed by determining an order of transplantation of the different components of the model, and then transplanting factors one after the other from the original distribution F to the target distribution G, so $\Delta_k^S = \theta(F^{c(k)}) - \theta(F^{c(k-1)})$ where $F^{c(k)}$ is a counterfactual distribution obtained by transplanting all first k factors onto distribution F (and $F^{c(0)} \equiv F$ and $F^{c(K)} \equiv G$). Note that the last factor K can be a 'residual' (or 'unexplained') factor that is not modelled and transplanted explicitly but that collects all residual difference between the target distribution G and the counterfactual distribution obtained after transplantation of all modelled components.

The main drawback of sequential decompositions is the necessity to choose a particular sequence of transplantation of the factors. As soon as factors enter the model non-linearly—and in our application, the components are far from linear combinations of each other—the estimated contribution of each component will depend on its order in the particular sequence adopted. In some settings, it is possible to defend specific sequences of introduction of the factors, in particular when there is a natural sequential dependence of the various factors (see, e.g., Altonji et al., 2012; Hildebrand et al., 2015), but often one has to accept the dependence of the contribution's impact on its position in the sequence.[1]

The main alternative which avoids the sequential dependence is to transplant and assess the impact of each factor from the same benchmark distribution, typically the original distribution: $\Delta_k^A = \theta(F^k) - \theta(F)$ where F^k is a counterfactual distribution obtained by isolating and transplanting factor k only onto distribution F , all other factors held at their original values. But now, it does not generally hold that the total difference Δ is the sum of estimated contributions $\sum_{k=1}^{K} \Delta_k^A$. As demonstrted by Biewen (2014), the residual difference $R = \Delta - \sum_{k=1}^{K} \Delta_k^A$ captures all interactions between the different components in the model.

2.5 Parametric specifications

We have so far remained agnostic about how the main components of the model can be estimated in practice and how to isolate and transplant par-

[1]Some authors have proposed to calculate the contribution of each factor in all possible sequence of introduction of factors and take averages across sequences (Chantreuil and Trannoy, 2013; Devicienti, 2010; Sastre and Trannoy, 2002; Shorrocks, 2013). This approach can however be computationally prohibitive for complex models and does not necesssarily improve the economic interpretation of the estimated components.

ticular parameters or functional estimates from the model. In theory, all components could be estimated nonparametrically; see, e.g., Matzkin (2003) on estimation of general non-separable models of the form of m^s or Rothe (2010) for an application to modelling earnings distributions. The generation of statistical distributions which approximate the conditional and joint distributions can be done parametrically or semi-parametrically or by combining both techniques (Biewen and Juhasz, 2012; Bourguignon et al., 2008; DiNardo et al., 1996; Ferreira, 2012; Herault and Azpitarte, 2015; Hyslop and Mare, 2005; Juhn et al., 1993).

Given the high number of variables considered, we apply mostly a parametric approach in the tradition of Bourguignon et al. (2008) , combined with Juhn et al. (1993)'s approach of importing the residual distribution from one (country) distribution to another. A semi-parametric reweighing technique is applied for the exogenous demographic characteristics in the tradition of (DiNardo et al., 1996). The parametric approach is more convenient for our purposes because it allows the approximation of the true conditional distributions using standard econometric models, where the parameters estimates have a direct economic interpretation.

We built a statistical model of the distribution of household income that models explicitly and fully parametrically the presence of an income source, the level and distribution of the income source, the occupational and industrial structure, and labour market participation components. In addition, the benefit components that are not simulated in EUROMOD (e.g. pensions) are modelled as statistical distributions function of the demographics and other available relevant characteristics. The income distribution model has a common specification for each country so as to permit the simulation of counterfactual distributions holding components constant across countries. The model is composed of: (i) Market Composition Module (assuming no labour supply responses); (ii) Income or "Returns" Module; (iii) Semi-parametric Demographic Module; (iv) Tax-Benefit Module; (v) Labour Supply Responses Module.

We first model the functions m^s in what we refer to as our "income generation model", which includes earnings functions, occupational and industrial structure, labour market participation components, as well as pension and non-labour income components. Second, we store the parameter estimates for each country. Third we simulate the various swaps. For example, the counterfactual distribution of household disposable income that would prevail in country 1 had it had the market structure of country $2(f(M_2Y_1TB_1Data_1))$ would be simulated by applying the parameter estimates of country 2 on data 1, while importing the residuals of country 1.

2.5.1 The distribution of market characteristics

These models are part of the market composition module (Figure A.1). They estimate the statistical distribution of market factors: in-work, employee/self-employed, occupation/industry/sector, unemployed, retired, presence of income sources (investment income, property income, private pension, other income), paying for housing (home owner, mortgage, rent), paying contributions (private pensions).

The market composition module involves two types of estimation techniques: (i) binary models for binary outcomes, and (ii) multinomial models for m outcomes, m >2. The aim is to retrieve the parameters estimates and a measure of individual specific errors for each estimated model in both countries. Models of binary events (e.g. in work) are estimated using logistic models. Starting from the standard latent-variable expression, $y^* = x'\beta + \epsilon$, where we only observe $y = 1$ if $y^* > 0$, the conditional probability of observing a positive outcome equals:

$$p = Pr(y_i = 1|x) = Pr(x_i'\beta + \epsilon_i > 0) = Pr(-\epsilon_i < x_i'\beta) = F(x'\beta),$$

where $F(x'\beta)$ is the CDF of $(-u)$. Assuming ϵ is logistically distributed, this yields the logit model:

$$y^* = logit(p_i) = ln\frac{p_i}{1-p_i} = x_i'\beta + \epsilon.$$

In order to use the estimated probabilities from logistic models within a Monte Carlo simulation, we draw a set of uniform random numbers (r_i) such that we predict the actual dependent variable in the initial data. The stochastic term, ϵ_i , is obtain using the relationship

$$\epsilon_i = ln(\frac{u_i}{1-u_i})$$

such that $y = 1$ if $u_i < logit^{-1}(x_i'\beta)$, where u_i equals

$$u_i = (y = 1)(r_i p_i) + (y = 0)(p_i + r_i(1 - p_i))$$

.

After establishing which individuals are in work, we use the same strategy to determine whether the individual is en employee of self-employed, his occupation/industry/sector, etc. Multinomial reduced logit models are used to simulate occupation and industry choices, in the same manner as Bourguignon et al. (2008). The probability of individual i selecting choice k from $j = 1, ..., m$ alternatives conditional on a set of X personal characteristics is

$$p_i(y = k) = p_{ik} = \frac{exp(x_i^{'}\beta_k)}{exp(x_i^{'}\beta_k) + \sum_{j \neq k}^{m} exp(x_i^{'}\beta_j)}$$

The disturbance terms are generated by drawing a set of uniform random numbers (u) and generating random variables for each of the counterfactual choices (not the actual choice observed in the data) using the extreme value distribution: $v_j = -ln(-ln(u))$. The objective is to choose a random number from the extreme value distribution for the actual choice v_k, such that:

$$x'\beta + v_k > x'\beta + v_j, \forall j \neq k$$

Once the market characteristics have been updated in the market composition module, the income module estimates and simulates income components.

2.5.2 The distribution of earnings, m^{L1} and m^{L2}

The distribution of earnings is a key—albeit not the sole— determinant of the distribution of household incomes. This is the most elaborate component of our model. Total annual earnings depend on employment and hours worked as well as wage rates, and the latter itself depends on the sector of activity, occupational choices and on the returns to individual (human capital) characteristics. Annual earnings differ across individuals because of all of those factors, and so does the distribution of earnings. To capture the respective impacts of those components, we use the models in the market composition module described above.

For estimating and simulating the wage structure, we use the Singh-Maddala distribution regression, with endogenous selection for women and without endogenous selection for men (Van Kerm, 2013). The Singh-Maddala distribution regression is a flexible parametric approach that captures differences across the entire distribution, allowing at the same time the presence of covariates and endogenous labour force participation (Van Kerm 2013). The Singh-Maddala cumulative distribution function is formalized as:

$$F(y) = \mathrm{SM}(y; a, b, q) = 1 - \left[1 + \left(\tfrac{y}{b}\right)^a\right]^{-q},$$

where q is a shape parameter for the 'upper tail', a is a shape parameter ('spread') affecting both tails of the distribution, and b is a scale parameter. Each of these parameters are allowed to vary log-linearly with a set of observed characteristics, similarly with Biewen and Jenkins (2005) and Van Kerm (2013).

For each observed wage value we store the conditional rank u obtained from $F(y)$. The individuals in the working age without a wage is given a random rank. In the simulation stage, we use the quantile function while preserving these ranks to simulate the new wage rate.

$$F^{-1}(y) = [(1-u)^{-\frac{1}{q}} - 1]^{\frac{1}{a}}$$

2.5.3 The distribution of capital income, pensions and other incomes, m^K, m^P andm^O

We adopt a much simpler specification for non-labour incomes (capital income, private pensions, other income, housing payments (which links to certain benefit payout), private pensions contributions).

Self-employment income and other sources of income (investment, property, private pensions, other income, mortgages, rents, and contributions for private pensions) are estimated using ordinary least squares, complemented by Juhn et al. (1993)'s approach of importing the residual distribution. The models are estimated separately for men and women following the specification:

$$y_i = exp(X_i\beta + \epsilon_i),$$

where ϵ $N(0, \sigma_\epsilon^2)$ and X is a vector of the individual characteristics such as age and education.

