Micro-simulation and Normative Policy Evaluation: An Application to Some EU Tax Benefits Systems

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Abstract

In this work we explore the impact of alternative tax benefits systems on household welfare. The framework of our analysis is the theory of optimal taxation with the distribution of potential wages replaced by the distribution of household abilities. The latter has been calculated by inversion of the household's utility maximization problem. This methodology has then been implemented in order to compare the tax benefits systems of France and the United Kingdom. We have employed a behavioral micro-simulation model that has been applied on samples extracted from the "Households Budget Survey 1989" of INSEE and from the "Family Expenditure Survey" of ONS.

1. Introduction

During the last 20 years, many developed countries have implemented structural reforms of their redistribution systems. The effects of these reforms have been analyzed using a multiplicity of hypotheses and techniques, which in turn have produced a wide range of results. One of the main goals of these analyses was to clarify, both from a theoretical and an empirical point of view, the relationship between individual welfare and existing tax benefit structures.

Theoretical models have analyzed, in a normative framework, the importance of taking into account the strategic behavior of economic agents in the evaluation of alternative redistribution policies. Probably, the most relevant of these theoretical contributions are the optimal income taxation models. This

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approach highlights the trade-off between equity and efficiency that characterizes public decisions regarding redistribution policies. The principal result of the theory of optimal taxation, expounded by James Mirrlees (1971) and extended by many other authors (see Tuomala 1990), is that optimal income tax depends fundamentally on government aversion to inequality, on the behavior of economic agents in terms of effort supply, and on the distribution pattern of the population's abilities (or productivity).

Several studies have analyzed these issues empirically, via the use of micro-simulation models in a partial equilibrium framework.[1] This type of instrument allows for a detailed study of the redistribution potential of alternative tax benefit systems. For this reason, it has become an important tool in the comparative analysis of different systems.[2]

Atkinson et al. (1988), for example, analyze the redistribution impact of a reform in which, for a given sample of French households, the French tax system is replaced by the UK tax system. De Lathouwer (1996) simulates the implementation of the unemployment benefit scheme enforced in the Netherlands, on a sample of Belgian households, thus reflecting the importance of the socio-demographic characteristics of the population on the resulting effects. Callan and Sutherland (1997) compare the effects of different types of fiscal and social policies on the welfare of households in certain EEC countries. Bourguignon et al. (1997) use a micro-simulation model to simulate the effects of the enforcement of the same child benefit scheme on the populations of France, the United Kingdom, and Italy. They show that this policy can have a strong impact on the reduction of poverty in those countries.

The analysis performed in these "micro-simulation" studies is arithmetic (i.e., they suppose that agents do not react to changes in prices and wages). Without questioning the validity of the arithmetic approach, we think that it is extremely important to extend the framework of policy evaluation analysis to the second-order effects by including agent's behavior reactions. One of the principal reasons is that taking explicitly into account labor supply and/or consumption behavior allows us to perform comparative welfare analysis of policy scenarios. With a micro-simulation model including behavioral reactions it is thus possible to compute social welfare functions and to introduce

[1]Empirical analysis has been also performed in a general equilibrium framework using calculable general equilibrium (CGE) models (see Shoven and Walley 1984). Compared with partial equilibrium models, the use of CGE allows for a comprehensive analysis of the effects of fiscal reforms on prices and quantities in different markets. The problem with CGE is that the burden of construction and computation increases dramatically with the number of agents and their heterogeneity. This is the reason for which we have not used this approach in this paper.

[2]We can classify various types of micro-simulation models depending on timing issues (static and dynamic models) and depending on whether they include behavioral reactions or not. For a survey of the aforementioned, please see Bourguignon and Spadaro (2005).

in a more theoretically structured framework (as, for example, the Mirrlees framework) all the policy evaluation analysis.[3]

In this paper we follow this direction. By using a micro-simulation model, we characterize the agents' economic behavior, and we calculate a social welfare function specifying different levels of aversion to inequality of the government. This framework is used to compare two alternative real tax benefit systems—the 1995 French system and the 1995 UK system.

The inclusion of behavioral reactions in the micro-simulation models is not an easy task. In order to ensure the robustness of the procedure and the results, an in-depth knowledge of the behavior—in terms of labor supply—of the members of the household and, above all, their potential wages (or, in more general terms, "productivity") are required.

Our knowledge of the empirical facts of such issues is limited. Firstly, it can be very restrictive for a model to assimilate labor supply and work duration. The work effort invested can be as important as the time spent working in determining the total gross income, while the exogeneity of the wage rate (above the eventual legal minimum) can be questionable.[4] Secondly, even if we disregard this limitation, econometric estimations of labor supply that satisfactorily integrate the effects of the redistribution systems in force are often not very accurate.[5] Thirdly, the fact that a guaranteed minimum income policy, like the UK Income Support (IS) or the Revenu Minimum de Insertion

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[3]Offering his opinions on the subject, Mirrlees (1986 chap. 24, pp. 1198) states, "...*There are, it seems to me, only two promising approaches to making well-based recommendations about public policy. One is to use a welfare function of some form and develop the theory of optimal policy. The other is to model the existing state of affairs in some manageable way, and on that basis to display the likely effects of changes in government policy, these effects being displayed in sufficient detail to make rational choice among alternative policies possible. If a welfare function were used to evaluate the changes predicted, the second approach would come fairly close to the first, and in fact, there is a closer theoretical relationship.*"

[4]Several authors (including Mirrlees himself) have pointed out, in theoretical analyses of fiscal reforms, the limitation represented by the use of hours of work and, consequently, the limitation of the hourly gross wage as an indicator of abilities. Stern (1976), for example, shows how and why the distribution of gross wages can be a highly biased proxy of the distribution of productivities (or abilities) of the agents. He demonstrates that, if the non-observed effort supply curve is backward bending, the distribution of abilities is more unequal than the distribution of gross wages. Similarly, Feldstein (1995) shows that the impact on efficiency of the 1986 US tax reform act was not well described by using estimates of elasticities taken from labor supply expressed in hours of work. He shows that, by looking at changes in gross taxable income instead of looking at changes in working hours, a very great impact on efficiency is obtained.

[5]Econometric labor supply models in presence of non-linear budget constraints have been treated in a considerable number of books. See, for example, Hausman (1981). Also, see the special edition of the *Journal of Human Resources* (vol. 25 no. 3 1990) presenting estimations for several developed countries. The limitations of this structural approach to the problem appeared at the end of the 80s and publications on the subject became rare. A good example of the present approach to these questions is Blundell and MaCurdy (1999).

(RMI) in France, is often associated with the inactivity of household members, makes observation of their potential wage and labor supply reactions difficult.

While we do not wish to question the relevance of the econometric approach to redistribution and labor supply issues (more to the point, we would like to highlight the need to improve the methods used and to refine estimations), in this paper we explore a different approach to the problem of how to represent household behavioral reactions. Firstly, we took a labor supply specification that is simple to treat analytically. Secondly, we identify the "natural" distribution of the household's work productivities from income data obtained from surveys. This is done by micro-simulation, inverting the previous model under arbitrary hypothesis of the price elasticity of the labor supply, taking into consideration the budget constraints implicit in the redistribution systems in force in the countries that we are studying. Finally, using this "true" distribution in the algorithm of the micro-simulation model in order to calculate effort supply responses and the indirect utility function, we analyze the effects of replacing the French and UK real tax benefit systems, respectively on samples of French and UK households drawn from the INSEE's 1989 Households Budget Survey and the ONS's 1991 Family Expenditure Survey, in accordance with parameters describing the social aversion to inequality and the previous hypothesis on the elasticity of the labor supply within an optimal tax theory framework.

The unit of analysis used is the household rather than the individual. The justification for the adoption of this approach is manifold. First of all, most studies on distribution, redistribution, and welfare use the household as the basic unit of analysis. A second important factor is that the basic unit around which the tax benefit systems that we analyzed revolve is the household (this is specially true for French systems). Thirdly, put as simply as possible, we wished to take into account that the size of a family is an important source of heterogeneity among economic agents. This source of heterogeneity was not considered in the original Mirrless model.

