EUROMOD WORKING PAPER SERIES

EM 18/17

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December 2017

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Abstract

We present an exercise in empirical optimal taxation for European countries from three areas: Southern, Central and Northern Europe. For each country, we estimate a microeconometric model of labour supply for both couples and singles. A procedure that simulates the households' choices under given tax-transfer rules is then embedded in a constrained optimization program in order to identify optimal rules under the public budget constraint. The optimality criterion is the class of Kolm's social welfare function. The tax-transfer rules considered as candidates are members of a class that includes as special cases various versions of the Negative Income Tax: Conditional Basic Income, Unconditional Basic Income, In-Work Benefits and General Negative Income Tax, combined with a Flat Tax above the exemption level. The analysis show that the General Negative Income Tax strictly dominates the other rules, including the current ones. In most cases the Unconditional Basic Income policy is better than the Conditional Basic Income policy. Conditional Basic Income policy may lead to a significant reduction in labour supply and poverty-trap effects. In-Work-Benefit policy in most cases is strictly dominated by the General Negative Income Tax and Unconditional Basic Income.

JEL: H21, C18

Keywords: Basic Income, Negative Income Tax, Optimal tax, Micro-simulation, Welfare

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* This is part of a research project Optimal Tax Rules in Europe: A Micro-simulation Approach (OTaRiE) at LISER that involves Philippe Van Kerm (LISER and University of Luxembourg, Luxembourg), Nizamul Islam (LISER, Luxembourg), Denisa Maria Sologon (LISER, Luxembourg), Ugo Colombino (University of Turin, Italy), Lennart Flood (Gothenburg University, Sweden), Francesco Figari (University of Insubria, Italy). We wish to thank Flavia Coda Moscarola, Francesco Figari and Marilena Locatelli, who provided us the estimation programs, originally written for Coda Moscarola et al. (2014), which have been useful as a basis for developing our programs for the estimation of the microeconometric model. The results presented here are based on EUROMOD version G3.0+. EUROMOD is maintained, developed and managed by the Institute for Social and Economic Research (ISER) at the University of Essex, in collaboration with national teams from the EU member states. We are indebted to the many people who have contributed to the development of EUROMOD. The process of extending and updating EUROMOD is financially supported by the European Union Programme for Employment and Social Innovation 'Easi' (2014-2020). We make use of microdata from the EU Statistics on Incomes and Living Conditions (EU-SILC) made available by Eurostat (59/2013-EU-SILC-LFS). The results and their interpretation are the authors' responsibility.

1. Introduction

Since the end of the 2nd World War up to the mid-70s, means-tested transfers have been the main form of income support mechanism in most Western countries. Abstracting from lots of details and variations in eligibility criteria, level of generosity, population coverage etc., those policies adopted mechanisms that in this paper – in a stylized representation – we will call Conditional Basic Income (CBI), where incomes below a certain threshold are – somehow – subsidized up to the threshold.[2] For incomes below the threshold, a marginal tax rate close to (and sometimes greater than) 100% is applied. This introduces a disincentive to work, especially so for people with a low wage rate. The phenomena of poverty trap, or welfare trap, or welfare dependence have been observed – and to an increasing degree – in many countries. Welfare policies based on CBI-type mechanisms have also been criticized for other possible problems: high transaction costs and "welfare stigma" effects leading to low take-up rates, incentives to under-reporting of income, errors in setting eligibility, litigation costs etc. (e.g. Friedman and Friedman 1980; Atkinson 2015). Since the second half of the 70s, also as a response to the problems mentioned above, various reforms have been implemented in many countries: work-fare programs, less generous transfers, policies targeted towards smaller segments of the population, more sophisticated design of eligibility conditions and of the timing of transfers, in-work benefits or tax credits in order to strengthen the incentives to work (e.g. Blank et al. 1999). On the one hand, the reforms have been successful with regards to work participation incentives. On the other hand, they might have increased the administration and transaction costs of the mechanisms and – to a certain extent - also the direct cost when it comes to in-work-benefits or tax credits. Moreover, more complex conditioning and eligibility criteria might paradoxically induce more effort in trying to overcome the hurdles that limit the access to the policy, rather than in trying to find a job or a better one, thus encouraging a waste of potentially productive resources. During the last two decades, three processes have contributed to put the current welfare policies under stress and possibly to worsen their intrinsic drawbacks. Globalization and technological progress (automation), while creating big aggregate benefits, also imply massive adjustments in re-allocation of physical and human resources. Job losses and skill destruction and an increased demand for

[2] The qualification "Conditional" in this paper is used as equivalent to "means tested". In the literature on income support, the term conditional is also commonly used in relation to policies where monetary transfers are conditional upon the fulfillment of certain behavioural requirements, e.g. working a minimum of hours, sending children to school etc.

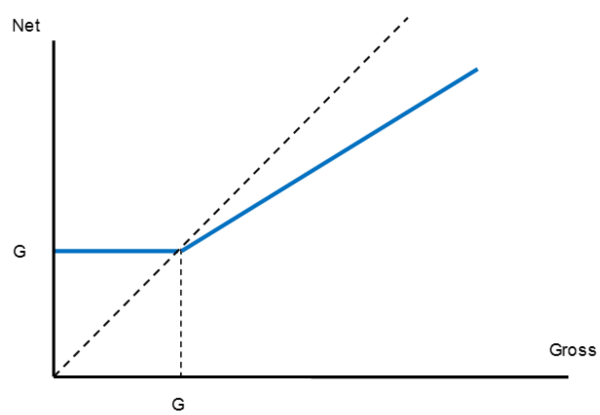
income support interventions– at least in the short-medium term – are natural consequences. The "Big Crisis" of the last decade obviously worsened the scenario. More recently, in many countries, a new interest emerged for a reform direction somehow opposed to the one taken since the end of 70s: less conditioning, simpler designs and ultimately some form of Unconditional Basic Income (UBI), i.e. a policy based on non-means tested transfers (e.g. Atkinson 2015, Colombino 2015*b*, Sommer 2016, Standing 2008, van Parijs 1995). In a similar perspective, proposals have been put forward for universal share of GDP (Shiller 1998, Raj 2016) or of the revenue from "common resources" (as it is actually implemented by the Alaska Permanent Fund). Experiments have been done, among others, in India (Standing 2015), Kenia (Haushofer & Shapiro 2016) and Uganda (Blattman et. 2014) with promising results. Experiments are currently being discussed (in the Netherlands) and actually run (in Finland, KELA 2016). Other experiments are planned, e.g. one by the hi-tech incubator Ycombinator in the USA. Although the idea goes back to a philosophical tradition focusing on ethical-distributive criteria (van Parijs 1995), from the strict economic point-of-view UBI might be particularly interesting for its possible efficiency properties. It must be noted at this point that both CBI and UBI are members of a more general class: the Negative Income Tax (NIT). The NIT was originally proposed by Friedman (1962) as an incentive-improving mechanism with respect to CBI-like policies. It consists of applying a lower-than-100% marginal withdrawal rate (MWR) to the basic transfer. In the limit, if the MWR is close to the first MTR applied to incomes above the subsidized level, the policy becomes indistinguishable from UBI. Thus we have a whole class of income support mechanisms (NIT) that ranges from one extreme (CBI) to the other (UBI), where each member of the class is characterized by the degree of means-testing (i.e. the value of the MWR). Another idea pointing towards simplification, which is often associated with NIT-like income support mechanisms, is the so-called Flat-Tax (FT), i.e. a proportional tax applied to all personal incomes above an exemption level (e.g. Hall and Rabushka 1995, Atkinson 1996). Despite the proportional marginal tax rate, the whole system is progressive in the sense that – due to the exemption level or to the guaranteed minimum income – the average tax rate increases with income. Overall, the "package" NIT+FT, besides being simple and transparent might provide a good equilibrium between progressivity, labour incentives and administration costs.

In what follows, we adopt an empirical optimal taxation perspective in order to scan the NIT+FT class and its special cases for the best (social-welfare-wise) policies and compare them to the current tax-transfer systems in six European countries.

2. The alternative policies

All the income-support mechanism that we consider below are matched with a FT. Overall we consider very stylized tax-transfer rules. On the one hand, they can be seen as simplified representation of the rules that are, or might be, actually implemented. On the other hand, they might be viewed as reforms in the direction of simplification. A Conditional Basic Income (CBI) mechanism essentially works as follows (Figure 1a). There is a threshold G, the guaranteed minimum income. If your own (gross) income Y falls below G, you receive a transfer equal to G – Y. If your own income goes above G you do not receive any transfer and pay taxes on Y – G. Therefore, your net available income will be G if Y is smaller than G, or else G + (1 – t)(Y – G) if Y is larger than G. According to an alternative interpretation (or implementation), everyone receive a transfer G. For Y < G, Y is taxed away at a 100% marginal tax rate up to Y = G. For Y > G, Y – G is taxed at some marginal rate t.

Figure 1a: Conditional Basic Income (CBI)



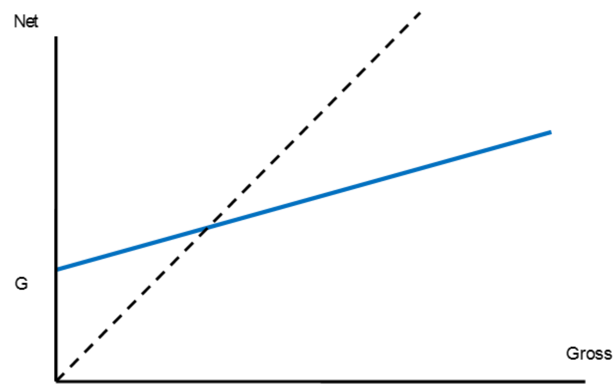
This mechanism suffers from the "welfare trap" or "welfare dependence" problem: there is no incentive to work for an income lower than G. But even a job paying more than G might not be convenient when accounting for hours to be spent on the job rather than devoted to leisure.[3] How strong is this effect

[3] Empirically, one might observe people located on the horizontal segment of the budget line since non-pecuniary or intertemporal benefits from working might make that location attractive.

depends of course on G, on the wage you can command on the labour market, on your relative preferences for income vs leisure etc.

The Unconditional Basic Income (UBI) mechanism is illustrated in Figure 1b. It consists of an unconditional transfer G to everyone (every citizen, say).

Figure 1b: Unconditional Basic Income (UBI)



The amount G would typically be lower than with CBI. Net available income would be G + (1 – t)Y, where again we assume a FT rate t. As noted with CBI, also UBI can be interpreted or implemented in a different way. Above an "exemption level" G/t, the amount (Y-G/t) is taxed at a marginal rate t. Below the exemption level, there is a transfer equal to (G – tY). The two alternatives obviously imply the same budget constraint in a static scenario. However, they might imply some differences in an intertemporal scenario. For example, with uncertainty and imperfect credit markets, it makes a difference to receive G upfront (say at the beginning of the year) or to receive a means tested transfer (say at the end of the year).

Clearly, with UBI: (i) there is no welfare trap, since even starting from Y = 0 for every euro of earnings you get (1 – t) euros; (ii) there is no incentive to under-report income or employment status, since you receive G whatever your income or your employment status is; (iii) there is no "stigma" or marginalization effect, since everyone receives the transfer; (iv) administration costs are relatively low; it has been estimated that the administrative costs of conditional transfer can be up to four times larger than the administrative costs of an equal unconditional transfer (de Walle 1999).[4] More in general, according to some analysts, UBI might represent a viable alternative to the prevailing current policies in order to help reallocating jobs and resources in the globalized and progressively automated economy, where employers need flexibility to compete on a global scale and employees need support to redesign their careers and occupational choices (e.g. Standing 2008, Colombino 2015a, Raj 2016). Experimental evidence suggests that UBI might reduce risk-aversion and therefore promote entrepreneurial activities and investment in human capital (Blatman 2014). Although a lump-sum transfer equal for everyone might appear as "unfair" or "wasteful" , this negative perception is not justified: even with a flat tax rate t, the average (net) tax rate increases with income, due to the transfer G (a negative tax); from a different perspective, since everyone pays taxes (1-t)Y, the lump-sum transfer G is progressively "given back" up to the break-even point G/t. UBI has its own difficulties. It is going to be more expensive than CBI; if, and how much, more expensive depends on the respective amounts of the transfers G; it also depends on how much UBI allows to save on administration costs. Although welfare trap effects are absent, there is however an income effect (due to the transfer G) with possibly negative effects on labour supply. However, the experimental evidence available so far suggests small negative effects and in some cases even positive effects.