For each model, we require values of the disturbance term for all individuals. For observed individuals, the disturbances are obtained from the estimation. For unobserved individuals, they are generated stochastically using random draws from $N(0, \sigma_\epsilon^2)$.

The modules are interdependent, the income module updates income values after each labour market simulation.

2.5.4 The joint distribution of income sources: estimating C_X

The multivariate nature of the copula function makes it difficult to model parametrically while retaining flexibility. Convenient parametric and non-parametric estimators are available for bivariate copulas—see **?** for an application to household earnings—but with more than two margins, the dimensionality of the problem makes it difficult to build a model that can be swapped and transplanted across models.[2] As a consequence, this is the only

[2]See **?** for an examination of the role of copula-based income dependence on inequality.

component that we do not attempt to model and isolate in our simluation exercises. It will therefore be the residual component between the observed distribution ... when we transplant all other components of the model.

2.5.5 The distribution of household characteristics, h

Some basic household characteristics are treated as exogenous to the model: the age, gender, migrant status, marital status, and education level of adult members of the household and the number of children. We assume these characteristics and their prevalence in the population form the basic "demographic structure" of the population. Their (joint) distribution h is not modelled parametrically. Transplantation of demographic characteristics is however commonly done via semi-parametric re-weighting techniques in the tradition of DiNardo et al. (1996), and we resort to this technique too to assess how much differences in h alone can account for differences in inequality across countries.

In a nutshell, this technique involves re-weighting the distribution of country A h_A in order to "mimic" the joint distribution of demographic characteristics of country B h_B . The re-weighting function $\omega(D)$ equals the ratio between the probabilities of observing there characteristics in the two countries:

$$\omega(D) = \frac{Pr(D|C_2)}{Pr(D|C_1)}$$

Given that the joint probability of being in country C_i and observing distribution D equals

$$Pr(D|C_i) * Pr(C_i) = Pr(C_i|D) * Pr(D)$$

it follows that the rewighting applied to country 1 to mimic country 2 equals:

$$\omega(D) = \frac{Pr(C_2|D) * Pr(C_1)}{Pr(C_1|D) * Pr(C_2)} = \frac{Pr(C_2|D) * (1 - Pr(C_2))}{(1 - Pr(C_2|D)) * Pr(C_2)}$$
.

$Pr(C_2)$ is the share of households in country 2. $Pr(C_2|D)$ is the conditional probability of being in country 2 given the joint distribution D , estimated with a binary model.

2.5.6 Tax-benefit functions

The last component of the model is essentially a tax-benefit microsimulation calculator which calculates cash benefit entitlements and tax liabilities from market income and household characteristics in any given country and year (Figari et al., 2015). Many such calculators exist for different countries, but for cross-country comparative analysis, it is important to rely on an engine that models taxes and benefits in a consistent way across different countries. For European countries, harmonized taxes and benefit calculations can be taken from EUROMOD, a large-scale pan-European tax-benefit static microsimulation engine (Sutherland and Figari, 2013). This large-scale income calculator incorporates the tax-benefit schemes of the majority of European countries and allows computation of predicted household disposable income, on the basis of pre-tax, pre-benefit incomes, employment and other household characteristics. 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 time periods (see, e.g., Bargain, 2012; Bargain and Callan, 2010; Levy et al., 2007). EUROMOD simulates direct taxes and a wide range of cash transfers to households: income and property taxes, social insurance contributions, family benefits, housing benefits, social assistance, and, where relevant other income-related benefits (Figari et al., 2015). Transfers which are not simulated by EUROMOD are contributory benefits and public pensions as well as disability benefits since the level of such transfers generally depend on past employment histories or other information (e.g., about the severity of a disability) that is usually not available in source household survey data.

EUROMOD also allows exercises of ‘policy swaps’ in which particular tax or benefit policies from one reference country are applied to other countries, thereby allowing a simulation-based assessment of the impact of policy differences on disposable income distributions. For conducting complete system swaps, however, the situation is more complex. EUROMOD uses standardized datasets for each country-model[3]. For system swaps, further standardization steps are required in order to insure that system of country A can be simulated on dataset of country B. For this purpose, our infrastructure contains a Pre-Euromod Data Standardization sub-module, which is basically creating the eligibility conditions for simulating the taxes and benefits of each system. The definition of disposable income contain both simulated and non-simulated components.

The simulated components, which we call instruments, depend on a series of explanatory factors, which may include some of the the non-simulated benefits mentioned above. We identify which explanatory factors are common

[3]For more details on EUROMOD, see Sutherland and Figari (2013), and see EUROMOD country reports for details on the country-specific modules. EUROMOD country reports are available online at https://www.iser.essex.ac.uk/euromod/using-euromod/country-reports

across countries and which are not. The non-overlapping explanatory factors are created/simulated using the existing information. More details on the standardization routine can be provided upon request from the authors. For current purpose we ignore in our implementation several important aspects inherent to policy swaps as discussed in Bargain and Callan (2010) and Figari et al. (2015). In particular, we implement crude policy swaps leaving monetary parameters (such as income tax brackets, or cash transfer levels) unchanged. This allows us to best preserve the welfare and the tax incentive of a system.

2.5.7 Behavioural Responses of Labour Supply

As labour supply behaviours are often coupled with tax benefit system design, we also extract the structural parameters that allow us to identify the behaviour patterns in both countries labour market. The model endogenous micro-level labour supply and simulates behavioural changes induced by the tax benefit system. We opted for discrete choice labour supply models, similar to van Soest(1995), Creedy and Duncan (2005) etc. The labour supply response is only applied to those who are between age 18 and 60 years old who are neither in education nor retirement. We assume an inelastic labour supply for students and retirees.

Empirically, we use the direct quadratic utility specification as in Keane and Moffitt (1998) .

$$u = \beta_c c + \beta_{cc} c^2 + \beta_{ch} c \cdot h + \beta_h h + \beta_{hh} h^2 + \beta_{ue} d_u + \beta_{iw} d_w$$

where c is the household disposable income, and h is the number of hours worked per week. The coefficients β are heterogeneous, varying linearly with several taste-shifters such as age, presence of children, marriage status etc. We also incorporate two state dummies, one work dummy, which captures the cost of working, and one unemployment dummy d, which captures the cost of claiming unemployment benefit in the case of inactive. The fixed cost dummy (d_w) is a flexible way of specifying the utility, which may explain the skewed distribution in the number of working hours (van Soest et al., 2002), and to some extent captures the demand side constraints (Aaberge et al., 1995). The unemployment dummy (d_u) is expected to have a negative coefficient, reducing the overall utility should the individual be involuntarily unemployed. Similar to Colombino et al. (2010), there are five choices for each individuals, namely

$$y = \begin{cases} h=0,\ d_u=0,\ d_w=0 & \text{inactive} \\ h=0,\ d_u=1,\ d_w=0 & \text{unemployed} \\ h=20,\ d_u=0,\ d_u=1 & \text{working parttime (20 hours per week)} \\ h=40,\ d_u=0,\ d_w=1 & \text{working fulltime (40 hours per week)} \\ h=50,\ d_u=0,\ d_w=1 & \text{working fulltime (50 hours per week)} \end{cases}$$

Our estimation is based on the tax unit which can be composed of one or two decision makers. Households with multiple families are split into multiple tax units based on the relationship status. A tax unit contains one adult and his or her dependent children in the case of single person household or single-parent, or two partnered adults and their children in the case of a married or de facto couple. We estimated singles and couples separately. A unitary utility function applies to couples. The model can be estimated under the conditional logit framework with a Type I extreme value distributed error term. As the residuals are latent, we draw the residuals for all non-chosen choices following the Type I extreme value distribution, and a truncated Type I extreme value distribution where $\epsilon_j > max(x_i\beta + \epsilon_i) - x_j\beta$ for all $i \neq j$ for the observed choices j. Such approach allows us to preserve the individual heterogeneities of their labour supply preferences.

2.6 Decomposition approach

The decompositions follow the logic of the Generalized Oaxaca-Blinder decompositions developed in Bourguignon et al. (2008). The contribution of factor x to the difference between the distributions of household disposable income in country 1 and 2 can be assessed as follows. We construct the counterfactual distribution that would prevail in country 1 had it had the distribution of factor x from country 2, $f_1^*(y)$. The difference $f_2(y) - f_1(y)$ can be decomposed into the effect of factor x $[f_1^*(y) - f_1(y)]$ and a residual effect $[f_2(y) - f_1^*(y)]$. In a different sequence, using an alternative counterfactual $f_2^*(y)$, the difference can be decomposed into the effect of x $[f_2(y) - f_2^*(y)]$ and a residual effect $[f_2^*(y) - f_1(y)]$. This decomposition is path dependent with respect to the reference country. The matter becomes increasingly complicated once several factors are taken into account as the path dependence is influenced both by the reference category and the order of swaps between factors. The debate is how to evaluate these effects (Biewen, 2014).