It can be argued that the discrete search for an optimal income redistribution scheme (i.e., comparisons of a finite number of alternatives) may represent an oversimplification of the government policy problem. It is probably true from a theoretical point of view, but when the objects of the analysis are real redistribution systems (and their reforms) or international comparisons, the use of a discrete approach is more appropriate.[6] Provided that we are aware of the limitations of this type of discrete search for optimality, there is no doubt about its validity as an instrument for improving our understanding of the structure of these systems. With many precautions, this methodology can also be a starting point for the analysis of the "government social preferences" regarding the extent of aversion to inequality and the size of elasticities implicitly defined in the redistribution mechanisms analyzed.

[6] On this point see Atkinson et al. (1988).

The structure of the paper is as follows. The first section is devoted to the description of the data and the micro-simulation model used, together with the redistribution systems in France and the United Kingdom. The second section describes the results of the simulations that consist of applying the two systems, respectively, on French and UK households without considering behavior reactions. In the third section, after giving a definition of the theoretical framework necessary to design an effort supply response model and to determine the distribution of households' remuneration of abilities (ROA) by inversion of the utility maximization problem, we present the results of the same simulations to those in Section 2 but including behavioral reactions. In Section 4, the definition of the criteria of optimality used to evaluate alternative tax benefit structures is dealt with. In this section the welfare analysis of the two systems is also performed. Section 5 is devoted to the robustness analysis of the results of the simulations. The last section sets out the conclusions.

2. The Micro-simulation Model and the Principal Features of the UK and French Tax Benefit Systems

The samples and the micro-simulation model were taken from a project in progress whose objective was to propose an integrated micro-simulation model for the 15 countries of the European Community.[7] The model replicates the laws enforced in 1995. All the national modules replicate social contributions levied on wages (for employers and employees) and on self-employed workers; social contributions on other types of income (unemployment benefits, income from pensions and capital return); income taxes; family benefits; and social assistance mechanisms. In order to make computation easier, a random subsample of 939 households was drawn from each national sample, and to harmonize the UK and French models, some adjustments were made to the data.[8] A full description of the features of the tax

[7]The Households Budget Survey for France was given by the INSEE. The UK data came from the Household Expenditure Survey (Crown Copyright). They have been provided by the National Office of Statistics (ONS) through the Data Archive. It has been used with the permission of the organization. The ONS and Data Archive are not responsible for the data analysis or interpretation of this paper. The same applies to the INSEE for the French data.

[8]Namely, (a) the transformation of monetary variables taking into account purchasing power parity (we have applied a conversion factor of 1 Sterling Pound = 8.12 Francs); (b) the assignment of a label "part time" or "full time" to the work-hours computed. This correction is necessary because certain kinds of benefits (Income Support and Family Credit in the United Kingdom) are computed in relation to part-time or full-time status. The limit to part-time work in the United Kingdom is 15 hours per week. By analyzing the computed distribution of effort supply in France we were able to determine a limit, which could be identified as a part-time limit. Using this as a starting point, we assigned the corresponding label to each household (on the basis of the number of workers and

Table 1: Comparative importance of redistribution systems in France and United Kingdom (money values expressed in 1995 real exchange rate Ecu per household per year)

	France	Percentage of Gross Income	United Kingdom	Percentage of Gross Income
Average size of household	2.5		2.4	
Gross income from labor, unemployment insurance property, pensions and	28,590		26,095	
Social security contributions on labor income	4450	16%	1300	5%
Primary income	24,140	84%	24,795	95%
Income tax	2080	7%	4002	15%
Family benefits	1470	5%	1397	5%
Of which: child payments	730	3%	573	2%
Disposable income	23,530	82%	22,190	85%

Source: INSEE (France),ONS (UK), own calculations.

benefit systems of France and the United Kingdom as well as the models and statistical properties of the datasets used is contained in Bourguignon et al. (1998).

The importance of the various components of a tax benefit system varies from country to country (see Table 1).[9] Let us start with the concept of *gross income,* that is the income that households derive from their labors, property, or in the form of replacement income from national insurance benefits if they are retired or unemployed. The national insurance contributions paid directly by households out of their gross income when they are active or health insurance contributions, when they are retired, differ dramatically between France and the United Kingdom. In France, they represent 16% of their gross income on average, while in the United Kingdom they represent only 5%. This difference can be explained by the importance of private insurance mechanisms in the United Kingdom.

Let us define what is left as a household's *primary income*: that is, what is actually paid to households as a result of their economic activity or what is paid in the format of a replacement income, after national insurance

the total number of computed units of effort supply). The algorithm of constrained utility maximization of each household, helped us to calculate the value of the indirect utility function corresponding to each possible alternative of effort and, by comparing these values, we could select the level of effort that maximizes indirect utility.

[9]This excludes employers' national insurance contributions, which are not part of the gross income.

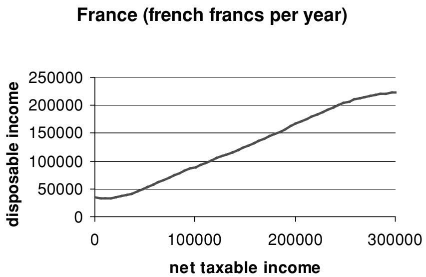

Figure 1: Real budget constraints computed on subsample of single person households (6° order polinomial fit)

contributions have been paid.[10] The difference between this concept and that of *disposable income*—i.e., what can actually be spent—is the income tax[11] and various family benefits. These vary a great deal between the two countries. Income taxes are higher in the United Kingdom, making up about 16% of the average primary income per household. Family benefits in the United Kingdom represent about the same proportion of primary income as family benefits in France. However, income taxes are much lower in France, only slightly higher than the level of family benefits. If we want to obtain an overview of the effects of the tax benefit systems of both countries vis-à-vis incentives and redistribution, it is interesting to look at the distribution of the real budget constraint (Figure 1 shows the distribution of the real budget constraint computed on the subsample of single-person households). We can see that, in the case of France, the budget constraint is S-shaped. The UK figure looks the same on the left side of the budget constraint graph, but the two systems differ in the treatment of the high-level incomes. This is due to the differences in the progression of the marginal income tax rate (higher in France for the last two deciles). The horizontal area on the left of the budget constraint curves is due mainly to the existence of redistribution mechanisms such as the RMI in France and the IS in the United Kingdom. The RMI and IS schemes are means tested and provide a minimum level of resources for all households: each supplementary unit of income, earned by augmenting effort supply, is fully subtracted from the amount of *IS* or *RMI*. This mechanism implies a 100% effective marginal tax rate (*emtr*) and acts as a great disincentive on effort supply. On the other hand, it has a high redistribution effect. A comparison of the distribution of equalized primary and disposable

[10]Note that employee contributions to private and occupational pension schemes have been treated as private savings instruments rather than as benefit contributions. Although not a significant issue in France, these pensions are especially important in the United Kingdom.

[11]Here we refer only to income taxes on personal income and not local taxes.

incomes for the two countries is given in Table 2.[12] In both countries, the redistribution is quite substantial. This is due to income tax (the rate of which increases monotonically along the income scale), family benefits (which are concentrated on the lower portion of the distribution), and national insurance contributions (which also allow for a certain redistribution effect). As shown in Atkinson et al. (1988), one of the main differences between the two systems is represented by the fact that the French system addresses redistribution from the point of view both of income and family size. Households with a large number of children (with the same level of income) pay proportionally less taxes than a single person or households without children. The effect of the "quotient familiale" (QF) mechanism in France is double: on the one hand, it encourages fertility, and on the other hand, it provides greater assistance for higher-income families. This second point (i.e., the regressivity of the QF) is one of the principal arguments (together with the pressure for greater harmonization within Europe) for a reform of the income tax system in France.

3. Simulations without Behavioral Reactions

The first exercise consisted of replacing the original tax benefits system (i.e., the French system on the French sample and the UK system on the UK sample) with the alternative system, without considering behavioral reactions in terms of effort supply, and to analyze the redistribution effects of these reforms. The results are shown in Table 3. As expected, after a general overview of the two tax benefits systems, we observe that the UK system is harmful for the first deciles of the household distribution.