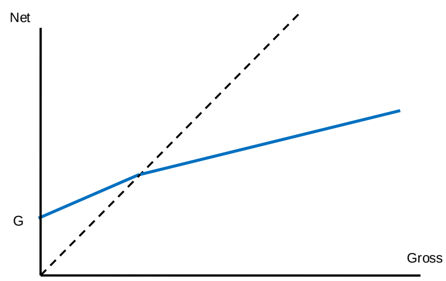
As noted in the Introduction, both CBI and UBI can be interpreted as special cases of a general mechanism known as Negative Income Tax (NIT). As we have seen when discussing CBI and UBI, there are two possible interpretations of NIT-like mechanisms. The first one goes as follows. You receive an unconditional transfer G. Then your own income Y is taxed according to a rate t_1, up to $Y = G/t_1$. The additional income (if any) $Y–G/t_1$ is taxed according to a tax rate t_2. In a second interpretation, G/t_1 is defined as the exemption level; below the exemption level, you receive a transfer equal to $G – t_1Y$. In the original proposal made by Friedman (1962), t_1 is larger than t_2, (convex profile of the tax-transfer rule) but in general it needs not to be. If $t_1< t_2$ we get a concave profile. If $t_1 = t_2$, we get the UBI rule. If $t_2 < t_1 = 1$, we get a CBI rule. Intermediate cases generate a variety of incentives configurations. Figure 1c represents two possible intermediate versions of the NIT mechanism. The NIT class can also be generalized to include in-work benefits (IWB) or tax credits. Fig. 1.d represents a simple case of IWB, where for a range of low gross incomes the marginal tax rate is negative, e.g. the net wage rate is larger

[4] A recent contribution documents the importance of take-up costs when comparing means tested vs non-means tested policies (Paulus 2016).

than the gross wage rate. This mechanism has become popular in the last decades especially in view of improving incentives to work (e.g. Moffit 2003, Blank et al. 1999).

Figure 1.c: Different profiles of NIT

Concave



Convex

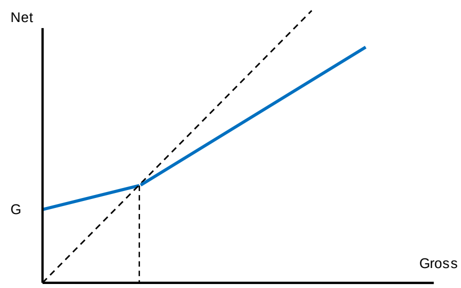
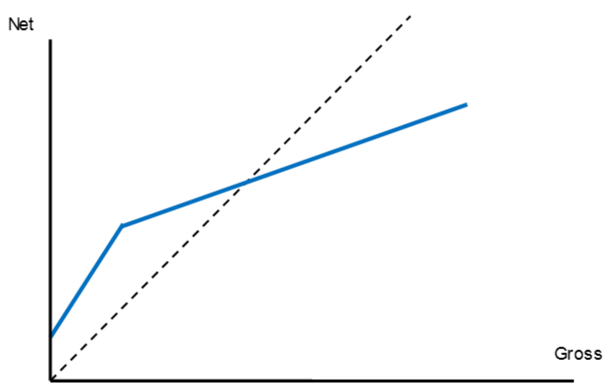


Fig. 1d. An example of IWB



3. Empirical optimal *taxation*: combining microsimulation and numerical optimization

Optimal Taxation concerns the question of how tax-transfers rules should be design in order to maximise a social welfare function subject to the public revenue constraint. We depart from the approach of computing optimal policies using theoretical formulas with imputed or calibrated parameters, as many authors have done, e.g. using the results of Mirrlees (1971) or the more recent ones by Saez (2001, 2002). The background of our analysis is represented by a series of papers where a microeconometric-numerical approach to optimal taxation is adopted. Aaberge and Colombino (2006, 20013) identify optimal taxes for Norway within the class of 9-parameter piece-wise linear tax-transfer rules. Aaberge and Colombino (2012) perform a similar exercise for Italy. Aaberge and Flood (2008) study the design of tax-credit policies in Sweden. Colombino et al. (2010) study the design of income support mechanisms in various European countries Blundell and Shepard (2012) focus on the optimal tax-transfer systems for lone mother in the UK.[5] Our methodology is based on two steps. First, we estimate a microeconometric model of household labour supply for six countries from different European areas. The specification of the models permits more flexibility as compared to the typical assumptions made in Optimal Taxation theory. Second, given a certain class of tax-transfer rules, we iteratively run the models in order to identify the optimal rule belonging to that class. In order to identify optimal policies we consider four types that belong to the NIT class: Conditional basic Income (CBI), Unconditional basic Income (UBI), In Work Benefit (IWB), and General Negative Income Tax (GNIT). With GNIT we mean a NIT scheme where t_1 and t_2 are unconstrained, differently from CBI, UBI and IWB that belong to the NIT class but are defined by some constraints on t_1 and t_2. The members of each type are defined by a policy-specific vector of parameters π:

$\pi_{CBI} = (G, t_1, t_2)$, with $t_1 = 1$,

$\pi_{UBI} = (G, t_1, t_2)$, with $t_1 = t_2$,

$\pi_{IWB} = (G, t_1, t_2)$ with $t_1 < 0$,

$\pi_{GNIT} = (G, t_1, t_2)$ with no constraints on (t_1, t_2),

where G is adjusted according to the household size (square root rule).

[5] Closely related contributions are Fortin et al. (1993) and Sefton and de Ven (2009). The first one uses a calibrated labour supply model to evaluate a large set of policies including NIT and work-fare policies. The second one employs a calibrated representative agent stochastic dynamic model to identify the optimal pension benefits scheme.

The policies replace the whole tax-benefit system. The public budget constraint requires that the "net revenue" is the same as under the current regime. We define net revenue = taxes – transfers, where:

taxes = income taxes + employee's social security contributions.

Therefore, in terms of the parametric definition of the policies given above, we require that the following constraint be satisfied:

revenue collected through the tax rates (t_1, t_2) – G = current net revenue.

In Section 4.3 we define the comparable money-metric utility index $\mu_i(\pi)$ for each household and the Social Welfare function $W(\mu_1(\pi), \ldots, \mu_N(\pi))$. The optimal tax-transfer rule π^* for a given type (UBI, CBI etc.) is then defined as:

$$\boldsymbol{\pi}^* = \arg\max_{\boldsymbol{\pi}} W(\mu_1(\boldsymbol{\pi}), \ldots, \mu_N(\boldsymbol{\pi})) \qquad (1)$$

s.t. public budget constraint is satisfied. The maximization of W is performed with an iterative procedure explained in Section 4.5.

Note that GNIT is by definition more general than the other NIT special cases. Therefore, GNIT must be at least as good as the special cases. Yet it is important to define the optimal design of the special cases: although necessarily not superior to GNIT according to the Social Welfare criterion, they might be more attractive than GNIT according to other dimensions that are not taken into account by the Social Welfare function.

4. The Empirical Model

4.1 Household preferences and choices

Households can choose within an opportunity set Ω containing jobs or activities characterized by hours of work *h*, sector of market job *s* (wage employment or self-employment) and other characteristics (observed by the household but not by us). We define *h* as a vector with one element for the singles and two elements for the couples, $h = (h_F, h_M)$, where the subscripts F and M refer to the female and the male partner respectively. Analogously, in the case of couples, *s* is read as (s_F, s_M). The above notation assumes that each household member can work only in one sector. We write the utility function of the i-th household at a (h, s) job as

$$U_i(h,s,\varepsilon;\boldsymbol{\pi}) = \mathbf{Y}_i(h,s;\boldsymbol{\pi})'\boldsymbol{\gamma} + \mathbf{L}_i(h)'\boldsymbol{\lambda} + \varepsilon \qquad (2)$$

where:

$\boldsymbol{\gamma}$ and $\boldsymbol{\lambda}$ are parameters to be estimated;

$\mathbf{Y}_i(h,s;\boldsymbol{\pi})$ is a vector including household disposable income on a (h,s) job given the tax-benefit parameters $\boldsymbol{\pi}$, its square and its interaction with the household size;

$\mathbf{L}_i(h)$ is a row vector including the leisure time (defined as the total number of available weekly hours (80) minus the hours of work h) for both partners, its square and the interaction with household disposable income, age (and age square), presence of children of different age range (i.e. >0, 0-6, 7-10);

ε is a random variable that accounts for the effect of unobserved (by the analyst) characteristics.

The opportunity set each individual can choose among is $\Omega = \{(0,0),(h_1,s),(h_2,s),(h_3,s)\}$, where (0,0) denotes a non-market "job" or activity (non-participation), h_1,h_2,h_3 are values drawn from the observed distribution of hours in each hours interval 1-26 (part time), 27-52 (full time), 52-80 (extra time) and sector indicator s is equal to 1 (wage employment) or 2 (self-employment).

A *(h,s)* job is "available" to household i with p.d.f. $f_i(h,s)$, which we call "opportunity density".

We estimate the labour supply models of couples and singles separately. In the case of singles, we have 7 alternatives, while in the case of couples, who make joint labour-supply decision, we combine the choice alternatives of two partners, thus getting 49 alternatives.

When computing the salary of any particular job (h, s) we face the problem that the wage rates of sector s are observed only for those who work in sector s. Moreover, for individuals who are not working we do not observe any wage rate. To deal with this issue, we follow a two-stage procedure presented in Dagsvik and Strøm (2006) and also adopted in Coda-Moscarola et al. (2014).

By assuming the ε is i.i.d. Type I extreme value and choosing a convenient specification of the opportunity density we obtain the following expression for the probability that household i holds a *(h,s)* job (e.g. see Colombino 2013, Coda Moscarola et al. 2014):

$$P_i(h,s)=\frac{\exp\left\{\mathbf{Y}_i(h,s;\boldsymbol{\pi})'\boldsymbol{\gamma}+\mathbf{L}_i(h)'\boldsymbol{\lambda}+\mathbf{D}_i(h,s)'\boldsymbol{\delta}\right\}}{\sum_{j=1}^{2}\sum_{x\in\Omega}\exp\left\{\mathbf{Y}_i(x,j;\boldsymbol{\pi})'\boldsymbol{\gamma}+\mathbf{L}_i(x)'\boldsymbol{\lambda}+\mathbf{D}_i(x,j)'\boldsymbol{\delta}\right\}} \tag{3}$$

where, for a single household, $\mathbf{D}_i$ is the vector

$$\begin{aligned}
D_{1,0} &= 1[s=1, h>0],\\
D_{1,1} &= 1[s=1, h\in(1\div 26)],\\
D_{1,2} &= 1[s=1, h\in(27\div 52)],\\
D_{2,0} &= 1[s=2, h>0],\\
D_{2,1} &= 1[s=2, h\in(1\div 26)],\\
D_{2,2} &= 1[s=2, h\in(27\div 52)].
\end{aligned} \tag{4}$$

and $\boldsymbol{\delta}$ is vector of parameters to be estimated. For consistency of notation, we must set $D_{0,0}=0$.

For couples, $\mathbf{D}_i$ contains two analogous sets of variables, one for each partner.

The parameter estimates of the behavioral models for singles and couples for six countries (Belgium, France, Ireland, Italy, Luxembourg and the United Kingdom) are reported in Tables A.1 - A.6 of Appendix A.