We consider four main factors: the market composition (M), the structure of returns (Y), the tax-benefit system (TB), and the population (comprised of D=demographics and R=residual population differences). If we sequentially swap each factor, $f_2(y) - f_1(y)$ could be decomposed as:

$$f(M_2Y_2TB_2Data_{2(D_2,R_2)} - f(M_1Y_1TB_1Data_{1(D_1,R_2)}) =$$

$= f(M_2 Y_1 TB_1 Data_{1(D_1,R_1)}) - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)})$ (MC)
$+f(M_2 Y_2 TB_1 Data_{1(D_1,R_1)}) - f(M_2 Y_1 TB_1 Data_{1(D_1,R_1)})$ (R)
$+f(M_2 Y_2 TB_2 Data_{1(D_1,R_1)}) - f(M_2 Y_2 TB_1 Data_{1(D_1,R_1)})$ (TB)
$+f(M_2 Y_2 TB_2 Data_{2(D_2,R_2)}) - f(M_2 Y_2 TB_2 Data_{2(D_2,R_1)})$ (Population)

In total, for these components, there are 24 possible sequences (4!). A popular approach is to evaluate these decompositions using the Shapley-Shorrocks index, which approximates each effect by the arithmetic mean over all possible sequences (Shapley, 1953; Shorrocks, 1980, 2013). The index however masks large variations in effects. This prompted recent studies to emphasize the importance of isolating the interactions between factors (Biewen, 2014; Rothe, 2012).

Acknowledging the obvious 'simultaneity' of tax-benefit policy packages and labour market structures, consideration of particular sequences and of interaction effects (Biewen, 2014; Rothe, 2012) will also shed light on how different labour market structures mediate the impact of tax-benefit differences in cross-country 'policy swaps'. To this end, we isolate the ceteris paribus effect of each factor from the interaction effects (see Biewen (2014)). This partially takes care of path dependency, as the decomposition remains sensitive to which country is taken as reference. In this situation, following Biewen (2014), the decomposition could be evaluated by taking country 1 as reference:

$$f(M_2 Y_2 TB_2 Data_{2(D_2,R_1)} - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)}) =$$

$= f(M_2 Y_1 TB_1 Data_{1(D_1,R_1)}) - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)})$(MC)
$+f(M_1 Y_2 TB_1 Data_{1(D_1,R_1)}) - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)})$ (R)
$+f(M_1 Y_1 TB_2 Data_{1(D_1,R_1)}) - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)})$ (TB)
$+f(M_1 Y_1 TB_1 Data_{2(D_2,R_2)}) - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)})$ (Population)
$+Interactions$ (Interaction effect).

The interaction effect incorporates all two-way, three-way and four-way interactions, and is equal to the overall difference minus the direct effects. The interaction effects mask also the indirect effects coming from the labour supply responses to each swap. We will isolate the labour supply responses by taking the difference between the counterfactual distribution when labour supply responses are considered and the "static" counterfactual. For example, the total effect of the system swap can be decomposed into a direct effect and indirect effect from the labour supply response:

$f(M_1 Y_1 TB_2 Data_{1(D_1,R)}) - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)})$ (Direct eff.)
$+f(M_1 Y_1 TB_{2,LS} Data_{1(D_1,R)}) - f(M_1 Y_1 TB_2 Data_{1(D_1,R_1)})$ (Indirect Labour Supply eff.)

The labour supply responses to the other swaps are identified in a similar manner.

The overall difference will be decomposed into:

$f(M_2 Y_2 TB_2 Data_{2(D_2,R_1)} - f(M_1 Y_1 TB_1 Data_{1(D_1,R_1)}) = \sum Direct_f + \sum Indirect_f + \sum Interactions.$

The other possible decomposition is by changing the reference to country 2, which reduces considerably the degree of path dependency.

In addition to the main components we asses the contribution of market sub-components (in work, employee/self-employee structure, occupation/industry/sector and others), the contribution of income sub-components (labour income, private pensions and others) and the contribution of demographics (isolated from the residual population differences).

3 Data

Our application uses data from two sets of nationally representative household surveys: the 2008 European Union Statistics of Income and Living Conditions (EU-SILC) for Ireland and the 2008 Family Resourcse Survey (FRS) for the United Kingdom. These surveys contain detailed information on household incomes for the year 2007 as well as a wide range of variables about the characteristics of households and their members in both countries.

Because a tax-benefit component of our model relies on EUROMOD, we use an incarnation of those datasets that has been standardized to common income variables and household characteristics definitions in order to serve as input to the microsimulation engine Since income data cover the year 2007, we use the EUROMOD 2007 tax-benefit systems in both countries. Our outcome income measure is the equivalised household disposable income using the LIS equivalence scale which applies the square root of the household size.

3.1 The cross-country distributional differences in income

Differences between the distributions of equalized household disposable income in the two countries is illustrated in Figure 1, which plots the quantile function divided by mean income. Overall, the UK displays a steeper profile, especially past the the 50th quantile. These differences translate into a higher inequality in the UK than in Ireland as measured by the Gini index (Table 1). The country ranking in inequality is confirmed by the dominance of the Lorenz curves (Figure A.3) .

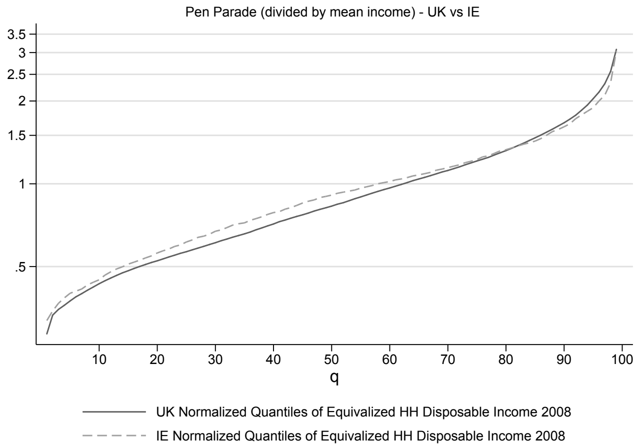


Figure 1: Distribution of equivalised Household Disposable Income UK vs. IE
Note: Normalized = Pen Parade/Mean Income

Table 1: Survey Statistics Equivalized Disposable Income (Euro)- the UK vs. IE in 2007

	Mean	Median	GINI
UK	2347.0	2249.8	0.317
Ireland	2554.1	2505.8	0.277

Notes: 1 = UK distribution (Euromod output based on the 2007 system); 2 = IE distribution (Euromod output based on the 2007 system)

To illustrate the cross-country difference, Figure 2 shows the relative difference between the pen parades of the two countries, taking UK as base.The bottom 80% are better off in Ireland than in the UK, whereas the top 20% are better off in the UK. The incidence curves become negative past the 80th quintile, sign that the pen parades for the UK and IE cross. The richest 20% individuals hold a larger share of total income in the UK compared with the respective shares in Ireland (Table A.1).

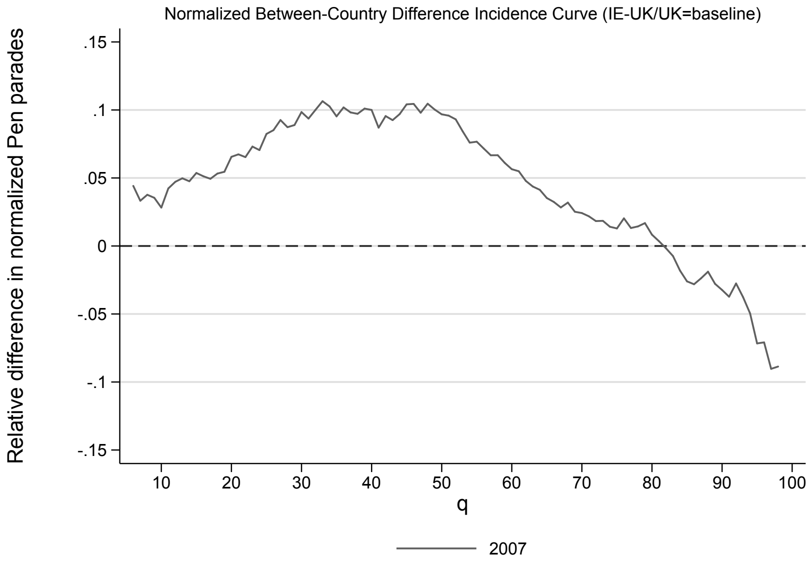


Figure 2: Relative Difference in normalized Pen parades in 2007 (UK=base)

The decomposition of gross income inequality by sources is illustrated in Table A.3. Gross income comprises the main market income sources (labour, private pensions, capital and other). The pre tax-benefit income pie relies more heavily on labour income in Ireland and much less on the other sources of income compared to the UK. Labour income is more unequally distributed in the UK with roughly 7 percentage points. The concentration coefficient shows that in the UK a larger share of labour income is concentrated on individuals with high gross incomes than in Ireland. The contribution to overall inequality is however lower in the UK (over 89% in the UK and over 92% in Ireland) because the share in total income amounted by labour income is with 8 percentage points lower in the UK (82% of total income). Private pensions represent around 6.7% of total income in the UK, as opposed to around 4.4% in Ireland; moreover they are less unequally distributed in the UK (with almost 4 percentage points) and to a lesser extent concentrated among the richest individuals than in Ireland. More people have access to private pensions in the UK than in Ireland. The other sources of income represent around 11% in the UK and around 5.3% in Ireland, and are with roughly 0.8 percentage point more unequal in the UK; their resulting contribution to overall inequality is around 8.8% in the UK versus 5% in Ireland. Despite these differences, the overall inequality in gross income differs between the two countries by 1.4 percentage points.