Enforcing the UK system on the French population leads to a reduction in disposable income for the lower five deciles and an increase in income for the top five deciles. The reason for the "negative" effects on poor households is basically the reduction of means-tested benefits (from 162% to 134% of their gross income). This effect depends on the fact that poor French households are, on average, richer than poor UK households as we can observe in Table 2. In Table 2, we report the average gross income of each decile, for the two populations: the average gross income of the first French deciles, expressed in Pounds (the real exchange rate used is 1 pound = 8.12 francs), is 1820.32, that is 1.57 times the correspondent value for the first UK deciles. The second, third, and fourth French deciles are respectively 1.59, 1.31, and 1.2 times richer than the correspondent UK deciles. On the other side of the income distribution scale, rich households perform better because of the reduction in social security contributions (from 20% to 5% on average) (see Tables 2 and 3).

[12]Aggregate figures in Table 2 slightly differs from the correspondent aggregate figures in Table 1 because Table 2 is computed on per adult equivalent incomes figures.

Table 2: Comparative performance of present redistribution systems in the model. Households ranked by gross annual income per adult equivalent (adult equivalent = square root of household size)

	France (in French francs)						United Kingdom (in pounds)					
Deciles of Gross Income	**Gross Income**	**Disposable Income**	**Size**	**Social Insurance Contributions/ gr. inc. (%)**	**I.Tax/ gr.inc (%)**	**Benefits/ gr.inc (%)**	**Gross Income**	**Disposable Income**	**Size**	**Social Insurance Contributions/ gr. inc. (%)**	**I.Tax/ gr.inc (%)**	**Benefits/ gr.inc (%)**
1	14,781	39,199	2.5	8	0.0	162.1	1157	3386	2.4	0.3	0.1	226
2	39,975	47,565	2.1	7	0.4	18.0	3088	4362	1.7	0.4	0.7	55
3	54,048	59,323	2.5	12	1.2	13.9	4751	5068	2.3	1.1	2.7	25
4	68,833	67,927	2.4	13	3.6	5.0	7052	6702	2.7	3.2	7.9	14
5	85,789	76,565	2.6	15	3.9	2.5	9018	8183	2.7	3.8	11.1	10
6	101,646	86,212	2.7	16	4.8	2.0	11,390	9870	2.5	5.5	12.5	6
7	117,621	94,410	2.6	18	5.5	1.3	13,964	11,573	2.8	5.9	13.6	2.6
8	140,901	109,420	2.5	18	6.7	0.9	17,315	14,044	2.6	6.2	15.2	2.2
9	181,526	134,985	2.4	19	8.9	0.3	21,673	17,205	2.4	6.6	17.4	1.1
10	314,288	212,839	2.9	20	14.3	0.4	35,807	27,902	2.3	4.4	23.6	0.6
Total	112,088	92,933	2.5	17	7.9	4.5	12,541	10,843	2.4	4.9	15.9	5.3

Source: INSEE (France), ONS (UK), own calculations.

Table 3: Redistribution performance of replacing the two tax-benefits systems on national samples without behavior reactions. All figures are expressed in values per adult equivalent (adult equivalent = square root of household size)

	UK System on French Sample (in French francs)					French System on UK Sample (in pounds)				
Deciles of Gross Income	**Disposable Income**	**Social Insurance Contributions/ gr. inc. (%)**	**I.Tax/ gr.inc (%)**	**Benefits/ gr.inc (%)**	**Average Change in Disposable Income from Base Scenario (%)**	**Disposable Income**	**Social Insurance Contributions/ gr. inc. (%)**	**I.Tax/ gr.inc (%)**	**Benefits/ gr.inc (%)**	**Average Change in Disposable Income from Base Scenario (%)**
1	35,581	1	1.7	134.6	−9	5653	11.9	0.0	368	67.0
2	47,266	2	5.1	17.3	−1	6045	8.0	0.0	96	38.6
3	53,251	4	8.8	7.4	−10	6433	14.6	0.0	33	26.9
4	62,459	4	12.0	4.2	−8	7737	13.6	0.1	14	15.4
5	75,225	5	14.1	4.3	−2	8328	14.6	0.7	6	1.8
6	86,337	5	15.4	3.2	0	9842	16.4	1.8	5	−0.3
7	94,455	7	16.8	2.2	0	11,130	18.2	2.8	2.5	−3.8
8	111,169	6	18.7	2.3	2	13,282	18.0	4.4	1.7	−5.4
9	138,163	6	20.0	1.6	2	15,528	17.4	6.2	0.9	−9.7
10	220,743	5	26.7	1.0	4	24,194	20.7	12.9	0.2	−13.3
Total	92,553	5	18.7	4.7	0	10,822	17.6	5.9	7.4	0

Source: INSEE (France), ONS (UK), own calculations.

In the scenario based on the enforcement of the French tax benefits system on the UK sample, the effects are the opposite of what we have just described. Means-tested benefits rise from 226% to 368% for first decile. The second, third, and fourth deciles also receive more subsidies. All the deciles pay less income tax but there is a big rise in the national insurance contributions paid by all. The amount of national insurance contributions paid worsens the situation for the upper part of the distribution scale (the last deciles, for example, lost 13.3% of the equivalent disposable income).

It is interesting to note that the two experiments are not perfectly symmetric. If we look at the last column of each of the two sectors of Table 3 (the "percent average change of disposable income from base scenario"), we can observe that, in the case of the first deciles, the gain for UK households when changing from the UK tax benefits system to the French system is much greater than the corresponding loss for French households in the symmetric experiment. If we take the first decile of each population as an example, we see that the gain for the UK decile is 67%. Meanwhile, the first French decile only lost 9% of its disposable income when the UK system was enforced. There are two fundamental reasons for this asymmetry: the first is that means-tested benefits in France (i.e., Allocations Familiales and the RMI) are more important (in terms of money) than Income Support and Child Benefits in the United Kingdom. The second (and probably most important) reason is that in the samples we used for our simulations, the average gross income of the bottom of the income distribution was lower in the United Kingdom than in France. This means that UK households are, on average, poorer than French households, and so with the French system, they receive proportionally more means-tested benefits with the French system than French households would.

An interesting aspect of the analysis in this "no-reactions" framework is to look at the inequality effects generated on the population as a whole by the replacement of the national tax benefits system. To this end, we computed Gini and Atkinson indexes on the distribution of *per adult equivalent* disposable income before and after the reform using, in the case of the Atkinson measure, two alternative values of the parameter a (0.1 and 0.99).[13] As shown

[13]This parameter represents the inequality aversion of the analyst: the larger is a, the more important for the analyst are the lowest income brackets. The Atkinson index measures the fraction of income that can be sacrificed without losing social welfare if income were equally distributed. We can compute it with the following expression:

$$I(a) = 1 - \left[\frac{1}{N}\sum\left(\frac{YDpae_i}{\mu}\right)^{1-a}\right]^{\frac{1}{1-a}} \quad \text{if } a \neq 1,$$

$$I(a) = 1 - \frac{\sqrt[N]{\prod YDpae_i}}{\mu} \quad \text{if } a = 1,$$

where $YDpae_i$ is the household i disposable income per adult equivalent and μ is the average disposable income per adult equivalent on the whole population. Atkinson's index varies between 0 and 1. For values close to 1 the amount of inequality is very great (see Atkinson 1970).

Table 4: Inequality index for different scenarios calculated on per adult equivalent disposable income

Sample	Tax/Benefits System	Gini Coefficient	Atkinson Index ($a = 0.1$)	Atkinson Index ($a = 0.99$)
United Kingdom	United Kingdom	0.35	0.0216	0.1955
United Kingdom	French	0.27	0.0134	0.116
French	French	0.28	0.0136	0.1234
French	United Kingdom	0.30	0.0157	0.1422

Source: INSEE (France),ONS (UK), own calculations.

in Table 4, the enforcement of the French tax benefits system always reduces the inequality in the distribution. It is interesting to note that the initial level of inequality is very high for the UK sample and the enforcement of the French tax benefits system decreases this inequality substantially (the Gini index changes from 0.35 to 0.27). The opposite is true for the experiment on the French population, but in this case, the increase in inequality is less pronounced (the Gini index changes from 0.28 to 0.30). It is also interesting to note that the introduction of judgment values regarding inequality in the analysis (Atkinson index) of the reforms shows that if a certain level of "Rawlsanism" is considered (as is the case of $a = 0.1$), the French tax benefits systems perform much better than the UK system.