4.2 Data

The datasets used in the analysis are the EUROMOD input data based on the European Union Statistics on Income and Living Conditions (EU-SILC) for the year 2010. The input data provide all required information on demographic characteristics and human capital, employment and wages of household members, as well as information about various sources of non-labour income. We apply common sample selection criteria for all countries under study by selecting individuals in the age range 18-65 who are not retired or disabled. Then EUROMOD (version G3.0+)[6] provides calculations of household-level tax

[6] EUROMOD is a large-scale pan-European tax-benefit static micro-simulation engine (e.g. 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 gross earnings, employment and other household characteristics.

and transfer liabilities given the household characteristics and gross incomes according the existing tax and transfer rules. It also allows re-calculating liabilities for alternative, hypothetical Tax Transfer Rules. The target population consists of all private households throughout the national territory in every country.

4.3. Comparable Money-metric Utility

Based on the estimated model described in Section 4.1, we define the Comparable Money-metric Utility (CMU). This index thus forms the household utility level into an inter-household comparable monetary measure that will enter as argument of the Social Welfare function (to be described in Section 4.4). First, we calculate the expected maximum utility attained by household i under tax-transfer regime π (e.g. McFadden 1978):

$$V_i^*(\pi) = \ln\left(\sum_{j=1}^{2}\sum_{x\in\Omega}\exp\left\{\mathbf{Y}_i(x,j;\boldsymbol{\pi})'\boldsymbol{\gamma} + \mathbf{L}_i(x)'\boldsymbol{\lambda} + \mathbf{D}_i(x,j)'\boldsymbol{\delta}\right\}\right) \qquad (5)$$

Second, we calculate the CMU of household i $(\mu_i(\pi))$ under tax regime π. It is defined as the gross (full) income that a reference household under a reference tax-transfer regime π_0 would need in order to attain an expected maximum utility equal to $V_i^*(\pi)$.[7] The reference tax-transfer regime is a FT with G=0 (subject to the public budget constraint). The reference household is the couple household at the median value of the distribution of $V^*(\pi_0)$.

4.4 Social Welfare function

We choose Kolm (1976) Social Welfare index, which can be defined as:

$$W = \bar{\mu} - \frac{1}{k}\ln\left[\sum_{\mathrm{i}}\frac{\exp\left\{-k\left(\mu_{\mathrm{i}} - \bar{\mu}\right)\right\}}{\mathrm{N}}\right] \qquad (6)$$

[7] The CMU is analogous to the "equivalent income" defined by King (1983). A discussion of this type of money-metric measures is provided by Fleurbaey (2011). Although the choice of the reference household is essentially arbitrary, some choices make more sense than others. Fleurbaey (2011) presents some examples that can be motivated by ethical criteria. Decoster and Haan (2015) provide an empirical applications of Fleubaey's ethical criteria. Our choice of the median household as reference household can be justified in terms of representativeness or centrality of its preferences. Aaberge and Colombino (2006, 2013) adopt a related, although not identical, procedure that consists of using a common utility function as argument of the social welfare function (Deaton and Muelbauer, 1980).

where

$\bar{\mu} = \frac{1}{N}\sum_i \mu_i$ = is a measure of Efficiency (i.e. the average level of individual money-metric utility),

$\frac{1}{k}\ln\left[\sum_{\mathrm{i}} \frac{\exp\{-k(\mu_{\mathrm{i}} - \bar{\mu})\}}{\mathrm{N}}\right] =$ Kolm Inequality Index,

$k =$ Inequality Aversion parameter,

μ_i = comparable money-metric utility of household i (defined in Section 4.3).

The meaning of k might be clarified by the following example. Let us take two individuals with $\mu_2 - \mu_1 = 1$. Given the social marginal evaluation of μ_i, $\frac{\partial W}{\partial \mu_i} = \frac{e^{-\alpha\mu_i}}{e^{-\alpha\mu_1} + e^{-\alpha\mu_2}}$, we get the social marginal rate of substitution: $SMRS_{1,2} = e^{\alpha(\mu_2 - \mu_1)} = e^{\alpha}$. Now let us consider a (small) transfer $\tau < 1$ from individual 2 to individual 1 in order to reduce the inequality. Note that the social planner would be willing to take $\exp\{\alpha)\}\tau$ from individual 2 in order to give τ to individual 1. Since $\exp\{\alpha)\} > 1$, $\exp\{\alpha)\} - 1$ measures (approximately) the "excess willingness to pay" for a "inequality reducing" transfer from individual 2 to individual 1:

α	0.05	0.10	0.25	0.50
$\exp\{\alpha\} - 1$	0.051	0.105	0.284	0.649

The simulation results presented in Section 5 are based on $\alpha = 0.05$.[8]

Kolm Inequality Index is an absolute index, meaning that it is invariant with respect to translations (i.e. to adding a constant to every μ_i). Absolute indexes are less popular than relative indexes (e.g. Gini's or Atkinson's), although there is no strict logical or economical motivation for preferring one rather than the other.[9] Blundell and Shephard (2012) adopt a social welfare index which turns out to be very close to Kolm's. Their main motivation for their index seems to be the computational convenience, since it handles negative numbers (random utility levels, in their case). Our motivation in choosing Kolm's index

[8] We have run simulations also for $\alpha = 0.10, 0.15, 0.50$. The results are available upon request.

[9] Atkinson and Brandolini (2010) provide a discussion of relative indexes, absolute indexes and intermediate cases.

is analogous. In our case, μ_i is a monetary measure, yet it can happen to be negative when the utility level of household i is very far from the utility level of the reference household. Kolm's index handles negative arguments. Alternatively, it is also possible to shift the μ_i-s by adding a constant (which would not be allowed with a relative index).

4.5. Identifying the optimal policies

The maximization of W is performed numerically. First step: the microeconometric model simulates household choices and computes the expected maximum utility under a starting tax-transfer rule $\pi°$, $V_i(\pi°)$. Second step: $V_i(\pi°)$ is transformed into the comparable money-metric index $\mu_i(\pi°)$. Third step: the Social Welfare $W(\mu_i(\pi°),\ldots, \mu_i(\pi°))$ is computed. The steps are then iterated with new values of π until W is maximized (most of the time we use a BFGS algorithm[10]). Since W might have local peaks, the previous steps are preceded by a grid-search for partitioning the parameters space and locate the promising area.

It is important to keep in mind that the simulated policies differ from the current policies with respect to many dimensions. First, we simulate policies with a FT, while all the countries included in the present exercise adopt increasing marginal tax rates. Second, all the simulated policies are universal and permanent, i.e. identically applied to all the citizens, while the current systems are somehow categorical, adopt some sort of tagging and more or less complex eligibility rule, time-dependent treatments etc. In general, while the current systems might be somehow close to CBI or IWB or other versions of NIT-like mechanism, they are much more complicated. The comparison of the reforms to the current system is informative upon the effects of the reformed budget sets, including the effects of the universal and permanent extension to the whole population. It is not directly informative upon dimensions – such as the administration costs – which are not represented in our microeconometric model. However, since we measure social welfare effects in money-metric terms, in principle it might be possible to also account for those so far unaccounted dimensions. If we can obtain an estimate of the change in, say, administration costs implied by a reform, then we can incorporate that estimate into the money-metric social welfare evaluation of the reform.

[10] The BFGS (Broyden–Fletcher–Goldfarb–Shanno) algorithm is a quasi-Newton method for solving optimization problems. It has been shown to have good performance even with non-smooth functions.

5. Results

The main results of the exercise illustrated in Section 4 are summarized in the Tables of Appendix B and in the Graphs of Appendix C.

The Tables – one for each country – show, for each of the policies considered, the optimal tax-transfer parameters (G, t_1, t_2), the average individual labour supply, the household poverty rate, the percentage of household winners with respect to the current system and the change in the money-metric social welfare as percentage of the average household available income. G is the monthly guaranteed minimum income for a one-component household. The guaranteed minimum income for a N-component household is $G\sqrt{N}$. Labour supply is measured by average annual hours of work (including the zero hours of the non-employed). The poverty rate is the percentage of households with available equalized income below 60% of the median equalized income.[11] A household is a winner under a certain policy if it attains a higher utility than under the current tax-transfer regime. Let W_0 and W_P respectively the Social Welfare levels attained under the current regime and under a certain policy. Note that they are monetary measures (Euros). Let C_0 represent the average household gross income under the current regime. The last column of the Tables contains $100\times(W_P - W_0)/C_0$ for every policy *P*.

The literature typically represents GNIT with $t_1 > t_2$. Instead, for five out of six countries we get $t_1 < t_2$, France being the exception. Our result seems to be driven by the fact that the disincentive effect of high marginal tax rates is stronger for low-income households than for high-income households. A major concern regarding universalistic income support policies is the effect on labour supply. One might expect a reduction of labour supply both for an income effect (higher unearned income) and for a substitution effect (higher taxes required for financing the policies). With the exception of IWB (which is indeed typically adopted with the main purpose of encouraging labour supply), in most countries and for most policies we observe indeed a reduction of hours worked, although not so large to be considered a matter of concern. It may also happen that the optimal level of G is less generous (at least for part of the population) than the current transfers, the implication being an increase of labour supply with policies different from IWB. This is the case with CBI in France and Luxembourg. As with labour supply, what happens to the poverty rate is the result of many effects that contribute differently between the policies and between the countries. There is a "mechanical" effect due to G (which however may be more or less generous that the replaced transfers). There is an incentive effect that lead some household to remain

[11] It corresponds to the concept of "at risk of poverty" of the OECD statistics.

below the poverty line depending on the level of G and on the MWR. There are also other incentive effects that depend on the MTRs. Most policies in most countries lead to a majority of winners, the exceptions being CBI in Ireland and IWB in the UK and in Ireland.

The change in Social Welfare, since it is expressed as percentage of average household income, as explained above, can be interpreted as equivalent to a percentage (permanent) change of GDP. Under this criterion, the countries that might benefit more for adopting the optimal GNIT tax-transfer rule are the UK (+9.06%) and Ireland +(3.99%). More modest gains should be expected in France (+1.70%), Belgium (+1.51%) and Italy (+0.93%). The extreme case is represented by Luxembourg, where the adoption of the optimal GNIT would bring about a gain equal 0.1%.

The Graphs show – for the six countries – the location of the optimal policies in the space (–Inequality, Efficiency). Social Welfare (= Efficiency – Inequality) increases towards the upper right corner. Efficiency and Inequality are defined in Section 4.4. The Graphs also show the Iso-Social Welfare lines passing through the points that represent the current regime and the best optimal regime. The Graphs are useful for visualizing the distance in Social Welfare (and in its two components, Efficiency and Inequality) between the various policies. Note that the slope (= 1) of the Iso-Social Welfare lines is always the same in all the countries: it appears to differ because the scale used in the Graphs on the two axes differs among the countries.

By construction, in all the countries GNIT (the unconstrained version of NIT) is never inferior to the constrained versions of NIT: BCI, UBI and IWB. Note, however, that GNIT turns out to be strictly superior. What's more striking is that in all the countries GNIT strictly dominates the current tax-transfer rule.

The ranking of the policies varies a lot among the six countries. In most cases (Belgium, Ireland, Italy Luxembourg and the United Kingdom) UBI is second-best after GNIT. The current regime is dominated by at least two alternative policies in most countries: a notable exception is Luxembourg where the current regime is second-best (together with UBI) and however very close to the first-best GNIT.

The Social Welfare performance of CBI and IWB – the most popular schemes actually implemented – is, in general, poor, with the exception of France, where CBI is second-best after GNIT.

6. Conclusions

We present an exercise in empirical optimal taxation for European countries from three areas: Southern, Central and Northern Europe. For each country, we estimate a microeconometric model of labour supply for both couples and singles. A procedure that simulates the households' choices under given tax-transfer rules is then embedded in a constrained optimization program in order to identify optimal rules under the public budget constraint. Using a flexible microeconometric model to simulate household behaviour permits to drop the restrictive assumptions adopted in the traditional approach and allows for a richer and more realistic representation of preferences and opportunities. Using microsimulation combined with numerical methods permits to identify the optimal policies with no need for explicit analytical solutions of complex optimization problems. The new approach leads to the identification of optimal policies that are less assumption-driven (with respect to the traditional approach) and therefore better fitted to account for the country-specific characteristics.