Disposable income is not only much more unequally distributed in the UK than in Ireland, but also the relative contributions of the different sources differ between the two countries (Table A.4). Total gross income contributes over 167% to inequality in disposable income in the UK versus a contribution of over 162% in Ireland. Taxes and social insurance contributions contribute to a reduction of over 51% in the UK versus a reduction of over 48% in Ireland, and benefits contribute towards a reduction of over 16% in the UK and close to 14% in Ireland.

3.2 Tax benefit systems in UK/Ireland

Both the Irish and UK tax-benefit systems are part of the Anglo-Liberal system of Welfare States. With mainly flat rate or means-tested benefit instruments, the primary objective of the transfer system is poverty alleviation. While there are differences, many of the historical developments in the Irish benefit system have derived from reforms in the UK system. Both are characterized by:

- flat rate and means-tested income replacement benefits (the main difference rests in the presence of a previous earnings related component in the UK system, that although contemplated at various stages in Ireland was never introduced);
- in-work transfers (both countries have transfers targeted at low-income families with children, where payments are made once a particular number of hours have been made; there is an additional child care component in the UK system);
- flat rate universal child benefits;
- housing benefits (coverage has been lower historically in Ireland, but has been increasing).

Both have progressive income taxation systems and earnings-related social insurance contributions that vary by employee and self-employed. There are however some differences. The Irish income taxation system is optional joint, while the UK system is an individualized system.

The indices on progressivity/regressivity and redistribution of taxes and benefits are reported in Table 2. The benefit schedule increases the difference in inequality between the two countries by dropping inequality to a larger extent in Ireland compared with the UK, effect driven by a higher degree of redistribution in Ireland. The benefit schedule is more regressive in the UK (more low incomes receive benefits), but the average benefit rate is lower, thus the degree of redistribution is lower in the UK. The tax system increases further the percentage point difference in inequality between Ireland and the UK. This is due to a more progressive and a more redistributive tax system in Ireland.

As taxes are progressive and benefits are regressive, the net schedule is equalizing in both countries. The Reynolds-Smolensky index of net redistributive effect shows the Irish tax-benefit system is more redistributive than

Table 2: Progressivity and Redistribution of Taxes on Household Equivalized Disposable Income (Euro)in 2007 - the UK vs. IE

	UK	Ireland	Ratio: IRL/UK
Gini Gross Income	0.497	0.483	0.972
Gini Gross Income (incl. benefits)	0.376	0.341	0.907
Benefit Regressivity (K)	0.936	0.767	0.820
Benefit Redistribution (RS)	0.121	0.142	1.174
Averate transfer rate	0.158	0.248	1.568
Gini (gross + benefits - income taxes)	0.330	0.289	0.874
Tax Progressivity (K)	0.242	0.353	1.457
Tax Redistribution (RS)	0.045	0.052	1.146
Averate tax rate	0.159	0.131	0.822
Gini Disposable Income	0.317	0.277	0.873
Net Redistributive Effect	0.180	0.206	1.147

Notes: K = Kakwani; RS = Reynolds-Smolensky; CI = concentration index

the UK system (Lambert, 2001). Whether these differences are due to policy design or to differences in the market income distribution is revealed in the decomposition analysis.

3.3 Population structure differences

The two countries exhibit similar demographic profiles, except for a few differences (see Table A.2). The population aged 25-64 is generally more educated in Ireland than in the UK, and there are larger shares of people aged 65+ and smaller shares of children aged 4+ in the UK than in Ireland. The employment, occupational and industrial structure shows the UK has lower shares of top skill professions and higher shares of low and unskilled profession and a relatively larger industrial and public sector than Ireland.

The allocation of non-labour income sources differ significantly between the two countries, with the UK exhibiting larger shares of people with private pensions, capital and other sources of income (bottom Table A.2).

4 Decomposing Differences in Inequality between the UK and Ireland

4.1 Inequalities between the UK and Ireland

Table 3 presents the decomposition of the country differences in the Gini coefficients of disposable and gross income (labour market income, private pensions, capital and other income), the progressivity and regressivity measures, and the average tax and benefit rates in 2007.[4] The results for subcomponents are in Table 4.

The distribution of disposable income is the result of the interaction between the distribution of market income and the net redistributive character of the tax-benefit system. In 2007, market income was less unequally distributed in Ireland than in the UK by 1.4 Gini points. The differences in the two tax-benefit systems augment (almost triple) the cross-country differences in disposable income inequality relative to market income inequality, making Ireland less unequal than the UK by 4 Gini points. This signals the presence of strong interactions between policies and market income distributions.

The contribution of each factor to the -4 Gini point difference in disposable income inequality is assessed below the estimated difference in Table 3. Each effect is composed from a direct effect and an indirect behavioural response via the potential change of labour supply. The direct effect of each factor is captured by the difference between the counterfactual distribution that would prevail in the UK if we import each factor in isolation from Ireland (assuming no labour supply responses) and the original distribution. Controlling for market income distributional differences, the effect due solely to the differences in the two tax-benefit systems is roughly half the observed difference in disposable income inequality: the Irish tax-benefit system is with 2 percentage points more equalizing than the UK tax-benefit system. The effect of the labour supply response to the system swap, which is the difference between the counterfactual with the labour supply response and the "static" counterfactual, seems to be negligible in this case.

The decomposition of the differences between the normalized Pen parades of the two distributions of equivalised disposable income (IE-UK) in Figure 3 shows that the pattern of the tax-benefit effect (the difference in the normalized pen parades between the counterfactual that would prevail if we import in isolation the Irish tax-benefit system in the UK distribution and the original UK distribution) follows closely the total cross-country income differentials, confirming it is one of the main drivers of the difference between these two countries. As the tax-benefit effect is basically the policy effect controlling for differences in the market income distributions between the two countries, the larger deviation of the tax-benefit effect from the total difference observed for the bottom 60% indicate larger market income distributional differences between the two countries at the bottom 60% than at the top 40%.

[4] The validation of our simulations is discussed in the Annex B.

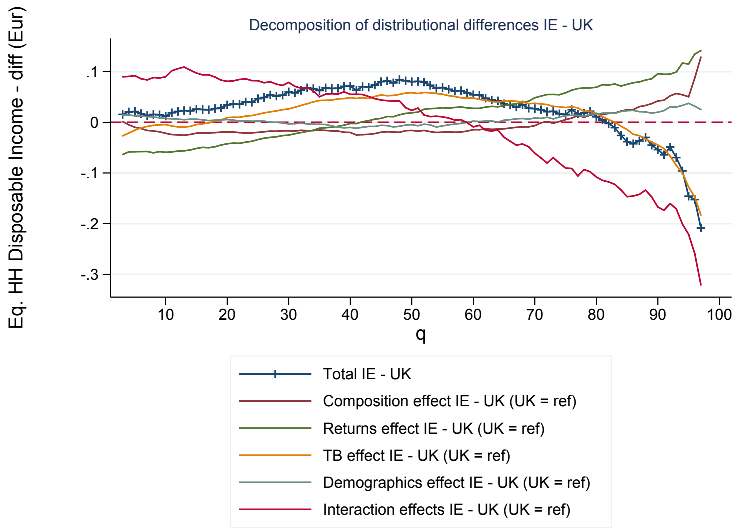


Figure 3: Distributional differences across quantiles of equivalised household disposable income due to market composition, returns, tax-benefit and demographics ceteris paribus effects in 2007
Note: Normalized = Pen Parade/Mean Income

The negative tax-benefit effect for the bottom and top 20% indicates that the UK tax-benefit rules favour the bottom poorest and the top richest households to a larger extent than the Irish rules. This is consistent with a higher benefit regressivity of the UK system and a higher tax progressivity of the Irish system.

4.2 Policy Design and Market Income Differences

To understand the sources of the strong equalizing effect of the Irish tax-benefit system we decompose the differences in the progressivity and regressivity indices (Table 3) for the main components, and Table 4 for the sub-components). Note that the benefit regressivity takes as base gross income, whereas tax progressivity takes as base gross income including benefits. The differences between the two tax-benefit systems at face value indicate that the Irish system is more redistributive than the UK system due to a higher tax progressivity and larger average benefits rates. The UK system has a higher benefits regressivity and lower average tax rates. We try to understand to what extent these differences are due to policy design and/or to differences in market income distributions.

4.2.1 Policy Design of Tax and Benefit Rules

Controlling for market income differences (e.g. importing the Irish TB system in isolation), tax progressivity and average benefit rates, and overall net redistribution, are still larger under the Irish tax-benefit system. Thus, by design, the Irish tax schedule is more progressive than the UK tax schedule, but the Irish lead in tax progressivity is eroded partially by the differences in market income distribution (the effect is stronger when we control for market income differences than the observed difference: 11.8 versus 11.1 percentage points). The difference in average benefit rates due solely to policy differences is lower (6.7 percentage points) than the observed difference (9 percentage points), concluding that market income income differences increase the gap in average benefit rates between the two countries.

The difference in benefits between Ireland and the UK concern both benefit regressivity (how many poor people receive the benefit) and their overall level. Benefit regressivity is lower in Ireland by 16.8 percentage points, difference mostly explained by the differences in policy design, returns and demographics. Controlling for market income differences, this difference would be larger, 17.4 percentage points. Thus, by design, benefit regressivity is lower in Ireland than in the UK, but the difference is narrowed by market income differences.

To sum up, the Irish tax-benefit system is more redistributive than the UK system due to a higher tax progressivity and larger average benefits rates. These differences are attributable not only to policy differences, but also to differences in market income distribution. Overall, the differences between two market income distributions increase the gap in the net redistributive effect of the two systems.