4. Introducing Behavioral Reactions

The analysis performed in the previous section is not new (see Atkinson et al. 1988) and although the experiment described is an important step on the way to understanding the principal features of the two tax benefits systems analyzed, the predictive power of the results is limited because we do not consider the second-order effects of the change in household budget constraints. The next step would naturally be to incorporate the behavioral reactions of agents into the analysis. In order to do it we need to recover the distribution of household productivities that will be used as exogenous input by the behavioral micro-simulation model.

4.1. Recovering the Distribution of Abilities

Recovering the distribution of the productivities represents an important step in the implementation of our analysis. The approach that we propose here is an intermediary between the econometric approach and the calibration approach (see Bourguignon and Spadaro 2000). It infers from the observed gross labor and non-labor income, the redistribution system in force $I(\cdot)$, and an arbitrary set of labor supply elasticity Ω, the implicit productivity w

coherent with the theoretical model of the effort supply that we impose on the data.

Let us assume that the data observed constitute the results of a rational process, in which every household maximizes a utility function $U(\cdot)$ (which depends on consumption c (whose price is fixed at one) and the supply of effort e (whose price is represented by w), and on the size of the household N) under the budget constraint represented by the tax benefit system in force in the country analyzed (where m is non-labor income).

This framework corresponds to a partial equilibrium analysis in which the variable w (the remuneration of abilities (ROA)) is fixed. It must be interpreted as a kind of interpolation of the remuneration offered by the market to each member of the household and it. We are also considering the household as a unit of decision.[14] Theoretically the household problem is

$$\mathrm{Max}_{c,e} U(c, e, N) \quad \text{s.t} \quad c = we + m - I(N, we + m). \tag{1}$$

Let us presuppose that the usual properties of the utility function are satisfied. If this theoretical model holds, it is possible to invert it and to recover the value of w starting from the observation of the gross income, the disposable income, and the redistribution system, after the definition of the elasticities Ω. Formally we have

$$(c^*, e^*) = \mathrm{Arg\,max}\, U(c, e, N) \quad \text{s.t.} \quad c = m + we - \mathrm{I}(N, m + we)$$
$$\Leftrightarrow w = \Phi[we^*, m, I(\cdot), \Omega, N]. \tag{2}$$

This inversion of the optimal problem (see Kurz 1968) can be easily implemented by replacing the original utility maximization problem with a non-linear budget constraint with the correspondent virtual problem. In the latter, agents maximize the same utility function as before but subject to a linearized budget constraint, which shape is determined by the marginal tax rate (t_{marg}).

Using the same notation as in (2) we can define the virtual problem as

$$(c^*, e^*) = \mathrm{Arg\,max}\, U(c, e, N) \quad \text{s.t.} \quad c = m_v + we(1 - t_{\text{marg}}), \tag{2.1}$$

where m_v is the virtual non-labor income. This last variable can be computed as the difference between observed disposable income YD and observed gross labor income Y times 1 minus the marginal tax rate $[m_v = YD - y(1 - t_{\text{marg}})]$.

The main property of this virtual problem is that it gives us exactly the same optimal solution (consumption and effort supply) of the original problem. Since this problem is more tractable than the original problem we use it for the inversion of optimal problem.

[14]This unitary approach is a simplification of the treatment with respect to recent development of collective models of household behavior (Chiappori 1992). Unfortunately, at this stage, the collective framework is not yet operative for empirical applications of this type (see Blundell et al. 1998).

The empirical inversion of the optimal problem must be implemented taking into account the anomalies of the data. In this case, the methodology used is the introduction of a correction error à la Hausman.[15]

The parametric specification we use for the effort supply (of the virtual problem) is the following type of Cobb–Douglas specification (see Stern 1986):

$$e = N\phi w_v^{\alpha} m_v^{\beta}, \tag{3}$$

where N is the number of people in the household, ϕ is a constant, α is the elasticity of e with respect to the ROA, β is the elasticity of e with respect to exogenous income, w_v is the virtual ROA $[w_v = w(1 - t_{\text{marg}})]$ and m_v is the virtual non-labor income.[16]

The indirect utility function $V(w_v, m_v, N)$ associated with this specification of e is

$$V(w_v, m_v, N) = \frac{N\phi w_v^{1+\alpha}}{1+\alpha} + \frac{m_v^{1-\beta}}{1-\beta}. \tag{4}$$

This specification satisfies the Slutsky condition if $\alpha \geq 0$ and if $\beta \leq 0$.[17] With this specification of effort, the result of the inversion procedure is

$$w = \left[\frac{y}{N\phi(1 - t_{\text{m arg}})^{\alpha} m_v^{\beta}}\right]^{\frac{1}{1+\alpha}}. \tag{5}$$

A last consideration needs to be taken into account. From Equation (5) we see that, if the effective marginal tax is one, we are not able to calculate a ROA rate. It is often the case that guaranteed minimum income mechanisms (like the RMI in France and Income Support in the United Kingdom) imply an *emtr* equal to one. This implies that households receiving the guaranteed minimum income will find it optimal to remain inactive and to receive the subsidy. A reform that changes these mechanisms or abolishes them can produce a change in the working behavior of these households. We therefore

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[15]In order to take into account measurement errors, heterogeneity of preferences and transitional effects we have corrected the distribution of observed gross earnings by a random error ε extracted from a normal distribution with zero mean and with minimum variance conditioned to the following restrictions: (a) $\varepsilon < \frac{Yd}{1-t_m} - y$ and (b) $y + \varepsilon > 0$ (where t_m is the effective marginal tax rate). These conditions assure the compatibility of observed data with the parametric specification adopted. For a full description of this method and the properties of the virtual problem see Hausman (1985).

[16]The effective marginal tax rate is a continuous function representing the derivative of the tax schedule. In practice it is calculated with the micro-simulation model by differentiating numerically the tax-benefit schedule.

[17]It is important to underline that, albeit on the one hand, this particular specification makes work easier for the reasons shown above, on the other hand, it considerably restricts the strength of the results due to certain features that make it particularly insensitive to variations in the ROA rate.

need to have a ROA for these households too.[18] The method we applied was to assign a ROA rate to each household observed to be in this situation,[19] by extracting one randomly from a lognormal distribution.[20] The upper limit of this distribution (the reservation wage) was calculated for each household simulating labor supply responses under alternative ROA rates.[21]

4.2. Results of the Simulations with Behavioral Reactions

In this section, we show the results of the same type of exercise as that described in the second section for two alternative scenarios that focus on the extent of the effort supply reactions (see Appendix A for the computational aspects). The first is a low-reaction scenario, while the second is a medium-reaction scenario.

In terms of Equation (3), the two alternative scenarios have been designed by keeping α and β (which represent the elasticity of e with respect to w_v and m_v, respectively) equal to $\alpha = 0.1$ and $\beta = -0.2$ for the hypothesis of low elasticities and to $\alpha = 0.3$ and $\beta = -0.4$ for the hypothesis of middle elasticities. The value of the constant ϕ has been always calibrated so as to normalize to 1 the effort supply of a single, full-time employee, with a gross income equal to the annual minimum wage.[22] The values employed are $\phi = 2.7$ for the hypothesis of low elasticities and $\phi = 2.5$ for the hypothesis of middle elasticities. These values of elasticities have been selected according to the range of possible values estimated in the micro-econometric literature on labor supply responses (Pencavel 1986, Blundell and MaCurdy 1999).