The optimality criterion is the class of Kolm's social welfare function, which takes as arguments the households' equivalent incomes. The tax-transfer rules considered as candidates are members of a class that includes as special cases various versions of the Negative Income Tax: Conditional Basis Income, Unconditional Basic Income, In-Work Benefits and General Negative Income Tax, combined with a Flat Tax above the exemption level. The analysis show that the General Negative Income Tax strictly dominates the other rules, including the current ones. In most cases the Unconditional Basic Income policy is better than the Conditional Basic Income policy. Conditional Basic Income policy may lead to a significant reduction in labour supply and poverty-trap effects. In-Work-Benefit policy in most cases is strictly dominated by the Negative Income Tax and Unconditional Basic Income. To the extent that our sample of countries is representative, the results suggest that there might be a case for supporting a NIT+FT as a promising reform for European countries, especially – due to the simplicity of the NIT+FT rule – in the perspective of implementing a common type of tax-transfer rule. The optimal tax-transfer parameters of all the policies present very large variations from one country to the other. On the one hand, this confirms the added value of our approach (based on a flexible microeconometric models, on rich datasets and on numerical optimization) with respect to the traditional empirical optimal taxation exercises (based on imputed or calibrated parameters and on analytical maximization). On the other hand, the variance of results calls for an analysis of how the optimal tax-transfer parameters depends on the "deep" characteristic, or the "primitives" of the different countries. This will be the focus of future work.

References

Aaberge, R. & Colombino, U. (2013). Using a microeconometric model of household labour supply to design optimal income taxes. Scandinavian Journal of Economics 115(2), 449–475.

Aaberge, R. & Colombino, U. (2012). Accounting for family background when designing optimal income taxes: a microeconometric simulation analysis. Journal of Population Economics 25(2), 741–761.

Aaberge, R. & Colombino, U. (2006). Designing optimal taxes with a microeconometric model of household labour supply. IZA Discussion Papers 2468, Institute for the Study of Labor (IZA).

Aaberge, R. & Flood, L. (2008). Evaluation of an in-work tax credit reform in Sweden: Effects on labor supply and welfare participation of single mothers. IZA Discussion Papers 3736, Institute for the Study of Labor (IZA).

Atkinson, A. B. (1996). Public Economics in Action: The Basic Income/Flat Tax Proposal.

Atkinson, A. B. (2015). Inequality. What Can be Done? Harvard University Press.

Atkinson, A. B. and A. Brandolini (2010). On Analyzing the World Distribution of Income, World Bank Economic Review, 24(1), 1-37.

Blank, Rebecca M., D. Card, and P. K. Robins (1999). Financial Incentives for Increasing Work and Income Among Low-Income Families. NBER Working Paper No. 6998.

Blattman, C., Fiala, N. and Martinez, S. (2014). Generating skilled employment in developing countries: Experimental evidence from Uganda. Quarterly Journal of Economics, 129 (2): 697–752.

Blundell, R. & Shephard, A. (2012). Employment, hours of work and the optimal taxation of low-income families. Review of Economic Studies 79(2), 481–510.

Coda Moscarola, Flavia & Colombino, Ugo & Figari, Francesco & Locatelli, Marilena (2014). Shifting taxes from labour to property. A simulation under labour market equilibrium, EUROMOD Working Papers EM20/14, https://ideas.repec.org/p/ese/emodwp/em20-14.html

Colombino, U. (2015a). Five crossroads on the way to basic income. An Italian tour. Italian Economic Journal 1(3), 353–389.

Colombino, U. (2015b). Is unconditional basic income a viable alternative to other social welfare measures? IZA World of Labor p. 128.

Colombino, U. (2013). A new equilibrium simulation procedure with discrete choice models. International Journal of Microsimulation 6(3), 25–49.

Colombino, U., Locatelli, M., Narazani, E. and O'Donoghue, C. (2010). Alternative basic income mechanisms: An evaluation exercise with a microeconometric model. Basic Income Studies 5(1), 1–31.

Dagsvik, J. and Strøm, S. (2006). Sectoral labour supply, choice restrictions and functional form. Journal of Applied Econometrics 21(6), 803–826.

Deaton, A. and J. Muellbauer (1980). Economics and Consumer Behavior, Cambridge University Press.

Decoster, A. and P. Haan (2015). Empirical welfare analysis with preference heterogeneity, International Tax and Public Finance, 22(2), 224-251.

de Walle, V. (1999). Public spending and the poor. in: Policy research working papers. Technical Report doi:10.1596/1813-9450-1476, World Bank.

Fleurbaey, M. (2011). Willingness-to-pay and the equivalence approach, Revue d'économie politique, 121(1), 35-58.

Fortin, B., Truchon, M. & Beausejour, L. (1993). On reforming the welfare system: Workfare meets the negative income tax. Journal of Public Economics 51(2), 119–151.

Friedman, M. (1962). Capitalism and Freedom. Chicago: University of Chicago Press.

Friedman, M. and R. D. Friedman (1980). Free to Choose, Harcourt.

Hall, R., and A. E. Rabushka (1995). *The Flat Tax*, Stanford: Hoover Institution Press.

Hauhofer, J. and Shapiro, J. (2016). The Short-Term Impact of Unconditional Cash Transfers to the Poor: Experimental Evidence from Kenia. Quarterly Journal of Economics online: https://www.princeton.edu/~joha/publications/Haushofer_Shapiro_UCT_2016.04.25.pdf.

KELA (2016). Basic Income Experiment 2017-2018. http://www.kela.fi/web/en/basic-income-experiment-2017-2018.

King M. A. (1983). Welfare analysis of tax reforms using household data. Journal of Public Economics, Volume 21, Issue 2, 183-214.

Kolm, S. C. (1976). Inequal Inequalities I, Journal of Economic Theory. 12, 416-442.

McFadden, D. (1978). Modelling the Choice of Residential Location. In: A. Karlqvist, F. Snickars and J. Weibull, Eds., Spatial Interaction Theory and Planning Models, North Holland, 1978, pp. 75-96. P. (ed.). Frontiers in Econometrics, Academic Press.

Mirrlees, J. A. (1971). An exploration in the theory of optimum income taxation. Review of Economic Studies 38(2), 175–208.

Moffitt, R., A. (2003). The Negative Income Tax and the Evolution of U.S. Welfare Policy, Journal of Economic Perspectives, American Economic Association, 17(3), 119-140.

Paulus, A. (2016). The antipoverty performance of universal and means-tested benefits with costly take-up, ImPRovE Working Papers 16/12, Herman Deleeck Centre for Social Policy, University of Antwerp. <https://ideas.repec.org/p/hdl/improv/1612.html>

Raj D. (2016). The Universal Basic Share. http://debrajray.blogspot.it/2016/07/the-universal-basic-share.html.

Saez, E. (2002). Optimal income transfer programs: Intensive versus extensive labor supply responses. Quarterly Journal of Economics 117(3), 1039–1073.

Saez, E. (2001). Using elasticities to derive optimal income tax rates. Review of Economic Studies 68(234), 205–229.

Sefton J., Van De Ven J. (2009). Optimal Design of Means Tested Retirement Benefits," Economic Journal, 119(541), 461-481.

Shiller, R. (1998). Macro Markets. Oxford University Press. The Economic Journal, Volume 119, Issue 541.

Sommer, M. (2016). A Feasible Basic Income Scheme for Germany: Effects on Labor Supply, Poverty, and Income Inequality. Springer, ISBN 978-3-319-24064-0.

Standing, G. (2008). How cash transfers promote the case for basic income. Basic Income Studies 3(1).

Standing, G. (2015). Basic Income: A Transformative Policy for India. Bloomsbury Academic.

Sutherland, H. & Figari, F. (2013). EUROMOD: the European Union tax-benefit microsimulation model. International Journal of Microsimulation, 6(1) 4-26.

van Parijs, P. (1995). Real Freedom for All. Oxford University Press.

Appendix A

Table A1 – Maximum likelihood estimates – couples (Belgium)

Model component	Variable	Coef.	Std. Err.
Opportunity density	Employee_Man	0.50123	0.57075
	Self-employed_Man	0.078134	0.56841
	Employee_Woman	-1.51074	0.39816
	Self-employed_Woman	-2.6137	0.41983
	Part-time_Employee_Man	-1.18354	0.32942
	Full-time_Employee_Man	2.31156	0.141785
	Part-time_Self-employed_Man	-2.91227	0.549158
	Full-time_Self-employed_Man	0.429565	0.175057
	Part-time_Employee_Woman	1.185532	0.286168
	Full-time_Employee_Woman	2.230595	0.228025
	Part-time_Self-employed_Woman	-0.53198	0.384845
	Full-time_Self-employed_Woman	0.736923	0.271273
Consumption Vector	Household_Disposable_income	0.000445	0.000189
	Household_Disposable_income2	-1.48E-08	9.05E-09
	Household_size×Household_disposable_income	0.045355	0.029412
Leisure Vector	Leisure_Male	0.000712	0.000202
	Leisure_Man2	0.141465	0.032454
	Leisure_Woman	-0.00012	0.000235
	Leisure_Woman2	1.02E-06	1.18E-06
	Leisure_Man×Household_disp_income	3.09E-07	1.20E-06
	Leisure_Woman×Household_disp_income	-6.04E-06	2.72E-05
	Leisure_Man×Age_Man	-0.00724	0.001157
	Leisure_Woman×Age_Woman	-0.00951	0.001122
	Leisure_Man×Age_Man2	9.47E-05	1.32E-05
	Leisure_Woman×Age_Woman2	0.000134	1.37E-05
	Leisure_Man×No. Children	-0.00438	0.002095
	Leisure_Woman×No. Children	0.0053	0.001875
	Leisure_Man×No. Children0-6	0.004191	0.002715
	Leisure_Man×No. Children7-10	0.004737	0.003249
	Leisure_Woman×No. Children0-6	0.01056	0.00234
	Leisure_Woman×No. Children7-10	0.008059	0.002724
	Leisure_Woman×No. Leisure_Man	0.000527	9.63E-05
Other			
	N. observations (N. couples*49 alternatives)	112406	
	N. couples	2294	
	LR chi2(32)	6644.16	
	Prob > chi2	0	
	Pseudo R2	0.3721	
	Log likelihood	-5605.75	

Table A.2 – Maximum likelihood estimates – singles (Belgium)

Model component	Variable	Coef.	Std. Err.	Coef.	Std. Err.
		Male		Female	
*Opportunity density	Employee	1.43241	0.832103	-0.56545	0.737465
	Self_employed	0.244382	0.84331	-2.72507	0.789455
	Part-time_Employee	-1.93811	0.514208	0.627918	0.471202
	Full-time_Employee	1.571062	0.242731	2.181197	0.332097
	Part-time_Self-employed	-3.28729	0.866698	-1.84446	1.157532
	Full-time_Self-employed	0.631566	0.339785	1.228533	0.488898
Y vector	Disposable income	0.001144	0.000408	-0.00031	0.000274
	Disposable income 2	-1.42E-07	4.61E-08	-3.52E-09	2.29E-08
	Household size×Disp_income	-0.01957	0.033986	-0.06954	0.040719
L vector	Leisure	0.001233	0.000324	0.001229	0.000374
	Leisure2	6.87E-07	3.85E-06	1.34E-05	3.15E-06
	Leisure×Disposable income	4.48E-05	7.69E-05	7.95E-05	6.56E-05
	Leisure×Age	-0.00345	0.000976	-0.00378	0.001082
	Leisure×Age2	5.02E-05	0.000012	0.00005	1.32E-05
	Leisure×No. Children	-0.00658	0.006615	0.003232	0.003525
	Leisure×No. Children 0-6	-0.0061	0.016856	0.00751	0.005437
	Leisure×No. Children 7-10	0.02056	0.013046	0.002791	0.005417
Other					
	N. observations (N. single*7 alternatives)	5943		6041	
	N. single	849		863	
	LR chi2(17)	1118.46		1118.41	
	Prob > chi2	0		0	
	Pseudo R2	0.3385		0.333	
	Log likelihood	-1092.85		-1120.12	

Table A3. – Maximum likelihood estimates – couples (France)