Next we explore the main drivers of the difference in the distribution of market incomes between the two countries and how they affect the features of the system, and ultimately the differences in disposable income inequality between countries.

Market income are less unequally distributed in Ireland than in the UK (Table 3, column for Gini Gross Income). This is driven mainly by the differences in returns and interaction effects, partially counterbalanced by the market composition factors and the labour supply behaviour (due to population and market composition differences).

4.2.2 Market Return Effects

Importing the structure of returns from Ireland in isolation would decrease inequality in gross market income by 1.2 percentage point (plus 0.1 percentage point decrease from the labour supply response). However, we find a disequalizing effect on the distribution of disposable income by 1.6 percentage points (minus 0.4 percentage points in labour supply response). This effect is driven by capital incomes, which disequalize both market and disposable income distributions (by 0.5 and 1.6 percentage points), as shown in Table 4, which breaks the effects by sub-components,. The effect of differences in labour market returns is turned mute by the tax-benefit system. Importing the Irish labour market returns structure has an equalizing effect on the distribution of gross incomes by 0.9 Gini points, driven most probably by the lesser inequality in labour market returns across occupations in Ireland observed in Figure A.9[5]. This effect disappears when we look at disposable income. Similar effects are found for private pensions: the difference in private pensions reduces inequality in gross income by 1 percentage points, effect which is turned mute by the tax-benefit system. The differences in labour market returns, pensions and capital incomes, assessed in isolation, erode tax progressivity, benefit regressivity and reduce average benefit rates.

The factor with the strongest eroding effect on tax progressivity are labour market returns: the differences between countries erode tax progressivity by 2 percentage points. Following the chain of effects in Table 4, we see that importing the Irish labour market returns reduces inequality in gross incomes. This effect disappears when transfers are included. Coupled with the reduction in the concentration of tax, this leads to a decrease in tax progressivity. Consistent with the trade-off between tax progressivity and the tax weight, average tax rate increased. The differences in private pensions reduce inequality in gross incomes, effect which lessens when transfers are included. The concentration of tax reduces to a larder extent than the decrease in inequality, resulting in a decrease in tax progressivity. The difference in capital incomes increases inequality in gross income, effect which is amplified by transfers. The concentration of tax increases to a lesser extent than the increase in inequality, resulting in the decrease in tax progressivity.

The net effect of the difference in the structure of returns is a reduction in net redistribution by 2.8 percentage points (plus 0.2 pp increase from the labour supply response to the difference in returns), with similar contributions from the three income sources. The decrease in net redistribution (due to differences in returns) is driven by the decrease in average benefit rates (by 2.3 percentage points) and tax progressivity (by 3.2 percentage points).

4.2.3 Market Compositions

The country differences in the market composition lead to an increase in both gross income inequality and disposable income inequality: by 1.9 percentage points (reinforced by a 2.3 percentage point increase due to labour supply responses) and by 1.5 percentage points (reinforced by a 0.7 percentage point increase due to labour supply responses). The net effect is an increase in net redistribution by 1.9 percentage points (0.4 from the direct effect and

[5]Labour income is less unequally distributed in Ireland than in the UK by 6.9 percentage points [cite table A.3].

1.5 percentage points from the labour supply response), resulting from an increase in benefit regressivity, average benefit rates and tax progressivity. Thus the differences in market components disequalize the distributions of income, thereby reinforcing net redistribution by increasing tax progressivity, average benefit rates and benefit regressivity.

Among the market components (Table 4), the main disequalizing market factor is the structure of having or not non-labour income sources (e.g. private pensions, capital income): importing the Irish factor in isolation, would increase both inequality in gross income (by 3.9 percentage points) and in disposable income (by 1.4 percentage points). This translates into an increase in net redistribution by 2.5 percentage points, determined by an increase of 4 pp in benefit regressivity, 2.4 pp in average benefit rates and 1.2 pp in tax progressivity. As less people have access to non-labour income sources in Ireland, importing this structure in the UK disequalizes the distribution of gross incomes (with or without transfers) and increases the concentration of income taxes. The increase in tax progressivity is determined by a larger increase in the concentration of income taxes relative to the disequalizing effect on gross incomes.

The differences between the in-work structures have the opposite effect. They reduce inequalities in gross incomes by 1.6 pp, while the tax system appears to silence the effect on disposable income. The net effect is a decrease in net redistribution. The reduction in net redistribution results from a decrease in tax progressivity, average benefit rates and benefit regressivity. Thus the in-work structure is one of the factors that drive the differences in the market income distributions that erode tax redistribution.

4.2.4 Population Effect

The population differences lead to an increase in inequality in both gross incomes (mostly via the labour supply response by 6.5 percentage points) and disposable income (both via the direct effect by 2.4 pp and the labour supply response by 2 pp). Considering the overall effect, the population differences determine an increase in net redistribution by 2.1 pp (4.5-2.4), driven by an increase in average benefit rates and tax progressivity .

In Table 4, we isolate the effect of the demographic structure. The impact of the differences in the demographic profiles of the two countries is disequalizing the distribution in gross incomes by 0.6 pp, but the effect is reversed (minus 0.4 pp) once the benefit schedule kicks in. Overall, the demographic differences enhance net redistribution by 1 pp. This is the net result of the increase in average benefit rates and tax progressivity by 1.5 pp and 0.6 pp.

Importing the Irish demographic structure, which has relatively more families with children, implies more benefit recipients. This translates into a lower concentration of benefits (a lower concentration means further away from -1 and closer to 0), consistent with the positive effect of 1.8 percentage points. This effect is larger than the increase in gross income inequality triggered by the swap in demographics, thus the reduction in benefit regressivity. More families with children translate in more benefit recipients, which explain the positive effect on average benefit rates. Importing the Irish demographic profiles decreases gross income inequality (post-benefits), while leaving the concentration of income taxes marginally unaffected, which results in an increase in tax progressivity.

4.2.5 Labour Supply Preference

While the direct swap of the tax and the population system explains the differences in some extent, it ignores the potential behavioural shift due to the change of the market and the taxation system. For instance, if the newly imposed taxation system favours the mid-high income earners with lower taxes, disregarding the behavioural shift might underestimate the size of the high income population as there is now a greater incentive for worker with mid-high earning capacity to work. Additionally, the labour supply model also captures the labour supply preference of the population, allowing us to swap the incentive structure of the economic system while retaining both the observed population characteristics and unobserved preferences to some extent. The labour supply preference interacts with all other components as the hours of labour supply is a function of the population structure, tax benefit system, the market composition and returns. We report both the results with and without the behavioural shift in Table 3. As shown, the behavioural response generally has a lessened impact than the direct impact. This is likely due to the relative inelastic labour supply curve in both countries.

4.2.6 Interactions and implications of ignoring labour supply responses

Our simulation suggests interactions also play an important role in explaining the differences of the income inequality between the two countries. They encapsulate all two, three and four-way interactions between the factors. Their individual exploration is beyond the scope of the current paper.

The implication of disregarding the labour supply responses to the different factor swaps is an interaction effect that comprises the labour supply behavioural effects. In our case, for example, for disposable income, the interaction effects when labour supply responses are ignored would be -0.076 (-0.099+0.023) instead of the -0.099. Our framework can therefore be used also for decompositions that do not include labour supply responses, as the direct effects are not affected. But one has to bear in mind that the interaction effects would be overestimated if the labour supply response goes in the same direction as the interaction effects and underestimated if they have opposite signs.

5 Concluding Remarks

This paper developed a methodological framework for exploring the drivers of the cross-national differences in the distribution of household disposable income, focusing on the role of tax-benefit systems, employment structures and market returns and demographic structures. Our framework extends the Bourguignon et al. (2008) methodology by developing a household income distribution, which incorporates a flexible parametric approach of modelling wage differentials across the entire distribution, the complexity of tax-benefit rules through micro-simulation (EUROMOD), and the integration of the labour behavioural shifts.The result is an integrated framework across countries for generating and simulating the distribution of household disposable income under alternative scenarios, thereby enabling the study of the various drivers of the cross-national distributional differences in household disposable income.

The paper demonstrates the use of the method through the analysis of two European neighbouring English-speaking countries –the UK and Ireland– that share many similarities, while displaying at the same time sufficient differences to merit understanding more clearly of the factors that have resulted in different levels of inequality. We explored the drivers of distributional differences between these countries in 2007, the latest year before the economic crisis in both countries. We applied the general additive and path-independent decomposition approach introduced by Biewen (2014), which separates the ceteris paribus effect of each factor from the interaction effects between factors.

Whereas market income distribution is with roughly 1.4 Gini point less in Ireland than in the UK, the absolute difference in inequality in disposable income is almost three times larger (4 Gini points). We explore the extent to which this difference is due to policy effects or drivers of market income distribution. Our findings suggest that the Irish tax-benefit system is more redistributive than the UK system due to a higher tax progressivity and more generous average transfer rates. These differences are largely attributable to policy differences, but also to differences in market income distribution.