As shown in Equation (5), one of the variables necessary for the analysis is t_{marg}, the *emtr* for each household. This variable was obviously not present in the survey and it was therefore necessary to compute it. The definition of *emtr* used was the derivative, in each point, of the budget constraint. A possible method of calculation is described in Bourguignon et al. 1997. This approach consists of the assignment of a lump-sum amount of gross income to each household and, in the computation with the micro-simulation model,

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[18]The population of sick and retired households is not included in our analysis.

[19]In France, during 1994, the percentage of RMI receivers was 1.3% of the total population. In the United Kingdom, the percentage of Income Support receivers was 20.3%. In our sample, the percentage of households receiving RMI (from our micro-simulation model) was 1.5% of the total households. For the UK sample, the percentage was much greater, (22% of all households).

[20]Literature on micro econometric models highlights that a lognormal distribution approximates very accurately the true distribution of low categories of wages (see Brown 1976 and Colombi 1990).

[21]We used an algorithm of utility maximization in order to find the level of w at which a household will offer a positive effort. This reservation wage was used as an upper limit of the normal log distribution.

[22]In 1995 it was about FF 68,000 in France and about 7280 pounds in the United Kingdom.

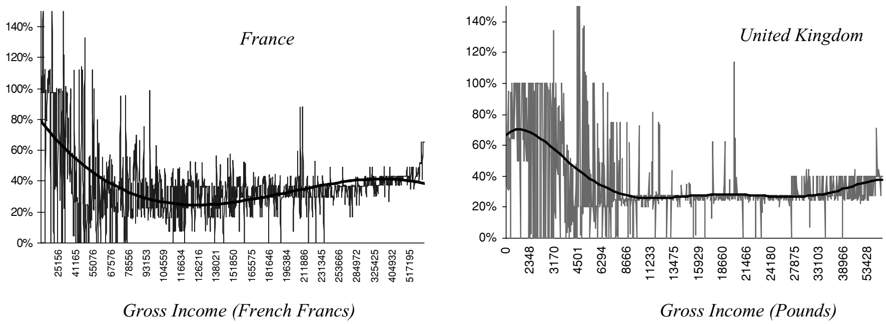

Figure 2: EMTR curves

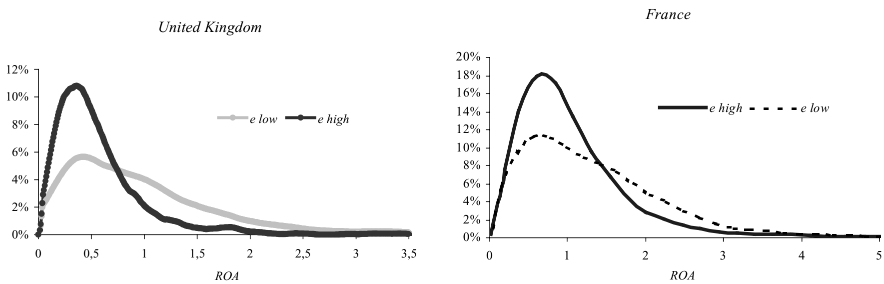

Figure 3: Distribution of ROA rate (expressed in multiples of average)

of a new distribution of disposable incomes. The effective marginal rate of taxation is thus obtained from the formula

$$emtr = \frac{\Delta\text{Taxes} + \Delta\text{Benefits}}{\Delta\text{GrossIncome}} = 1 - \frac{\Delta Yd}{\Delta y}.$$

In Figure 2, we have reproduced the *emtr*, computed by means of a microsimulation model classed by gross income. Looking at the figures shown in the model, we can observe *emtr* levels of over 90% at the bottom of the income distribution scale. This is no doubt due to means-tested benefits (like the RMI and Income Support) and represents a large disincentive to augmenting effort supply (e.g., this is the so-called "poverty trap" effect).

For each population we need the productivity distribution (the ROA rate) in order to be able to compute any reactions and evaluate the reforms in terms of efficiency. By applying the inversion methodology described in Section 3.1 we computed the ROA distributions shown in Figure 3 (in accordance with the aforementioned hypothesis regarding elasticities) for each population under his own tax benefits system.[23] It is interesting to note that

[23]It means that the computation of Equation (5) is done for each population using the observed labor and non-labor income, his own socio-demographic characteristics, and his national redistribution system.

the change in elasticities has a dramatic effect on the initial distribution of w. With higher elasticities, the inequality of initial productivities decreases (the kurtosis of $f(w)$ rises). This effect may have important implications in terms of optimal redistribution policies (as shown in Bourguignon and Spadaro 2000).

The results of behavioral simulations are reported in Table 5. Table 5 shows the average percentage changes in disposable income, gross income, and net taxes (income tax plus social insurance contributions minus benefits) by deciles of reference gross income for low (top of the Table) and high (bottom of the Table) elasticity scenarios. Aggregate net tax receipts under each system are also reported.

The enforcement of the UK tax benefits system on the French population leads to a reduction in the average net tax for each decile with a consequent generalized positive effect on household's gross income. This is true under both low and high Ω. The size of the efficiency effect is in general small (0.4% for low Ω and 1.3% for high Ω). For the poorer part of the income distribution the change is basically due to the reduction in average mean-tested benefits, average social contribution, and also average income tax. For the richer part of the population it is due to the mix income tax—social contributions, that, under UK system produces a lower marginal tax rate (see Figure 2). An exception is represented (in both scenarios) by deciles 1 and 3, for which the gross labor income is reduced. The reason is that, for these deciles of population, income effects deriving from reduction in average and marginal tax rate, dominate substitution effects.

The observed changes in disposable income show that the reduction in the size of means-tested benefits affect substantially the first five deciles of the population. On the contrary, the reduction of the net tax rate and his positive efficiency effect produce an increase in disposable income of the richer part of the population. The bigger positive effects are observed on the 10th decile (6% in low elasticity scenario and 7.9% in the other).

The enforcement of the French tax benefits system on the UK population leads to a general increase in the average net tax. For deciles one and two this is due to the increase in benefits rate. For the last three deciles, the net tax increase results from a reduction in income tax that is more than compensated by an increase in social contributions. The central part of the distribution (deciles three, four, five, and seven) is affected differently depending on the scenario. In the low Ω scenario, the net average tax of all these deciles, except for fifth, decreases. On the contrary, in the high Ω scenario, the net average tax rate decreases for deciles three and four, and increases for deciles five, six, and seven. The determinant of this difference is the subsidy we give to the household in order to respect the government aggregate budget constraint (that is higher with high elasticity).[24] The efficiency effects are in line with

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[24] See next section.

Table 5: Redistribution performance of replacing the two tax-benefits systems on national samples with behavior reactions. All figures are expressed in values per adult equivalent (adult equivalent = square root of household size)

	UK System on French Sample			French System on UK Sample		
Deciles of Gross Income	**Average Change in Disposable Income from Base Scenario (%)**	**Average Change in Gross income from Base Scenario (%)**	**Average Change in Net Taxes from Base Scenario (%)**	**Average Change in Disposable Income from Base Scenario (%)**	**Average Change in Gross Income from Base Scenario (%)**	**Average Change in Net Taxes from Base Scenario (%)**
			Low Elasticity Scenarios			
1	−12.538	−0.826	−13.12	61.192	3.428	57.85
2	−5.587	0.142	14.91	35.782	2.022	63.27
3	−12.375	−0.417	−588.57	10.735	−0.233	−13.21
4	−8.435	0.200	−15.34	5.268	−0.256	−89.66
5	−1.907	0.420	−21.83	−0.517	−0.473	89.80
6	0.390	0.432	−19.04	2.314	0.068	−5.00
7	0.469	0.327	−11.62	0.534	0.024	−1.18
8	2.922	0.435	−14.20	−2.684	−0.212	8.85
9	5.052	0.693	−18.77	−3.432	−0.052	1.75
10	6.052	0.757	−15.28	−10.636	−0.378	9.85
Total	0.501	0.417	−16.57	−6.964	−0.447	23.87
	Per household actual net tax receipt	19,156.87706 $\pi^* = -0.019$		Per household actual net tax receipt	1698.114957 $\pi^* = 0.023$	
	Per household reference net tax receipt	19,155		Per household reference net tax receipt	1698	
			High Elasticity Scenarios			
1	−13.905	−2.438	−13.02	71.941	10.567	57.40
2	−5.154	0.467	16.32	40.351	6.018	61.41
3	−12.928	−1.199	−567.14	9.010	−0.951	−17.92
4	−7.870	0.650	−16.64	3.375	−1.063	−124.14
5	−0.859	1.318	−22.74	−2.865	−1.738	110.20
6	1.493	1.356	−19.84	0.953	−0.137	3.33
7	1.372	1.040	−12.30	−0.984	−0.290	4.73
8	4.073	1.368	−14.83	−4.686	−1.014	14.06
9	6.782	2.154	−19.31	−5.164	−0.548	6.11
10	7.960	2.354	−15.72	−12.956	−1.557	13.50
Total	1.578	1.310	−17.30	−9.274	−1.702	30.32
	Per household actual net tax receipt	19,157.00517 $\pi^* = -0.021$		Per household actual net tax receipt	1699.160799 $\pi^* = 0.028$	
	Per household reference net tax receipt	19,155		Per household reference net tax receipt	1698	