Model component	Variable	Coef.	Std. Err.
Opportunity density	Employee_Man	0.7270474	0.3923332
	Self-employed_Man	0.7554641	0.4050371
	Employee_Woman	-0.7788057	0.2666533
	Self-employed_Woman	-2.178502	0.3186453
	Part-time_Employee_Man	-0.2440409	0.2492323
	Full-time_Employee_Man	2.56119	0.1175628
	Part-time_Self-employed_Man	-2.588734	0.3488273
	Full-time_Self-employed_Man	-0.2121669	0.1513041
	Part-time_Employee_Woman	0.9021808	0.2116786
	Full-time_Employee_Woman	2.373587	0.1672186
	Part-time_Self-employed_Woman	-1.028247	0.3376234
	Full-time_Self-employed_Woman	0.6874502	0.2550271
Consumption Vector	Household_Disposable_income	0.0004763	0.0001112
	Household_Disposable_income2	1.21E-08	4.50E-09
	Household_size×Household_disposable_income	0.1774082	0.0258235
Leisure Vector	Leisure_Male	-0.0001671	0.0001498
	Leisure_Man2	0.2697041	0.0245487
	Leisure_Woman	-0.0005948	0.0001492
	Leisure_Woman2	-0.0000103	8.12E-07
	Leisure_Man×Household_disp_income	-5.45E-08	6.66E-07
	Leisure_Woman×Household_disp_income	-0.000015	0.0000196
	Leisure_Man×Age_Man	-0.0069426	0.0010671
	Leisure_Woman×Age_Woman	-0.0117417	0.0009639
	Leisure_Man×Age_Man2	0.0000889	0.0000127
	Leisure_Woman×Age_Woman2	0.0001532	0.000012
	Leisure_Man×No. Children	0.0016908	0.0017411
	Leisure_Woman×No. Children	0.0112146	0.0015763
	Leisure_Man×No. Children0-6	0.0034856	0.0023651
	Leisure_Man×No. Children7-10	0.0010164	0.0027522
	Leisure_Woman×No. Children0-6	0.0093429	0.0019481
	Leisure_Woman×No. Children7-10	0.0039331	0.0022512
	Leisure_Woman×No. Leisure_Man	-0.0000346	0.0000882
Other			
	N. observations (N. couples*49 alternatives)	199822	
	N. couples	4078	
	LR chi2(32)	14983.88	
	Prob > chi2	0	
	Pseudo R2	0.4721	
	Log likelihood	-8378.9026	

Table A.4 – Maximum likelihood estimates – singles (France)

Model component	Variable	Coef.	Std. Err.	Coef.	Std. Err.
		Male		Female	
Opportunity density	Employee	0.436287	0.554416	-0.81196	0.439839
	Self_employed	0.525612	0.619728	-2.06672	0.528394
	Part-time_Employee	0.041962	0.404419	1.309146	0.349215
	Full-time_Employee	2.203896	0.262637	2.540004	0.266302
	Part-time_Self-employed	-3.66851	0.660694	-1.55785	0.672953
	Full-time_Self-employed	-0.72199	0.357185	0.375061	0.446207
Y vector	Disposable income	0.000639	0.000279	0.001557	0.000315
	Disposable income 2	1.45E-08	2.69E-08	-7.88E-08	2.79E-08
	Household size×Disp_income	0.214063	0.033138	0.283503	0.03497
L vector	Leisure	-0.00037	0.000275	-0.00042	0.000242
	Leisure2	-6.50E-06	2.80E-06	-1E-05	3.15E-06
	Leisure×Disposable income	-0.00015	5.66E-05	-0.00013	5.84E-05
	Leisure×Age	-0.00698	0.001069	-0.01057	0.001145
	Leisure×Age2	8.39E-05	1.38E-05	0.000126	1.43E-05
	Leisure×No. Children	-0.00619	0.005833	0.004664	0.0038
	Leisure×No. Children 0-6	0.004941	0.019979	0.012429	0.005315
	Leisure×No. Children 7-10	-0.01246	0.011583	0.010197	0.005619
Other					
	N. observations (N. single*7 alternatives)	9002		9821	
	N. single	1286		1403	
	LR chi2(17)	2136.64		2353.55	
	Prob > chi2	0		0	
	Pseudo R2	0.4269		0.431	
	Log likelihood	-1434.12		1553.339	

Table A5. – Maximum likelihood estimates – couples (Ireland)

Model component	Variable	Coef.	Std. Err.
Opportunity density	Employee_Man	-1.695756	0.5085893
	Self-employed_Man	-1.556796	0.5219124
	Employee_Woman	-4.525688	0.594666
	Self-employed_Woman	-5.064469	0.723828
	Part-time_Employee_Man	1.313884	0.3333798
	Full-time_Employee_Man	2.782065	0.2171855
	Part-time_Self-employed_Man	0.2140273	0.4255389
	Full-time_Self-employed_Man	1.224256	0.2371195
	Part-time_Employee_Woman	3.963227	0.582519
	Full-time_Employee_Woman	4.18229	0.5061436
	Part-time_Self-employed_Woman	1.821953	0.7565453
	Full-time_Self-employed_Woman	1.940312	0.6690711
Consumption Vector	Household_Disposable_income	-0.0001118	0.0001285
	Household_Disposable_income2	-5.92E-09	4.33E-09
	Household_size×Household_disposable_income	-0.054027	0.0320817
Leisure Vector	Leisure_Male	0.001049	0.0002057
	Leisure_Man2	0.0078135	0.0470057
	Leisure_Woman	0.0000903	0.0003176
	Leisure_Woman2	7.14E-06	1.15E-06
	Leisure_Man×Household_disp_income	9.26E-07	8.30E-07
	Leisure_Woman×Household_disp_income	5.58E-06	0.000014
	Leisure_Man×Age_Man	-0.0054068	0.0011841
	Leisure_Woman×Age_Woman	-0.005102	0.0015109
	Leisure_Man×Age_Man2	0.0000614	0.0000132
	Leisure_Woman×Age_Woman2	0.0000786	0.0000177
	Leisure_Man×No. Children	-0.0038817	0.001782
	Leisure_Woman×No. Children	0.00903	0.0022605
	Leisure_Man×No. Children0-6	-0.0028651	0.0023432
	Leisure_Man×No. Children7-10	0.0067456	0.0026822
	Leisure_Woman×No. Children0-6	0.0104304	0.0029593
	Leisure_Woman×No. Children7-10	0.0081639	0.0034718
	Leisure_Woman×No. Leisure_Man	0.0008276	0.0001022
Other			
	N. observations (N. couples*49 alternatives)	77567	
	N. couples	1583	
	LR chi2(32)	3881.04	
	Prob > chi2	0	
	Pseudo R2	0.315	
	Log likelihood	-4220.2307	

Table A.6 – Maximum likelihood estimates – singles (Ireland)

Model component	Variable	Coef.	Std. Err.	Coef.	Std. Err.
		Male		Female	
*Opportunity density	Employee	-3.32212	0.861173	-4.64562	0.810735
	Self_employed	-2.80477	0.852134	-5.13847	1.010678
	Part-time_Employee	2.159962	0.600708	4.319347	0.782998
	Full-time_Employee	3.118861	0.439122	4.28032	0.661221
	Part-time_Self-employed	0.055419	0.718346	1.845457	1.062762
	Full-time_Self-employed	1.112452	0.425765	2.269797	0.913188
Y vector	Disposable income (divided by 1,000)	-0.00029	0.000165	0.001971	0.000633
	Disposable income 2 (divided by 1e+06)	-6.82E-09	7.38E-09	-1.85E-07	5.98E-08
	Household size×Disp_income (divided by 1,000)	-0.02759	0.039421	0.129758	0.064343
L vector	Leisure	0.000718	0.000384	0.000298	0.000466
	Leisure2 (divided by 1,000)	7.77E-06	1.94E-06	-1.2E-05	5.96E-06
	Leisure×Disposable income (divided by 1e+06)	0.000112	3.93E-05	0.000162	6.64E-05
	Leisure×Age	-0.00317	0.000995	-0.00748	0.001517
	Leisure×Age2 (divided by 1000)	4.06E-05	0.000012	0.000101	1.85E-05
	Leisure×No. Children	-0.00978	0.007605	0.018666	0.004607
	Leisure×No. Children 0-6	0.023053	0.025524	0.014054	0.007398
	Leisure×No. Children 7-10	-0.0157	0.027441	0.013878	0.006604
Other					
	N. observations (N. single*7 alternatives)	4536		5572	
	N. single	648		796	
	LR chi2(17)	731.02		1275.16	
	Prob > chi2	0		0	
	Pseudo R2	0.2899		0.4116	
	Log likelihood	-895.442		-911.364	

Table A.7 – Maximum likelihood estimates – couples (Italy)

Model component	Variable	Coef.	Std. Err.
Opportunity density	Employee_Man	1.08715	0.429756
	Self-employed_Man	1.861982	0.4213483
	Employee_Woman	-2.849727	0.3904174
	Self-employed_Woman	-1.640404	0.3783688
	Part-time_Employee_Man	-1.671892	0.1807838
	Full-time_Employee_Man	2.391102	0.101409
	Part-time_Self-employed_Man	-3.527399	0.2231226
	Full-time_Self-employed_Man	0.7447007	0.0945173
	Part-time_Employee_Woman	1.330352	0.219782
	Full-time_Employee_Woman	2.841276	0.206185
	Part-time_Self-employed_Woman	-1.607303	0.215788
	Full-time_Self-employed_Woman	0.7093929	0.1782277
Consumption Vector	Household_Disposable_income	0.0010729	0.0001958
	Household_Disposable_income2	1.58E-09	1.38E-08
	Household_size×Household_disposable_income	0.1062977	0.0300928
Leisure Vector	Leisure_Male	0.000147	0.0002114
	Leisure_Man2	0.2395774	0.0278442
	Leisure_Woman	-0.0010875	0.0002558
	Leisure_Woman2	1.05E-06	1.40E-06
	Leisure_Man×Household_disp_income	-2.30E-06	1.15E-06
	Leisure_Woman×Household_disp_income	-0.0001462	0.0000213
	Leisure_Man×Age_Man	-0.0045536	0.0011518
	Leisure_Woman×Age_Woman	-0.0056281	0.0008218
	Leisure_Man×Age_Man2	0.0000517	0.0000134
	Leisure_Woman×Age_Woman2	0.0000705	0.0000101
	Leisure_Man×No. Children	-0.0024216	0.0015003
	Leisure_Woman×No. Children	0.0035692	0.0011469
	Leisure_Man×No. Children0-6	0.0027222	0.0020018
	Leisure_Man×No. Children7-10	-0.003195	0.0022538
	Leisure_Woman×No. Children0-6	0.0026451	0.0015162
	Leisure_Woman×No. Children7-10	0.0039845	0.0016038
	Leisure_Woman×No. Leisure_Man	0.0004159	0.0000741
Other			
	N. observations (N. couples*49 alternatives)	307328	
	N. couples	6272	
	LR chi2(32)	16929.68	
	Prob > chi2	0	
	Pseudo R2	0.3468	
	Log likelihood	-15944.655	

Table A.8 – Maximum likelihood estimates – singles (Italy)

Model component	Variable	Coef.	Std. Err.	Coef.	Std. Err.
		Male		Female	
Opportunity density	Employee	0.982272	0.637255	-4.66432	0.63892
	Self_employed	1.275008	0.624756	-3.5931	0.630431
	Part-time_Employee	-1.85815	0.252928	1.303948	0.284519
	Full-time_Employee	2.171138	0.160385	2.815467	0.258411
	Part-time_Self-employed	-3.31372	0.298503	-1.82078	0.330016
	Full-time_Self-employed	0.934029	0.161344	0.836974	0.228932
Y vector	Disposable income	0.00047	0.000229	0.001003	0.000235
	Disposable income 2	-5.45E-08	3.16E-08	-8.47E-08	3.24E-08
	Household size×Disp_income	0.215125	0.029516	0.369014	0.036568
L vector	Leisure	-0.00014	0.000341	-0.00219	0.000404
	Leisure2	-4.99E-06	2.36E-06	-4.15E-06	2.23E-06
	Leisure×Disposable income	5.57E-05	5.57E-05	2.25E-05	4.42E-05
	Leisure×Age	-0.00719	0.000731	-0.00764	0.000808
	Leisure×Age2	8.54E-05	9.61E-06	9.05E-05	1.04E-05
	Leisure×No. Children	-0.01383	0.007723	0.008831	0.002772
	Leisure×No. Children 0-6	-0.00304	0.017889	0.005098	0.004286
	Leisure×No. Children 7-10	-0.01409	0.01878	0.001498	0.004765
Other					
	N. observations (N. single*7 alternatives)	22918		19621	
	N. single	3274		2803	
	LR chi2(17)	4499.17		3688.16	
	Prob > chi2	0		0	
	Pseudo R2	0.3531		0.3381	
	Log likelihood	-4121.33		-3610.31	