Market income distributional differences reinforce the net redistributive policy effect via the market composition and demographic differences. The positive effect of the differences in market composition (mainly via the assignment of non-labour income sources and the occupational structure) and in demographics stem primarily from the positive effect on both average transfer rates and tax progressivity. The difference in returns (especially labour market returns) partially erodes the net redistributive policy effect

Table 3: Decomposition of differences in income distributions between Ireland and the UK

2007	Gini Disposable	Gini Gross Income	Concentration Benefits	Benefit Regressivity	ATR Benefits	Gini Gross (incl. transfers)	Concentration Tax	Tax Progressivity	ATR Tax	Net Redistr.
UK	0.317	0.497	-0.439	0.936	0.158	0.376	0.618	0.242	0.159	0.180
Country Differences										
IE-UK	-0.040	-0.014	0.154	-0.168	0.090	-0.035	0.076	0.111	-0.028	0.026
Contribution of direct effects (UK*-UK) to cross-national differences										
MC	0.015	0.019	0.017	0.002	0.006	0.015	0.021	0.006	0.002	0.004
Returns	0.016	-0.012	0.049	-0.061	-0.023	0.011	-0.021	-0.032	0.007	-0.028
TB	-0.020	0.002	0.176	-0.174	0.067	-0.010	0.109	0.118	-0.024	0.022
Population	0.024	0.000	0.070	-0.069	0.012	0.014	-0.005	-0.019	0.002	-0.024
Labour Supply Responses to Component Swaps										
MC	0.007	0.023	0.008	0.015	0.018	0.009	0.021	0.012	-0.003	0.015
Returns	-0.004	-0.001	-0.002	0.001	0.004	-0.004	-0.002	0.002	-0.004	0.002
TB	0.000	0.001	-0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Population	0.020	0.065	0.044	0.021	0.073	0.024	0.061	0.037	-0.012	0.045
Interactions	-0.099	-0.110	-0.208	0.098	-0.069	-0.094	-0.108	-0.014	0.005	-0.011

Notes: MC: market composition; TB: tax-benefit system; OPD: other population differences.

Table 4: Decompostion of differences in income distributions between Ireland and the UK

2007	Gini Disposable	Gini Gross Income	Concentration Benefits	Benefit Regressivity	ATR Benefits	Gini Gross (incl. transfers)	Concentration Tax	Tax Progressivity	ATR Tax	Net Redistr.
UK	0.317	0.497	-0.439	0.936	0.158	0.376	0.618	0.242	0.159	0.180
Country Differences										
IE-UK	-0.040	-0.014	0.154	-0.168	0.090	-0.035	0.076	0.111	-0.028	0.026
Contributions to cross-national differences (UK*-UK)										
MC	0.015	0.019	0.017	0.002	0.006	0.015	0.021	0.006	0.002	0.004
MC Components										
In-work	-0.001	-0.016	0.007	-0.023	-0.014	-0.003	-0.012	-0.009	0.003	-0.015
Empl/Self	-0.000	0.001	0.002	-0.001	0.001	-0.000	0.001	0.001	-0.000	0.001
Occ/Ind/Sec	-0.002	-0.000	0.003	-0.004	0.003	-0.002	0.002	0.004	-0.001	0.002
Has NL income	0.014	0.039	-0.001	0.040	0.024	0.017	0.029	0.012	-0.001	0.025
Other	0.005	0.000	0.008	-0.008	-0.004	0.004	0.001	-0.003	0.001	-0.005
Interactions	-0.001	-0.004	-0.002	-0.002	-0.004	-0.001	-0.000	0.001	-0.000	-0.003
Returns	0.016	-0.012	0.049	-0.061	-0.023	0.011	-0.021	-0.032	0.007	-0.028
Returns Components										
LM	0.001	-0.009	-0.005	-0.005	-0.012	-0.001	-0.021	-0.020	0.004	-0.010
PP	-0.001	-0.010	0.016	-0.026	-0.005	-0.003	-0.011	-0.008	0.001	-0.009
O	0.016	0.005	0.038	-0.033	-0.007	0.015	0.009	-0.006	0.001	-0.011
Interactions	-0.000	0.002	-0.000	0.002	0.001	-0.000	0.002	0.002	0.001	0.002
Population	0.024	0.000	0.070	-0.069	0.012	0.014	-0.005	-0.019	0.002	-0.024
Demographics	-0.004	0.006	0.018	-0.012	0.015	-0.003	0.000	0.003	-0.002	0.010
OPD	0.034	0.004	0.066	-0.062	0.005	0.023	0.003	-0.020	0.004	-0.029
Interactions	-0.006	-0.010	-0.015	0.004	-0.008	-0.006	-0.009	-0.003	0.000	-0.004

Notes: MC: market composition; TB: tax-benefit system; OPD: Other Population Differnces.

by eroding tax progressivity and average transfer rates. We also note that individuals have a similar level of incentives to participate in the labour market under the UK sand the Irish system. While the behavioural response does adjust the impact of the swapped component, the overall impact due to labour supply change is low compared with the first round effect.

This framework allows exploring not only the driving factors of the differences in inequality across countries at one point in time, but also the driving factors of the differences in changes in inequality between countries during an economic shock. By repeating the exercise during the crisis and taking a difference in difference approach pre-during the crisis, we could decompose the differences in changes in inequality between countries into the effect various factors. It should however, be noted that the framework proposed is descriptive by nature (no experimental or quasi- experimental setting is exploited), but the apparatus offers sufficient sophistication to allow detailed analysis of the way tax-benefit systems can interact with labour market structures, income structures and demographics in determining the distribution of household disposable income and in explaining the cross-national differences in disposable income inequality.

References

Altonji, J. G., Bharadwaj, P., and Lange, F. (2012). Changes in the characteristics of American youth: Implications for adult outcomes. *Journal of Labor Economics*, 30(4):783–828.

Bargain, O. (2012). Back to the future: decomposition analysis of distributive policies using behavioural simulations. *International Tax and Public Finance*, 19(5):708–731.

Bargain, O. and Callan, T. (2010). Analysing the effects of tax-benefit reforms on income distribution: a decomposition approach. *Journal of Economic Inequality*, 8(1):1–21.

Biewen, M. (2014). Additive decompositions and interaction effects. *Applied Economics Letters*, 21(9):636–642.

Biewen, M. and Juhasz, A. (2012). Understanding rising income inequality in germany, 1999/2000-2005/2006. *Review of Income and Wealth*, 58(4):622–647.

Bourguignon, F., Ferreira, F. H., and Leite, P. G. (2008). Beyond Oaxaca-Blinder: Accounting for differences in household income distributions. *The Journal of Economic Inequality*, 6(2):117–148.

Brandolini, A. and Smeeding, T. (2010). Income Inequality in Richer and OECD Countries. In Salverda W., Nolan B., S. T., editor, *The Oxford*

Handbook of Economics Inequality, chapter Income Inequality in Richer and OECD Countries, pages 71–100. Oxford University Press.

Chantreuil, F. and Trannoy, A. (2013). Inequality decomposition values: the trade-off between marginality and efficiency. *The Journal of Economic Inequality*, 11(1):83–98.

Chernozhukov, V., Fernández-Val, I., and Melly, B. (2013). Inference on counterfactual distributions. *Econometrica*, 81(6):2205–2268.

Daly, M. C. and Valletta, R. G. (2006). Inequality and poverty in United States: The effects of rising dispersion of men's earnings and changing family behaviour. *Economica*, 73(289):75–98.

Devicienti, F. (2010). Shapley-value decompositions of changes in wage distributions: a note. *Journal of Economic Inequality*, 8(1):35–45.

DiNardo, J., Fortin, N. M., and Lemieux, T. (1996). Labor market institutions and the distribution of wages, 1973-1992: A semiparametric approach. *Econometrica*, 64(5):1001–1044.

Ferreira, F. (2012). Distributions in motion: Economic growth, inequality, and poverty dynamics. In Jefferson, P., editor, *Oxford Handbook of the Economics of Poverty*, chapter Distributions in motion: Economic growth, inequality, and poverty dynamics. Oxford University Press.

Figari, F., Paulus, A., and Sutherland, H. (2015). Microsimulation and policy analysis. In Atkinson, A. B. and Bourguignon, F., editors, *Handbook of Income Distribution*, volume 2B, chapter 24, pages 2141–2221. North-Holland, Oxford, UK.

Fortin, N., Lemieux, T., and Firpo, S. (2011). Decomposition methods. In Ashenfelter, O. and Card, D., editors, *Handbook of Labor Economics*, volume 4A, pages 1–102. North-Holland, Amsterdam.

Fortin, N. M. and Lemieux, T. (1997). Institutional changes and rising wage inequality: Is there a linkage? *Journal of Economic Perspectives*, 11(2):75–96.

Genest, C. and Mackay, J. (1986). The joy of copulas: Bivariate distributions with uniform marginals. *The American Statistician*, 40(4):280–283.

Herault, N. and Azpitarte, F. (2015). Understanding changes in the distribution and redistribution of income: A unifying decomposition framework. *Review of Income and Wealth*, pages n/a–n/a.

Hildebrand, V. A., Pi Alperin, M. N., and Van Kerm, P. (2015). Measuring and accounting for differences in the 'deprivation gap' of Portuguese immigrants in Luxembourg. *Review of Income and Wealth.* Published online: DOI: 10.1111/roiw.12210.

Hyslop, D. R. and Mare, D. C. (2005). Understanding New Zealand's Changing Income Distribution, 1983 - 1998: A Semi-parametric Analysis. *Economica*, 72(287):469 – 495.

Jenkins, S. and Van Kerm, P. (2005). Accounting for income distribution trends: A density function decomposition approach. *The Journal of Economic Inequality*, 3(1):43–61.