Source: INSEE (France), ONS (UK), own calculations.
π^* = equilibrium value of the π parameter (see Section 4).

what can be expected: an increase in net taxes has a negative impact on labor supply. The size of the change in gross income is not important except for the first two deciles (for which the reduction of the net average tax and, the increase of the marginal tax determine a reduction in gross income of around 3% with low Ω and 8% with high Ω), all the deciles from 3 to 10, have a reduction of gross income of less than 2%.

From a distributional point of view, the effects are in line with what should be expected. The bottom deciles show a marked increase in their disposable incomes (varying from 3% for the fourth decile under high Ω to 70% for the first decile under high Ω) basically due to the increased amount of benefits they receive under the French system. On the other hand, the disposable household income for the top deciles decreases in both experiments (with changes ranging from 0.9% up to 12%).

As in the experiments undertaken which did not incorporate behavioral reactions, there is a certain deal of asymmetry between the two scenarios. The direction of the changes is symmetric in both experiments and is perfectly in line with what might be expected: the French tax benefits are more generous for poor households but, at the same time, create more disincentive effects for the rest of the population. Meanwhile, the extent of the changes shown is asymmetric. This effect is due to the differences in income and composition between French and UK households. Poor French households are richer than poor UK households and with more children (see deciles 1, 2, and 3 in Table 2).

At this point, it is interesting to look at the differences between the behavioral micro-simulations and the scenarios when second-order effects were not taken into consideration in order to have an idea of the importance of these effects on the evaluation of the reforms (compare Tables 3 and 5).

With regards the simulation using the French sample, the main difference in comparison with the "no-behavior" scenario is that the size of the changes is a little big higher. The introduction of behavioral reactions does not affect the direction of the changes in disposable income. With higher Ω, the effects are more important but they still remain small.

As for the previous case, in the experiments run on the UK sample, the progressive introduction of behavioral reactions does not change the qualitative impact of the reform. The first deciles of the population gained (in terms of disposable income); the others lost out because of the rise in national insurance contributions and the consequent disincentive that this implied.[25]

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[25]We have performed various simulations by using different values of elasticity parameters ($\alpha = 0.7$; $\beta = -0.5$ and $\alpha = 1$; $\beta = -0.7$) : the results are qualitatively very similar to what has been presented in this paper.

5. The Welfare Evaluation of the Tax Benefit Systems

As pointed out in the Introduction, the inclusion of behavioral reactions in the analysis of alternative tax benefits systems allows for a normative comparison based on the computation of individual and social welfare functions.

The model representing the government's problem is the following (it is inspired by the model à la Mirrlees). The government maximizes a social welfare function (BS) under a certain budget constraint PS_0 and under the constraint represented by the utility maximization problem of each household described in Section 3.

The problem of the government can be shown as follows:

$$\mathrm{MAX}_{\mathrm{I}()}\ \mathrm{BS} = \frac{1}{\lambda} \sum_{i=1}^{n} V_i(w_v, m_v, N)^{\lambda}, \tag{6}$$

subject to

(a) $V_i(w_v, m_v, N) = \mathrm{Max}_{c,l} U_i(c, e, N) \quad \text{s.t.} \quad c = m + we - I(N, m + we)$, and

(b) $\sum_{i=1}^{n} I_i(\cdot) = PS_0$,

where n is the number of households in the sample and λ is the indicator of the government's judgment value with respect to the equity of the distribution of incomes between households. The range of possible values of λ is restricted to the set $(-\infty, 1]$ to guarantee the quasi-concavity of the social welfare function; for $\lambda = 1$ we used a utilitarian specification, for $\lambda \to -\infty$ the government is only interested in the welfare of the poorest households (the Rawlsian specification).

This approach is based on the following assumptions:

1. The government does not know the productivity of each household but it knows the distribution of the ROA for the population as a whole. This means that there is asymmetric information and we can treat the model as a principal (the government)—agent (the taxpayers) model. For this reason, constraint (a) is equivalent to an incentive compatibility constraint. The optimal redistribution policy $I(\cdot)$ must be calculated in order to eliminate the incentive of more productive households to mimic less productive households.
2. The "agent monotonicity" (or Spence–Mirrlees) condition is satisfied. The demand for consumption is an increasing function of the ROA rate.
3. Average redistribution must remain unchanged under each redistribution scheme. It means that the value of the exogenous public spending PS_0 in constraint (b) must be the same before and after the reform (it remains the one of the benchmark system: the French system for

French population and UK system for UK population). A frequently used methodology (see, for example, Bourguignon et al. 1997) dealing with this problem is to redistribute as a subsidy/tax proportional to consumption the eventual surplus/deficit. This lump-sum subsidy/tax has an effect on labor supply of individuals that must be taken into account in optimal tax calculation. It is thus necessary to iterate the problem several times in order to find the proportional tax rate that satisfies the aggregate net tax receipt constraint.[26] Given the proportionality of the instruments used, this methodology has the advantage to minimize the second-round redistribution effects due to the subsidy/tax.

Within this theoretical framework, we then evaluated the welfare performance of one tax benefits system with regard to another (keeping a fixed distribution of the ROA rate and fixed socio-demographic population characteristics), by comparing the values of the social welfare function BS generated by each of the two systems under alternative hypothesis on social aversion to inequality (controlled by the parameter γ).

5.1. Results of the Simulations

The results of the "welfare" simulations are shown in Figure 4. The horizontal axis shows the values of γ going from -2 (Rawlsian specification) to 1 (Utilitarian specification). The vertical axis shows the computed value of BS normalized in order to be 1, the social welfare function of the reference tax benefits system. It means that, for example, if we look at the graph corresponding to the French versus UK tax benefits system on the French sample (top-left figure), we observe that the value of the social welfare function (BS) when $\gamma = -1.5$ is BS $= 0.8$ if the system is the UK system and BS $= 1$ if the system is the French system.

The main point of interest is the relation between the value of the parameter γ, the extent of behavioral reactions, and the optimality. We have seen, in Section 2, that the redistribution performance of the French system, without behavior reactions, is higher than that with the UK system. The main result of our social welfare simulations, concerning the progressive introduction of behavioral reactions, is that it does not affect the welfare ranking of the two systems. The important variable is the government aversion to inequality. For values of γ converging to Rawlsian specifications

[26]The iterative mechanism is the following. Denote the consumption level in country a under tax system b as c_a^b. The first step is to increase the country a household's non-labor income m_a^b by a quantity equal to $\pi\ c_a^b$ (with π arbitrarily fixed). We then solve the optimal tax problem taking into account the effect of the subsidy on individual labor supply. If the aggregate net tax receipt is the desired one we stop the routine. On the contrary, we continue iterating the optimal tax problem until finding the π satisfying the initial budget constraint.