Table A9. – Maximum likelihood estimates – couples (Luxembourg)

Model component	Variable	Coef.	Std. Err.
Opportunity density	Employee_Man	1.681988	0.731909
	Self-employed_Man	0.3950031	0.7392638
	Employee_Woman	-1.443217	0.3843198
	Self-employed_Woman	-1.608584	0.3995294
	Part-time_Employee_Man	-0.7655578	0.4025446
	Full-time_Employee_Man	2.827349	0.1731837
	Part-time_Self-employed_Man	-2.602053	0.662475
	Full-time_Self-employed_Man	0.3509576	0.2399455
	Part-time_Employee_Woman	1.815463	0.3285563
	Full-time_Employee_Woman	2.933669	0.2643454
	Part-time_Self-employed_Woman	-0.7528992	0.3919943
	Full-time_Self-employed_Woman	0.1315669	0.321719
Consumption Vector	Household_Disposable_income	0.0000776	0.0000298
	Household_Disposable_income2	-5.31E-10	2.36E-10
	Household_size×Household_disposable_income	7.42E-07	4.22E-06
Leisure Vector	Leisure_Male	-0.0009955	0.0407898
	Leisure_Man2	0.0010875	0.0002355
	Leisure_Woman	0.1097916	0.0341912
	Leisure_Woman2	0.0000462	0.0002157
	Leisure_Man×Household_disp_income	5.26E-07	4.40E-07
	Leisure_Woman×Household_disp_income	-1.67E-07	2.47E-07
	Leisure_Man×Age_Man	-0.0051071	0.001759
	Leisure_Woman×Age_Woman	-0.0078696	0.0013412
	Leisure_Man×Age_Man2	0.0000653	0.0000207
	Leisure_Woman×Age_Woman2	0.0001212	0.0000169
	Leisure_Man×No. Children	-0.0021142	0.0022308
	Leisure_Woman×No. Children	0.0141155	0.0017158
	Leisure_Man×No. Children0-6	0.0026347	0.0030665
	Leisure_Man×No. Children7-10	0.0073742	0.0033609
	Leisure_Woman×No. Children0-6	0.0105827	0.0024121
	Leisure_Woman×No. Children7-10	0.0055798	0.0026771
	Leisure_Woman×No. Leisure_Man	0.0001832	0.0001011
Other			
	N. observations (N. couples*49 alternatives)	104,615	
	N. couples	2135	
	LR chi2(32)	7481.4	
	Prob > chi2	0	
	Pseudo R2	0.4502	
	Log likelihood	-4568.3353	

Table A.10 – Maximum likelihood estimates – singles (Luxembourg)

Model component	Variable	Coef.	Std. Err.	Coef.	Std. Err.
		Male		Female	
Opportunity density	Employee	0.275375	1.211408	-4.23002	0.8481
	Self_employed	-0.30942	1.225912	-5.2153	0.923592
	Part-time_Employee	-0.49701	0.670525	3.662476	0.607114
	Full-time_Employee	2.462967	0.323977	4.57435	0.470727
	Part-time_Self-employed	-3.58405	1.283321	1.413303	0.915837
	Full-time_Self-employed	-0.63558	0.479261	2.332043	0.617426
Y vector	Disposable income	7.19E-05	4.44E-05	-0.00057	0.000441
	Disposable income 2	2.81E-11	3.35E-10	6.09E-08	3.16E-08
	Household size×Disp_income	0.193567	0.043438	0.1151	0.060788
L vector	Leisure	0.000131	0.000444	0.000458	0.000486
	Leisure2	-1.57E-06	8.13E-07	1.62E-06	4.41E-06
	Leisure×Disposable income	-5.90E-06	2.13E-05	2.11E-05	5.83E-05
	Leisure×Age	-0.00962	0.001379	-0.01141	0.001697
	Leisure×Age2	0.000115	1.73E-05	0.000142	2.13E-05
	Leisure×No. Children	0.001941	0.010168	0.015382	0.004674
	Leisure×No. Children 0-6	-0.00553	0.027376	0.004967	0.008117
	Leisure×No. Children 7-10	-0.05785	0.054809	-1.8E-05	0.006955
Other					
	N. observations (N. single*7 alternatives)	4417		4291	
	N. single	631		613	
	LR chi2(17)	1171.81		1070.81	
	Prob > chi2	0		0	
	Pseudo R2	0.4772		0.4488	
	Log likelihood	-641.963		-657.439	

Table A11. – Maximum likelihood estimates – couples (UK)

Model component	Variable	Coef.	Std. Err.
Opportunity density	Employee_Man	-0.5574113	0.3142135
	Self-employed_Man	-5.579355	0.4913977
	Employee_Woman	-2.530808	0.2266425
	Self-employed_Woman	-8.201661	1.015836
	Part-time_Employee_Man	-1.355056	0.190645
	Full-time_Employee_Man	2.321916	0.0955909
	Part-time_Self-employed_Man	0.6718765	0.5030007
	Full-time_Self-employed_Man	0	(omitted)
	Part-time_Employee_Woman	1.992643	0.2014804
	Full-time_Employee_Woman	2.985978	0.1700195
	Part-time_Self-employed_Woman	3.178171	1.033901
	Full-time_Self-employed_Woman	0	(omitted)
Consumption Vector	Household_Disposable_income	-0.0001689	0.0000787
	Household_Disposable_income2	-1.03E-08	4.21E-09
	Household_size×Household_disposable_income	-0.019727	0.0153645
Leisure Vector	Leisure_Male	0.0004199	0.0001422
	Leisure_Man2	0.108763	0.0185638
	Leisure_Woman	-0.0006454	0.0001348
	Leisure_Woman2	1.19E-06	8.89E-07
	Leisure_Man×Household_disp_income	2.51E-06	9.08E-07
	Leisure_Woman×Household_disp_income	0.0000497	0.0000164
	Leisure_Man×Age_Man	-0.0022317	0.000466
	Leisure_Woman×Age_Woman	-0.0047364	0.0005989
	Leisure_Man×Age_Man2	0.0000305	5.45E-06
	Leisure_Woman×Age_Woman2	0.0000655	7.41E-06
	Leisure_Man×No. Children	0.00267	0.0009233
	Leisure_Woman×No. Children	0.0122468	0.0011048
	Leisure_Man×No. Children0-6	-0.0010193	0.0010614
	Leisure_Man×No. Children7-10	-0.0011617	0.0012513
	Leisure_Woman×No. Children0-6	0.0176638	0.0014152
	Leisure_Woman×No. Children7-10	0.0081957	0.0016107
	Leisure_Woman×No. Leisure_Man	0.0005581	0.000047
Other			
	N. observations (N. couples*49 alternatives)	400477	
	N. couples	8173	
	LR chi2(30)	31112.24	
	Prob > chi2	0	
	Pseudo R2	0.4891	
	Log likelihood	-16251.725	

Table A.12 – Maximum likelihood estimates – singles (UK)

Model component	Variable	Coef.	Std. Err.	Coef.	Std. Err.
		Male		Female	
Opportunity density	Employee	-0.70109	0.463424	-2.9413	0.343978
	Self_employed	-6.36253	1.188215	-20.6651	562.6846
	Part-time_Employee	-0.68244	0.312215	2.291627	0.292447
	Full-time_Employee	2.549455	0.193777	3.535223	0.240938
	Part-time_Self-employed	0.760606	1.256085	15.53179	562.6846
	Full-time_Self-employed	0	(omitted)	0	(omitted)
Consumption Vector	Disposable income	-0.00024	0.000125	0.001491	0.00047
	Disposable income 2	-1.50E-08	8.90E-09	-2.94E-07	8.17E-08
	Household size×Disp_income	0.005375	0.02243	0.158949	0.026067
Leisure Vector	Leisure	0.000777	0.000229	2.67E-05	0.000198
	Leisure2	5.75E-06	1.76E-06	-6.78E-06	4.22E-06
	Leisure×Disposable income	0.000155	4.62E-05	0.000413	7.16E-05
	Leisure×Age	-0.00322	0.000514	-0.00731	0.000661
	Leisure×Age2	4.25E-05	6.33E-06	9.05E-05	8.44E-06
	Leisure×No. Children	0.012146	0.004081	0.021225	0.002126
	Leisure×No. Children 0-6	0.034395	0.017322	0.016766	0.002909
	Leisure×No. Children 7-10	0.021858	0.011777	0.007831	0.0029
Other					
	N. observations (N. single*7 alternatives)	20426		27,104	
	N. single	2918		3572	
	LR chi2(16)	5798.48		7423.68	
	Prob > chi2	0		0	
	Pseudo R2	0.5106		0.4926	
	Log likelihood	-2778.93		-3822.72	

Appendix B

Tables

Table 1. Optimal CBI, GNIT, UBI and IWB, k = 0.05, Italy

	G (euros per month)	t_1	t_2	Hours	Poverty (%)	Winners (%)	Δ% Social Welfare
CBI	337	1	0.31	1530	29.2	65	0.53
GNIT	303	0.37	0.47	1510	21.3	72	0.93
UBI	196	0.35	0.35	1535	25.8	73	0.62
IWB	144	-0.04	0.35	1539	16.2	73	0.59
Current	…	…	…	1540	26.6	…	…

Note: The guaranteed monthly minimum income for a N-component household is $G\sqrt{N}$.

Table 2. Optimal CBI, GNIT, UBI and IWB, k = 0.05, Belgium

	G (euros per month)	t_1	t_2	Hours	Povert (%)	Winners (%)	%Δ Social Welfare
CBI	804	1	0.44	1635	0	57	-1.07
GNIT	522	0.28	0.72	1635	5	61	1.51
UBI	905	0.64	0.64	1645	7.9	57	1.29
IWB	441	-0.02	0.52	1672	9	65	0.37
Current	…	…	…	1645	15	…	…

Note: The guaranteed monthly minimum income for a N-component household is $G\sqrt{N}$.

Table 3. Optimal CBI, GNIT, UBI and IWB, k = 0.05, Luxembourg

	G (euros per month)	t_1	t_2	Hours	Poverty (%)	Winners (%)	%Δ Social Welfare
CBI	626	1	0.19	1664	20	62	-1.01
GNIT	605	0.19	0.49	1643	11	63	0.1
UBI	1297	0.48	0.48	1642	3.7	51	-0.16
IWB	542	-0.01	0.33	1660	7.5	65	-0.24
Current	…	…	…	1648	10.7	…	…

Note: The guaranteed monthly minimum income for a N-component household is $G\sqrt{N}$.

Table 4. Optimal CBI, GNIT, UBI and IWB, k = 0.05, France

	G (euros per month)	t_1	t_2	Hours	Poverty (%)	Winners (%)	%Δ Social Welfare
CBI	374	1	0.17	1688	18.5	72	1.48
GNIT	123	0.36	0.16	1690	18.4	74	1.7
UBI	322	0.26	0.26	1645	7.9	57	0.23
IWB	245	0.26	-0.026	1684	9	73	0.06
Current	…	…	…	1645	15	…	…

Note: The guaranteed monthly minimum income for a N-component household is $G\sqrt{N}$.