Juhn, C., Murphy, K. M., and Pierce, B. (1993). Wage inequality and the rise in returns to skill. *The Journal of Political Economy*, 101(3):410–442.

Lambert, P. J. (2001). *The Distribution and Redistribution of Income.* Manchester University Press, Manchester.

Larrimore, J. (2014). Accounting for United States household income inequality trends: The changing importance of household structure and male and female labor earnings inequality. *Review of Income and Wealth*, 60(4):683–701.

Levy, H., Lietz, C., and Sutherland, H. (2007). Swapping policies: Alternative tax-benefit strategies to support children in Austria, Spain and the UK. *Journal of Social Policy*, 36(4):625–647.

Li, J. and O'Donoghue, C. (2013). A survey of dynamic microsimulation models: uses, model structure and methodology. *International Journal of Microsimulation*, 6(2):3–55.

Machado, J. A. F. and Mata, J. (2005). Counterfactual decomposition of changes in wage distributions using quantile regression. *Journal of Applied Econometrics*, 20:445–465.

Matzkin, R. L. (2003). Nonparametric estimation of nonadditive random functions. *Econometrica*, 71(5):1339–1375.

Milanovic, B. (1998). *Income, Inequality, and Poverty during the Transition from Planned to Market Economy.* The World Bank, Washington.

Milanovic, B. (2005). *Worlds Apart: Measuring International and Global Inequality.* Princeton: Princeton University Press.

Nelsen, R. B. (2006). *Introduction to Copulas.* Number 139 in Springer Series in Statistics. Springer Verlag, New York.

O'Donoghue, C. (2001). Redistribution over the lifetime in the Irish tax-benefit system: an application of a prototype dynamic microsimulation model for Ireland. *Economic and Social Review*, 32(3):191–216.

OECD (2011). *Divided We Stand: Why Inequality Keeps Rising*. OECD, Paris.

Rothe, C. (2010). Nonparametric estimation of distributional policy effects. *Journal of Econometrics*, 155(1):56–70.

Rothe, C. (2012). Partial distributional policy effects. *Econometrica*, 80(5):2269–2301.

Sastre, M. and Trannoy, A. (2002). Shapley inequality decomposition by factor components: Some methodological issues. *Journal of Economics*, 77(1):51–89.

Shapley, L. S. (1953). A value for n-person games. In Kuhn, H. and Tucker, A. W., editors, *Contributions to the Theory of Games, II*. Princeton: Princeton University Press.

Shorrocks, A. (1980). The class of additively decomposable inequality measures. *Econometrica*, 48:613–625.

Shorrocks, A. (2013). Decomposition procedures for distributional analysis: a unified framework based on the shapley value. *The Journal of Economic Inequality*, 11(1):99–126.

Sklar, A. (1959). Fonctions de répartition à n dimensions et leurs marges. *Publications de l'Institut de Statistique de L'Université de Paris*, 8:229–231.

Sutherland, H. and Figari, F. (2013). EUROMOD: the European Union tax-benefit microsimulation model . *International journal of microsimulation*, 6(1).

Wilkinson, R. and Pickett, K. (2009). *The Spirit Level: Why More Equal Societies Almost Always Do Better*. London: Allen Lane.

World Bank (2006). *World Development Report 2006: Equity and Development*. Oxford University Press and the World Bank, New York.

World Economic Forum (2011). *Global Risks 2011*. World Economic Forum, Geneva, 6 edition.

Appendix

A Background statistics

A.1 Modules of the Income Distribution Model

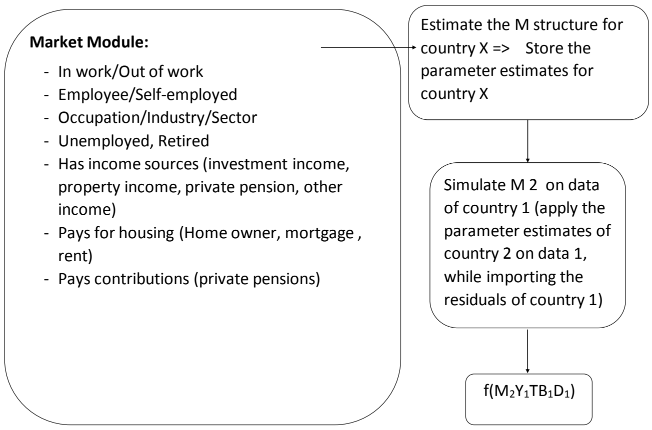


Figure A.1: Market Module

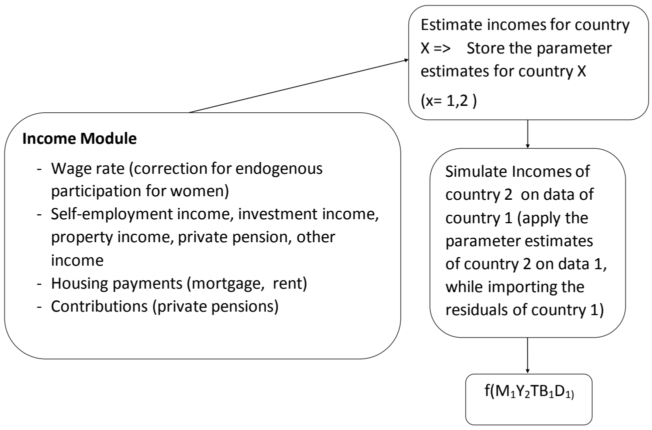


Figure A.2: Income Module

A.2 Income

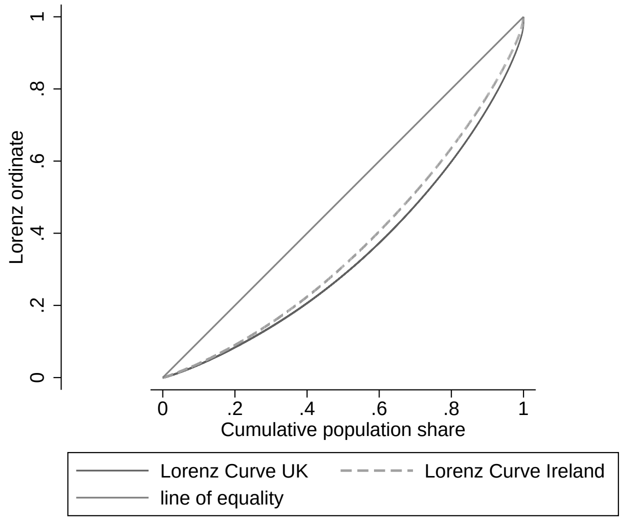


Figure A.3: Lorenz curves the UK vs Ireland 2007

Table A.1: Quantile group share of total disposable income 2007

Shares of total equivalized disposable income		
Quintile Groups	UK	Ireland
1	3.59	3.91
2	4.81	5.14
3	5.67	6.13
4	6.60	7.35
5	7.73	8.41
6	8.97	9.60
7	10.42	10.81
8	12.14	12.28
9	14.77	14.55
10	25.31	21.83

Notes: The estimates are weighted.

A.3 Market composition

Table A.2: Population structure 2007

	UK	Ireland
Demographic		
Tertiary Education	0.263	0.314
People 16-65	0.667	0.676
People ¿65	0.146	0.102
Child 0-3	0.052	0.051
Child 4-11	0.087	0.108
Child 12-15	0.048	0.063
Married	0.504	0.485
Citizen	0.906	0.927
Sex	0.486	0.496
Labour market		
In-work	0.557	0.619
Employee/Self-Employed	0.883	0.864
Occupation		
Managers	0.158	0.174
Professionals	0.136	0.182
Associate Prof.	0.149	0.049
Clerks	0.119	0.115
Service	0.153	0.180
Craft	0.113	0.162
Plant	0.072	0.045
Unskilled	0.101	0.092
Industry		
Agriculture	0.014	0.048
Industry	0.218	0.087
Services	0.769	0.865
Public/Private	0.283	0.234
Other market factors		
With private pensions	0.342	0.146
With capital income	0.576	0.214
With other income	0.099	0.052

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 A.3: Household Equivalized Gross Market Income Decomposition by Income Source (Euro) in 2007 - the UK vs. IE

Country	Share (s)	Gini (g)	Correlation (r)	Concentration (c=g*r)	Relative Contribution (s*g*r/G)
UK					
Labour Income	0.824	0.581	0.926	0.538	0.891
Private Pensions	0.067	0.904	0.169	0.153	0.021
Capital and other	0.109	0.847	0.474	0.401	0.088
Total		0.497			
Ireland					
Labour Income	0.902	0.512	0.966	0.494	0.923
Private Pensions	0.044	0.940	0.311	0.293	0.027
Capital and other	0.053	0.839	0.537	0.450	0.050
Total		0.483			

Notes: UK = UK distribution (Euromod output); IE = IE distribution (Euromod output); Labour Income = Employment + Self-Employment; Capital Income = Investment + Property; Other Income = other + private transfers.