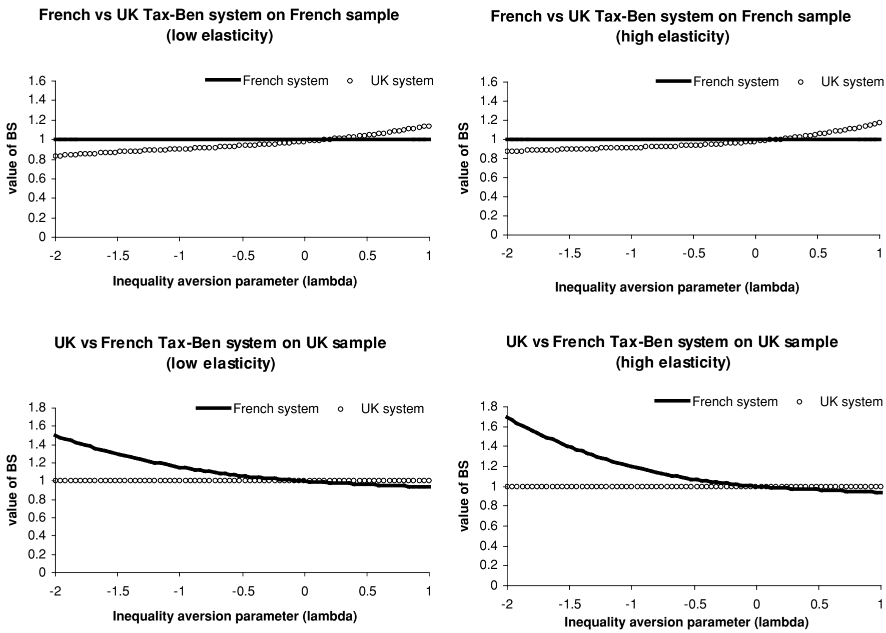

Figure 4: Social welfare functions under different hypothesis on elasticities and social aversion to inequality (λ parameter).

$(\gamma \to -2)$, independently on the hypotheses regarding elasticities, the French system is always preferred to the UK system. For values of γ converging to a utilitarian specification $(\gamma \to 1)$, the order of welfare ranking changes in favor of the UK system. This result is consistent for all the scenarios, regardless of the population used for the comparison of the two tax benefits systems.

We think that the "welfare ranking" observed is an important finding because it allows us, as a first glance, to be able to say something about the social aversion to inequality implicit in the two tax benefits systems. The argument is the following: let us suppose that the government chooses the redistribution system by solving a Mirrlees problem; if we agree, for example, that the French system was the optimal one for the French population (according to the French government's degree of aversion to inequality) in 1995, any other tax benefit systems should be "inferior" to the French system. By applying the methodology proposed, it is possible to identify a range of parameters describing the level of aversion to inequality (values of γ) that allow the French system to be welfare superior. Following this argument, the simulations carried out[27] reveal a higher degree of social aversion to inequality in the French system than in the UK system.

[27] See footnote 26.

6. Robustness Analysis

The welfare analysis performed in the previous section might be interpreted as a first example of the usefulness of behavioral micro simulation as a tool for "normative policy evaluation."[28] It must be recognized that performing an optimal tax calculation à la Mirrlees would imply looking for the best redistribution system among a continuum of alternatives. Our analysis simply shows that, given a social welfare function, an individual utility specification and a set of socio-demographic characteristics, the 1995 French system performed better than the 1995 UK system when the aversion to inequality represented by the social welfare function is high. This result can be considered as optimal if we suppose that the set of alternatives is only composed by the two alternatives analyzed.

It is also important to stress the exploratory nature of the analysis (and then the limited validity of the results) for (at least) two reasons. The first one is that optimal tax literature clearly highlights that optimality results strongly depend on the assumption made about functional forms of the (individual and social) utilities (see Stern 1976). A second possible source of weakness of the results can derive from the statistical property of the subsample used in the simulations, as well as the numerical computations.

Concerning the first problem (functional forms) our results are limited because we have performed all the calculations using only one functional form. Our choice (Cobb–Douglas specification) has been done taking into account four major issues arising when using this approach: (a) the tractability of effort supply and utility function; (b) the transparency of the important parameters; (c) the fulfillment of the Spence–Mirrlees condition; and (d) the inclusion of income effects. The first issue is important in order to avoid the burden of computational aspects concerning both the inversion of the individual optimal problem and the optimal tax computations. With alternative (non-linear) specifications of effort supply, Equation (5) becomes an implicit function of w and must be solved numerically. The second property is important in order to perform sensitivity analysis of predictions or judgments to assumptions concerning the elasticity of consumption demand and effort supply. The third one is a theoretical property that utility function (or effort supply) must satisfy when the framework of the welfare analysis is the Mirrlees one. It ensures that pretax earnings will be an increasing function of w for any relevant income tax function. In terms of functional forms this property requires that the condition $\frac{dc}{dw} > 0$ must hold (c is the optimal consumption). The last property is desirable in order to reduce the lack of generality of the results. Econometric evidence seems to show that the magnitude of income

[28]The revelation of social preferences by looking at the result of the optimal policy is not new in this type of literature. Christiansen and Jansen (1978) for example use a similar approach to reveal social preferences in the Norwegian system of indirect taxation by using an optimal commodity taxation model.

Table 6: Empirical distribution of household gross labor income, gross non-labor income, and family size in the original sub-samples

	French Sample (Annual French Francs)			UK Sample (Weekly Pounds)		
	Household Size	**Household Non-Labor Income**	**Household Labor Income**	**Household Size**	**Household Non-Labor Income**	**Household Labor Income**
Average	2.54383284	53,502.0688	147,529.5548	2.41061674	97.93861	270.186382
Standard deviation	1.38345389	71,782.67119	172,735.6951	1.30386927	189.635033	313.280614
Variance	1.91394465	5,152,751,884	29,837,620,349	1.70007508	35,961.4457	98,144.743
Kurtosis	−0.04126866	35.58104154	17.84879573	0.94507855	65.6932716	6.85347297
Skewness	0.67784232	4.532727719	2.910071082	0.94786324	6.63198956	1.78650167
Range of variation	7	866,937.64	1,969,343	9	2752.70855	2928.9096
Minimum value	1	0	0	1	0	0
Maximum value	8	866,937.64	1,969,343	10	2752.70855	2928.9096
Sum	2530	50,238,442.6	138,530,252	2425	97,938.61	270,186.382
No. of observations	939	939	939	1000	1000	1000

Source: INSEE (France),ONS (UK), own calculations.

Table 7: Bootstrap standard errors and confidence intervals for simulations results

Deciles of Gross Income	**No Reactions**				**Low Elasticities**				**High Elasticities**			
	Average Change in Disposable Income from Base Scenario (%)	**Standard Deviation**	**95% Lower (%)**	**95% Upper (%)**	**Average Change in Disposable Income from Base Scenario (%)**	**Standard Deviation**	**95% Lower (%)**	**95% Upper (%)**	**Average Change in Disposable Income from Base Scenario (%)**	**Standard Deviation**	**95% Lower (%)**	**95% Upper (%)**
					UK System on French Sample							
1	−9	0.002	−8.61	−9.39	−12.54	0.003	−13.03	−12.04	−13.91	0.006	−14.89	−12.92
2	−1	0.002	−0.61	−1.39	−5.59	0.003	−6.08	−5.09	−5.15	0.005	−5.98	−4.33
3	−10	0.001	−9.80	−10.20	−12.38	0.002	−12.70	−12.05	−12.93	0.002	−13.26	−12.60
4	−8	0.001	−7.80	−8.20	−8.44	0.002	−8.76	−8.11	−7.87	0.002	−8.20	−7.54
5	−2	0.001	−1.80	−2.20	−1.91	0.002	−2.24	−1.58	−0.86	0.002	−1.19	−0.53
6	0	0.001	0.20	−0.20	0.39	0.002	0.06	0.72	1.49	0.002	1.16	1.82
7	0	0.001	0.20	−0.20	0.47	0.002	0.14	0.80	1.37	0.002	1.04	1.70
8	2	0.001	2.20	1.80	2.92	0.002	2.59	3.25	4.07	0.002	3.74	4.40
9	2	0.002	2.39	1.61	5.05	0.003	4.56	5.55	6.78	0.003	6.29	7.28
10	4	0.003	4.59	3.41	6.05	0.004	5.39	6.71	7.96	0.006	6.97	8.95
Total	0	0.002	0.39	−0.39	0.50	0.003	0.01	0.99	1.58	0.004	0.92	2.24
					French System on UK Sample							
1	67.00	0.002	67.39	66.61	61.19	0.005	60.37	62.01	71.94	0.004	71.28	72.60
2	38.60	0.002	38.99	38.21	35.78	0.004	35.12	36.44	40.35	0.003	39.86	40.84
3	26.90	0.001	27.10	26.70	10.74	0.002	10.41	11.06	9.01	0.002	8.68	9.34
4	15.40	0.001	15.60	15.20	5.27	0.002	4.94	5.60	3.38	0.002	3.05	3.70
5	1.80	0.001	2.00	1.60	−0.52	0.002	−0.85	−0.19	−2.87	0.002	−3.19	−2.54
6	−0.30	0.001	−0.10	−0.50	2.31	0.002	1.99	2.64	0.95	0.002	0.62	1.28
7	−3.80	0.001	−3.60	−4.00	0.53	0.002	0.21	0.86	−0.98	0.002	−1.31	−0.66
8	−5.40	0.001	−5.20	−5.60	−2.68	0.002	−3.01	−2.36	−4.69	0.002	−5.02	−4.36
9	−9.70	0.002	−9.31	−10.09	−3.43	0.003	−3.93	−2.94	−5.16	0.003	−5.66	−4.67
10	−13.30	0.003	−12.71	−13.89	−10.64	0.004	−11.29	−9.98	−12.96	0.004	−13.61	−12.30
Total	0	0.001	0.20	−0.20	−6.96	0.002	−7.29	−6.64	−9.27	0.002	−9.60	−8.95