Table 5. Optimal CBI, GNIT, UBI and IWB, k = 0.05, UK

	G (euros per month)	t_1	t_2	Hours	Poverty (%)	Winners (%)	%Δ Social Welfare
CBI	641	1	0.25	1182	27.3	56	-0.46
GNIT	774	0.63	0.64	1157	16	76	9.06
UBI	674	0.55	0.55	1175	30.3	74	6.91
IZB	174	-0.03	0.19	1262	23.3	46	-6.6
Current	,,,	…	…	1196	30.3	…	…

Note: The guaranteed monthly minimum income for a N-component household is $G\sqrt{N}$.

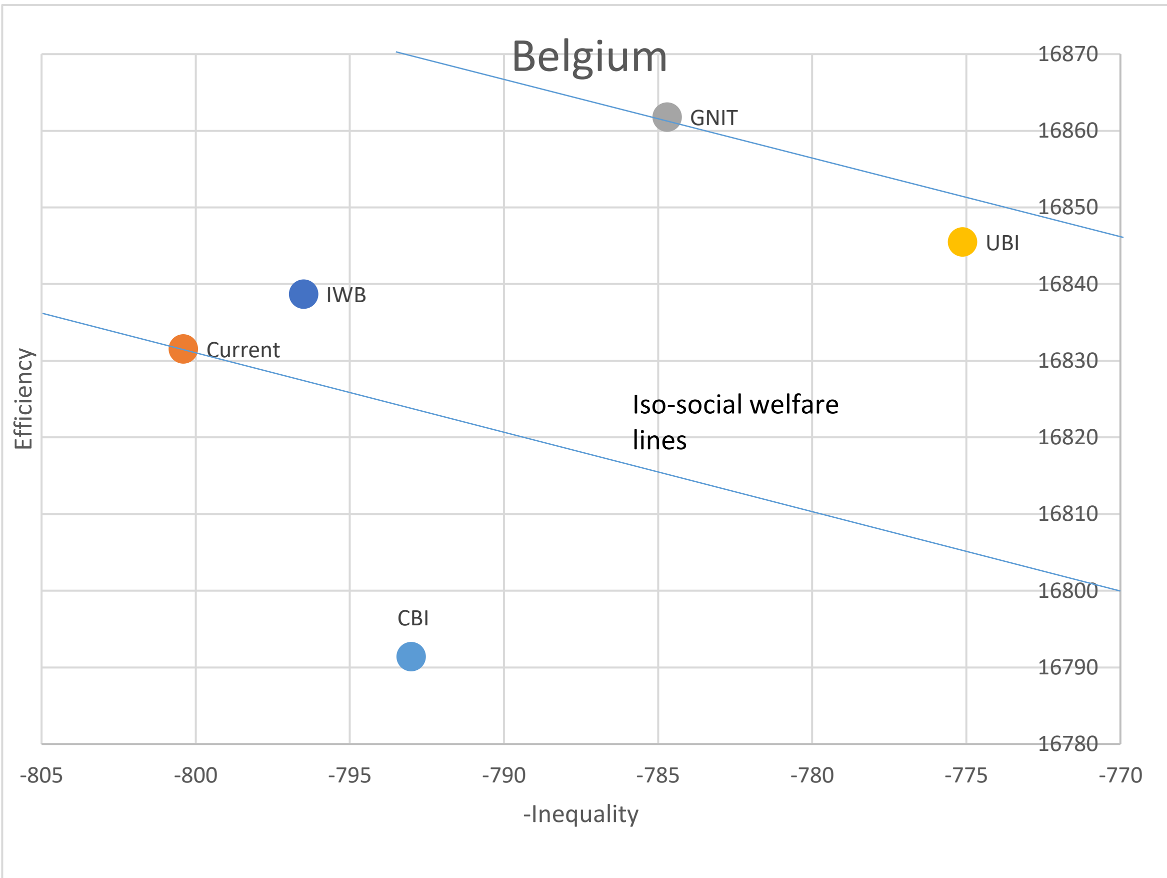
Table 6. Optimal CBI, GNIT, UBI and IWB, k = 0.05, Ireland

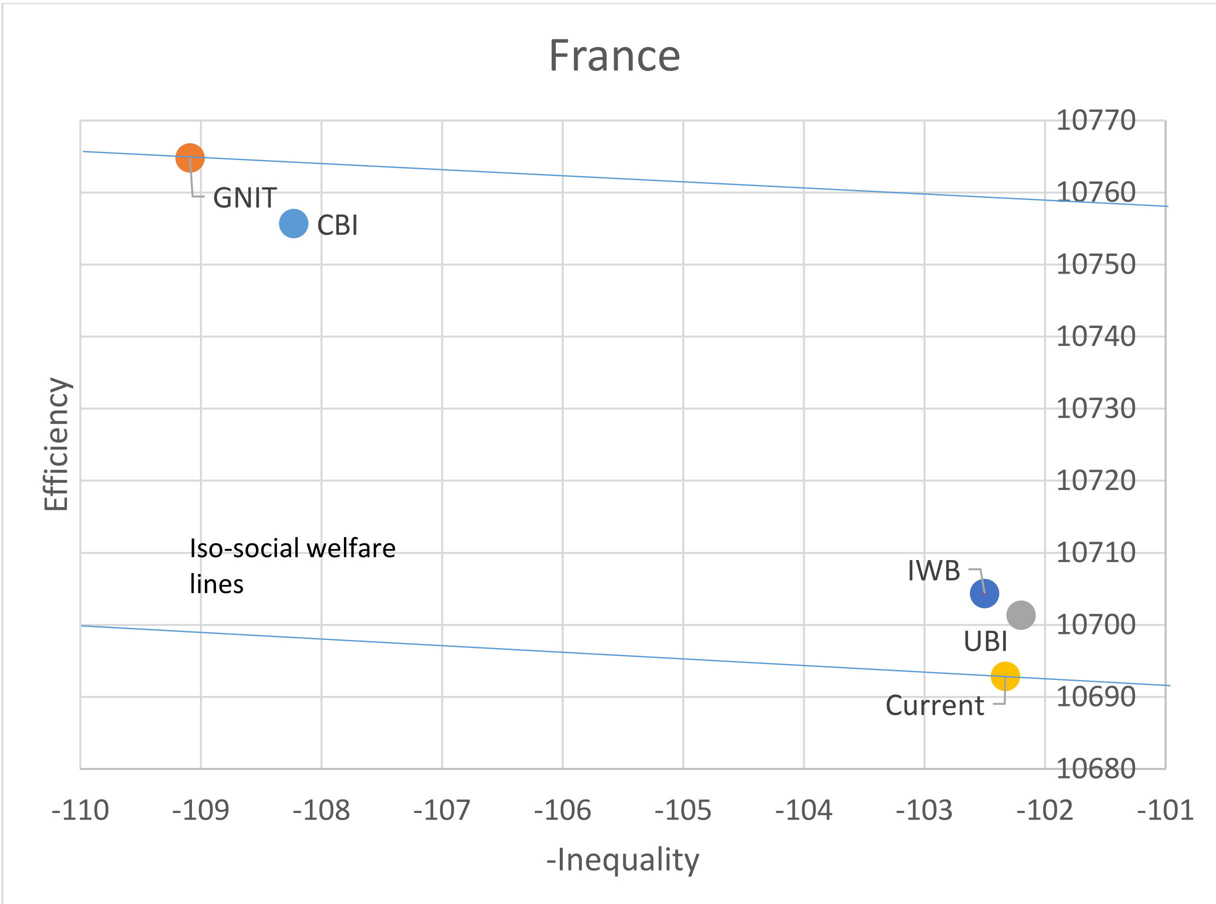
	G (euros per month)	t_1	t_2	Hours	Poverty (%)	Winners (%)	%Δ Social Welfare
CBI	981	1	0.27	1188	26.6	47	-2.81
GNIT	904	0.32	0.89	1191	12.8	61	3.99
UBI	1062	0.57	0.57	1161	0	57	1.48
IWB	494	-0.09	0.31	1274	15.8	48	-0.41
Current	…	…	…	1249	19.6	…	…

Note: The guaranteed monthly minimum income for a N-component household is $G\sqrt{N}$.

Appendix C

Graphs of Social Welfare components




France
Efficiency
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10760
10750
10740
10730
10720
10710
10700
10690
10680
GNIT
CBI
Iso-social welfare
lines
IWB
UBI
Current
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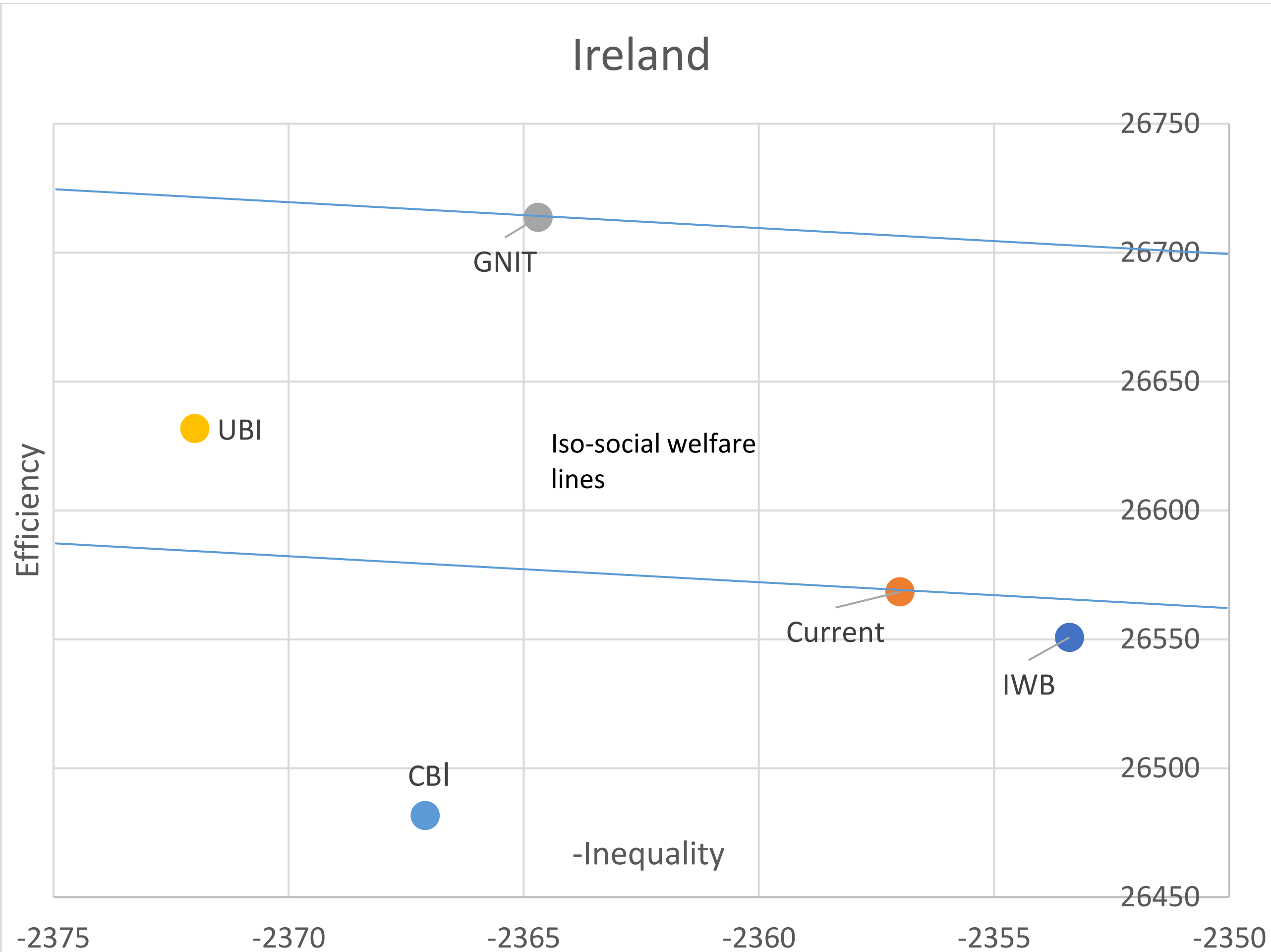
-109
-108
-107
-106
-105
-104
-103
-102
-101
-Inequality