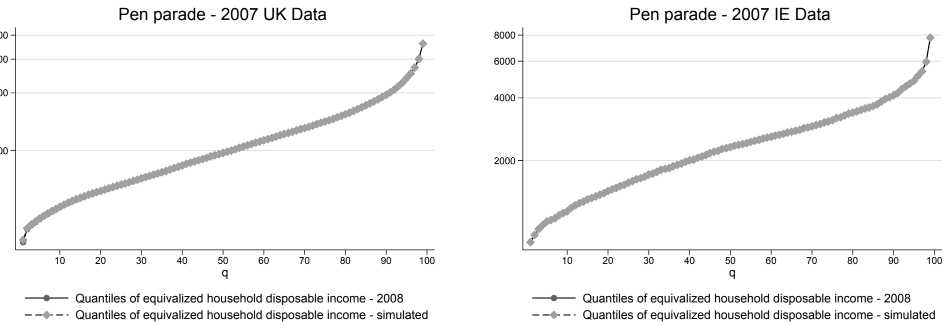
Table A.4: Household Equivalized Disposable Income Decomposition by Income Source (Euro) in 2007 - the UK vs. IE

Country	Share (s)	Gini (g)	Correlation (r)	Concentration (c=g*r)	Relative Contribution (s*g*r/G)
UK					
Labour Income	0.913	0.581	0.859	0.498	1.436
Private Pensions	0.074	0.904	0.335	0.303	0.071
Capital and other	0.121	0.847	0.521	0.441	0.168
Taxes	-0.205	-0.627	-0.969	0.607	-0.392
SIC	-0.079	-0.603	-0.796	0.480	-0.120
Benefits	0.175	0.562	-0.524	-0.295	-0.163
Total		0.317			
Ireland					
Labour Income	0.877	0.512	0.913	0.467	1.479
Private Pensions	0.043	0.940	0.405	0.381	0.059
Capital and other	0.052	0.839	0.522	0.438	0.082
Taxes	-0.159	-0.717	-0.939	0.673	-0.386
SIC	-0.054	-0.588	-0.848	0.499	-0.097
Benefits	0.241	0.436	-0.364	-0.159	-0.138
Total		0.277			

Notes: UK = UK distribution (Euromod output); IE = IE distribution (Euromod output); Labour Income = Employment + Self-Employment; Capital Income = Investment + Property; Other Income = other + private transfers.

B Validation results

To validate our simulations we compare the initial distribution of equivalised household disposable income with the one resulting from a full simulation: fully simulated labour market, income and tax-benefit structure. The two distributions for each period and their statistics are compared in Figure A.4. For both countries, the simulation framework does a good job at simulating back the original distributions, both before and during the crisis.



(a) UK

(b) IE

Figure A.4: Actual vs. Fully Simulated Quantiles of Household Disposable Income (EURO) - 2007

C Results: Pen Parades

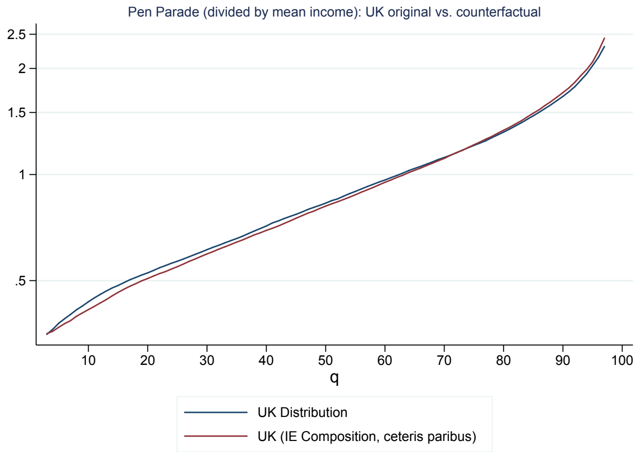


Figure A.5: Pen parades of equivalised household disposable income: UK original distribution vs. UK Counterfactual with IE labour market (LM), ceteris paribus in 2007
Note: Normalized = Pen Parade/Mean Income

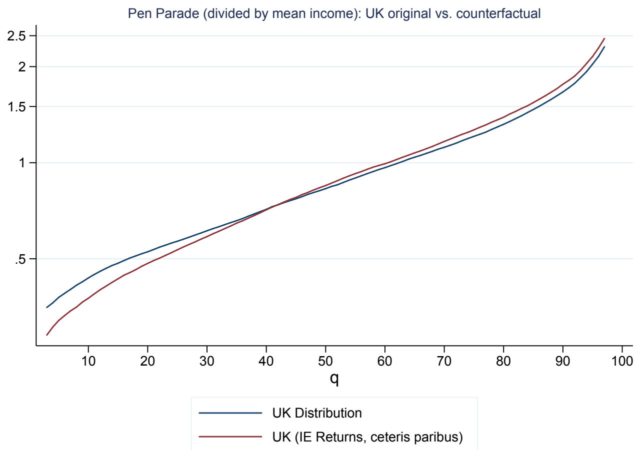


Figure A.6: Pen parades of equivalised household disposable income: UK original distribution vs. UK Counterfactual with IE income structure, ceteris paribus in 2007
Note: Normalized = Pen Parade/Mean Income

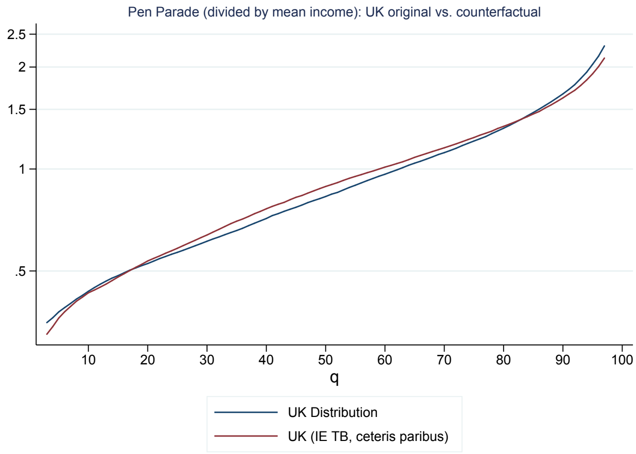


Figure A.7: Pen parades of equivalised household disposable income: UK original distribution vs. UK Counterfactual with IE tax-benefit (tax-benefit) system, ceteris paribus in 2007
Note: Normalized = Pen Parade/Mean Income

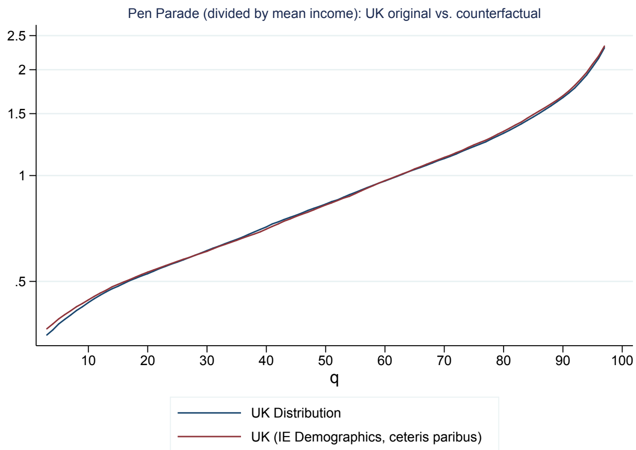


Figure A.8: Pen parades of equivalised household disposable income: UK original distribution vs. UK Counterfactual with IE demographic structure, ceteris paribus in 2007
Note: Normalized = Pen Parade/Mean Income

D. Estimation Results

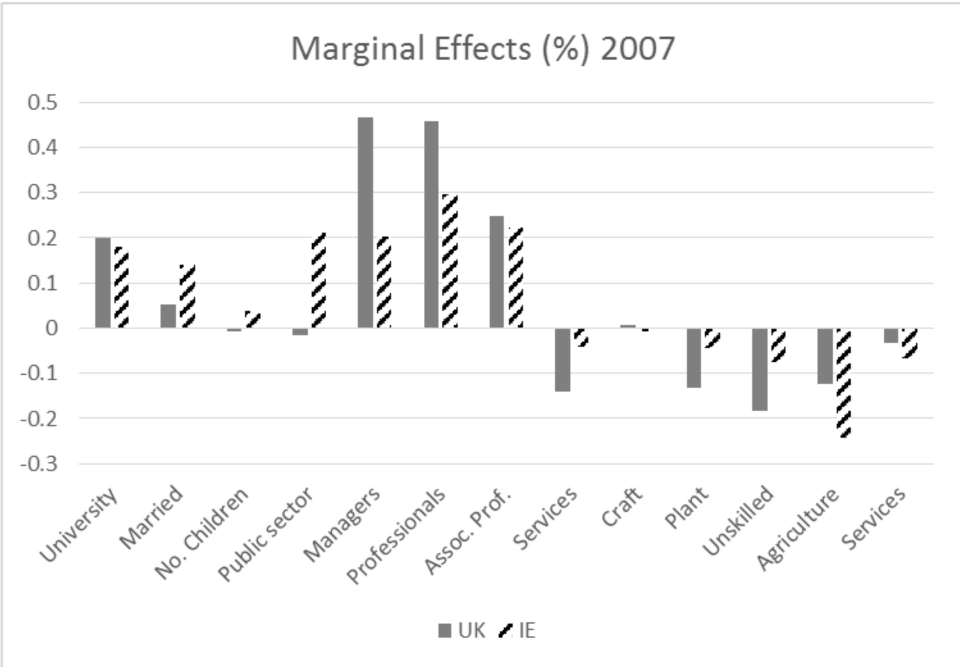


Figure A.9: Smfit wage marginal effects estimates for male wages at the median - 2007

Note: The effects are expressed in % differences relative to the base category (low education, unmarried, private sector, clerks, industry).