Ireland
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26700
26650
26600
26550
26500
26450
GNIT
UBI
Iso-social welfare lines
Current
IWB
CBI
-Inequality
Efficiency
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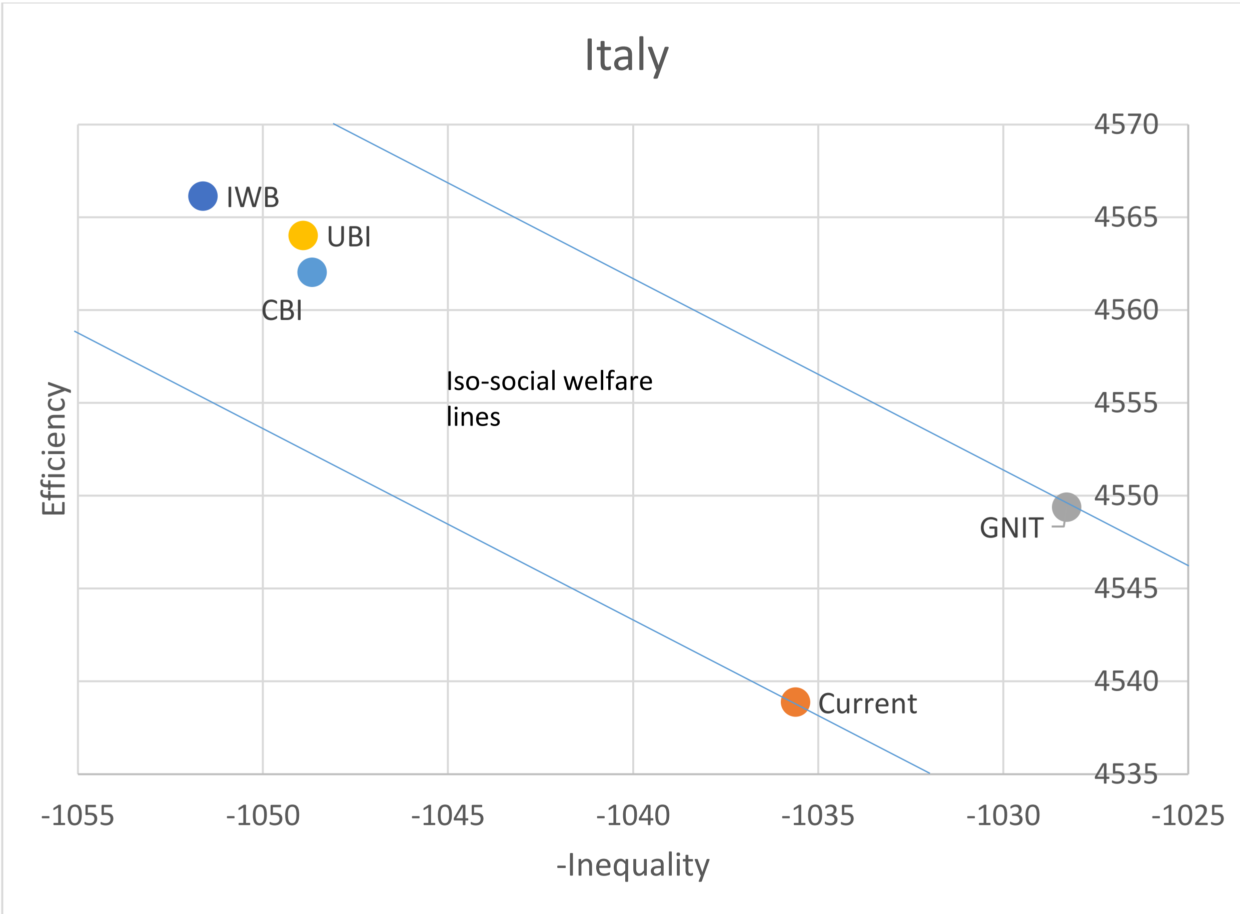
-2370
-2365
-2360
-2355
-2350


Italy
IWB
UBI
CBI
Iso-social welfare
lines
GNIT
Current
Efficiency
-Inequality
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4565
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4540
4535
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-1045
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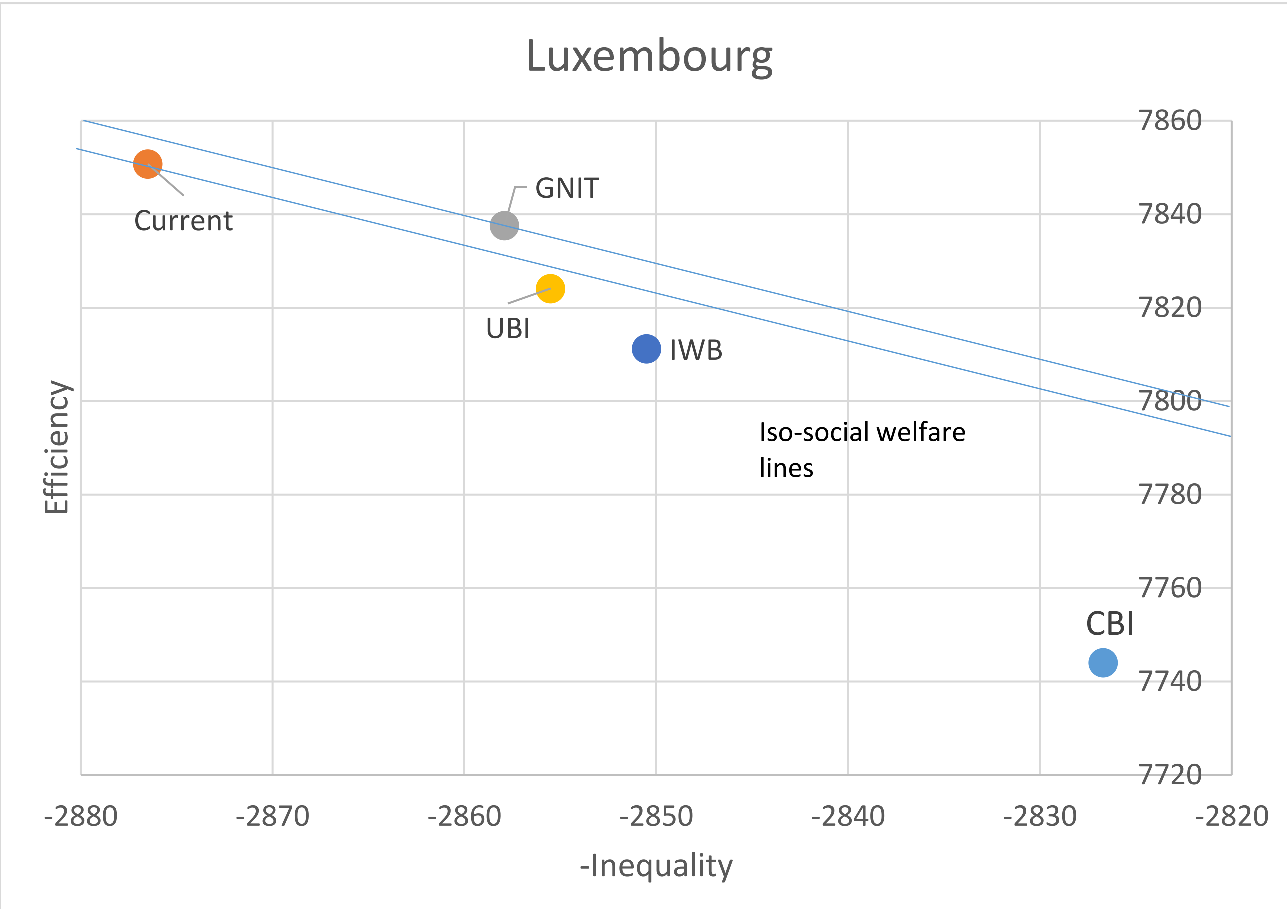
-1035
-1030
-1025


Luxembourg
GNIT
Current
UBI
IWB
Iso-social welfare lines
CBI
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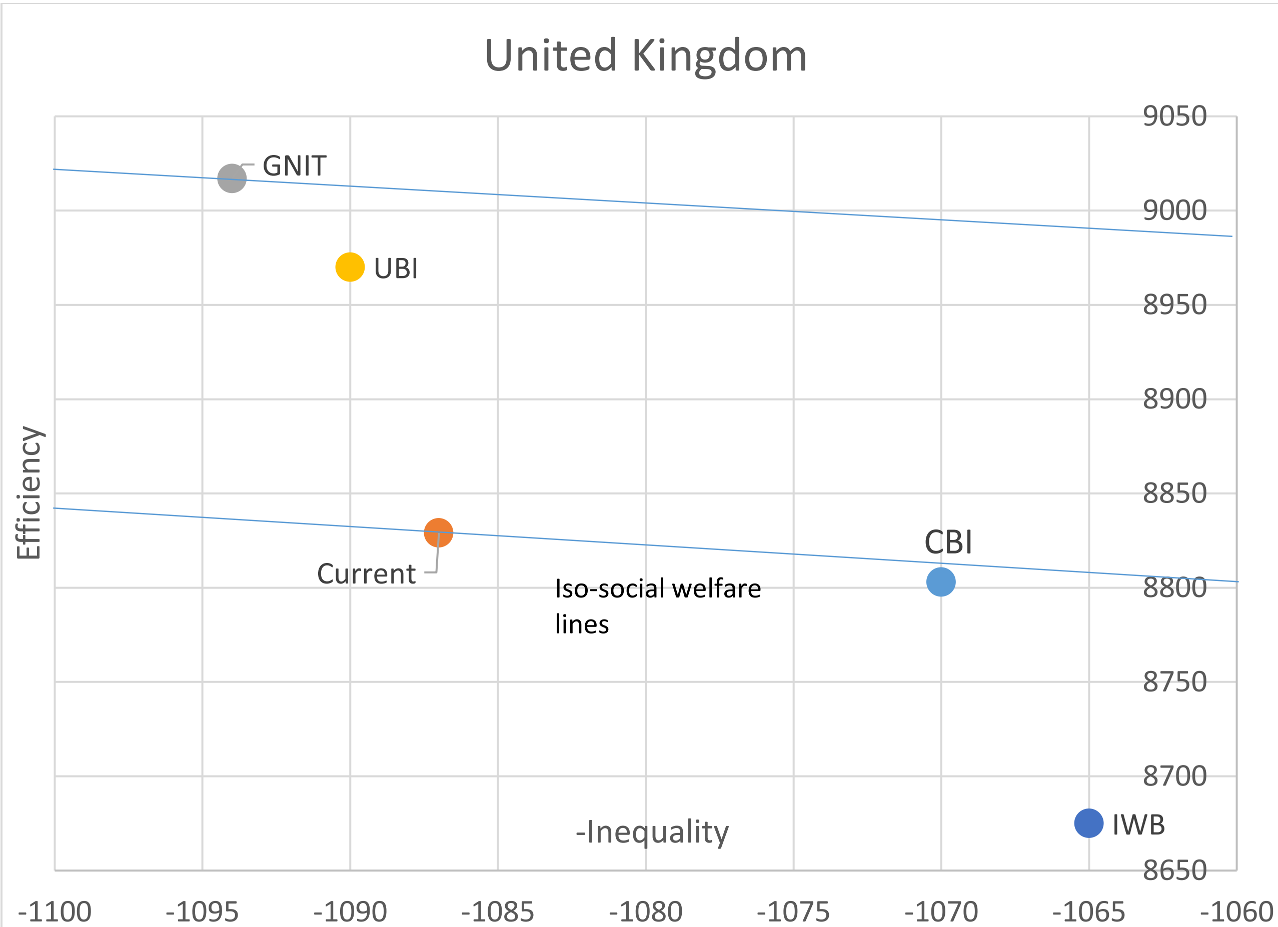
7840
7820
7800
7780
7760
7740
7720
-2880
-2870
-2860
-2850
-2840
-2830
-2820
-Inequality
Efficiency


United Kingdom
Efficiency
-Inequality
GNIT
UBI
Current
CBI
IWB
Iso-social welfare lines
9050
9000
8950
8900
8850
8800
8750
8700
8650
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-1095
-1090
-1085
-1080
-1075
-1070
-1065
-1060