Source: INSEE (France),ONS (UK), own calculations.

effects is probably most important than substitution effects (see Blundell and MaCurdy 1999).

In his "Michelin guide," Stern (1986) considers 11 possible parametric specifications of effort supply and/or utility functions assessing the usefulness of choosing a particular specification in a range of theoretical and applied problems. After looking carefully at it, it can be easily shown that Cobb–Douglas specification (of effort supply) is the best fit of the intersection of the four properties previously described. Using a Cobb–Douglas specification is a good "rule of thumb" in applied normative public policy analysis. However, the results must be considered bearing in mind that they strongly depend on this assumption and cannot be directly generalized.

The second major issue about the robustness of the results concerns the statistical representativity of our subsample. In order to test it we have performed a bootstrapping analysis consisting of replicating all the numerical computations on 1000 alternative subsamples generated randomly from the empirical distribution of the original one.[29] The original three-dimensional empirical distribution (the dependent variables are household gross labor income, household gross non-labor income, and household size) is described in Table 6. In Table 7 we have reported the bootstrap standard errors and confidence intervals (at 95%) for the changes in equivalent household disposable income per deciles of gross income. As we can see, from a statistical point view, the results are very robust: the standard deviations are always very small; and the upper and lower band of the confidence intervals (at 95%) is reasonably similar to the computed average changes.

7. Conclusions

The main objective of this work has been to propose a methodology for the evaluation of redistribution policies in a normative way by using micro-simulation techniques. We have also shown how it is possible to recover the distribution of household productivity (ROA) by using theoretical properties of a classical utility maximization problem.

As an example of the use of the methodology proposed, we analyzed the impact on inequality and efficiency of two reforms: the first was the replacement of the 1995 UK tax benefit system with the 1995 French system for a sample of UK households. The second was the replacement of the 1995 French tax benefits system with the 1995 UK system for a sample of French households. All the calculations were performed by means of a micro-simulation model that replicates the laws of the two countries, using a sample of households drawn, respectively, from the 1989 and 1991 household budget surveys by the French (INSEE) and UK (ONS) National Institutes of Statistics.

[29] See Appendix B.

Simulating different scenarios, depending on the values of the elasticities of effort supply with respect to ROA and non-labor income, we observed that welfare analysis results change depending on the value of the elasticities and on the degree of the aversion to inequality of the social welfare function used. In order to test the statistical robustness of the results we have also computed bootstrap standard errors and confidence intervals. We found that the French system was preferred (for both populations) when using Rawlsian specifications of the social welfare functions. On the other hand, the UK system proved better for utilitarian specifications. This seems to reveal a higher implicit aversion to inequality in the 1995 French tax benefits system than in the UK system.

As pointed out in Section 5, the results presented in this paper must be considered as a first attempt to compare alternative real tax benefits systems in a normative framework. The election of a particular functional form or a particular dataset always influences the results. For this reason, when applying micro-simulation techniques for normative analysis, it is important to look at the results having in mind this caveat. There are also others aspects that limit the validity of our results and which pave the way for future research. From a theoretical point of view, the model used is very simple because (a) the dynamic aspects of redistribution are not taken into account; (b) the multidimensionality of redistribution issues is not considered (in our model the government only redistributes income; nothing is said about family size or other issues that are important in policy design); and (c) the optimal tax model do not take into account factors related to tax collection technology (as tax evasion or administration constraints) that can be important when international comparisons are the object of the analysis. From an empirical point of view, the main limitation is the fact that the model does not contemplate certain types of tax or benefits (because of lack of data).

Bearing in mind the exploratory nature of this paper, the main conclusion that we reach is that the use of an integrated behavioral micro-simulation model (within a theoretical framework such as optimal taxation) allows us to analyze fiscal reforms of different countries in a comparative way and to measure the extent of their similarities in social policies. It also allows for different states' policies to be simulated in other countries and thus helps to draw on the more beneficial practices of other countries. This approach (and future extensions) will, therefore, enable us to focus on the differences and the impacts of alternative tax benefits systems in different countries in a very detailed way. This type of analysis can help, for example, to determine what needs to be done in order to achieve common social and economic policy objectives.

Appendix A: Computational Aspects of the Simulations

The algorithm of utility maximization of each household in the micro-simulation model, considers the set of the effort supply choices as a discrete one. Given a household productivity w and a non-labor income m, for each level of effort, the model computes the associate gross labor income $y = we$, the correspondent net taxes $I(y + m, N)$, the correspondent disposable income $YD = y - I(\cdot)$ and the correspondent indirect utility function (Equation 4). The model compares all the alternatives retaining the effort supply associated to the higher indirect utility.

This approach allows, obviously, to wide as much as we want the set of labor supply choices. A good rule of thumb is to fix 30 effort supply alternatives. This discrete approach is employed frequently in labor supply and consumption micro-econometric studies (see, for example, Bourguignon 1986). This way of modeling allows to easily introduce fixed costs of entry on the labor market. Our model, anyway, does not consider this type of costs.

Appendix B: The Bootstrap Principle [based on Bradley and Tibshirani (1993)]

The problem solved by bootstrapping can be formulated as follows. We have a random sample $X = (x_1, \ldots, x_n)$, obtained from an unknown probability distribution A and we want to estimate a parameter (e.g., the average change in labor supply) $\theta = t(A)$ on the basis of X. We calculate an estimation of $\hat{\theta} = s(X)$ using X; then the problem is to know how accurate this estimate is.

Bootstrapping technique is based on resampling with replacement. Each bootstrap sample X^* is an independent random sample of size n from the empirical distribution followed by X (that we call Â). To each bootstrap sample it corresponds a bootstrap estimation of $\hat{\theta} : \hat{\theta}^* = s(X^*)$ that is the results of applying to X^* the same function $s(\cdot)$ that has been applied to X. The bootstrap algorithm for estimating the standard error and the confidence intervals can be summarized by the following four steps:

(1) Select B independent bootstrap samples $X_1^*, X_2^*, \ldots, X_B^*$ each consisting of n data values drawn with replacement from X (a good rule of thumb is $B = 1000$).

(2) Evaluate the bootstrap replication corresponding to each bootstrap sample $\hat{\theta}^*(b) = s(X_b^*)$ with $b = 1, 2, \ldots, B$.

(3) Estimate the standard error using the formula

$$s\hat{e}_B = \left\{ \sum_{b=1}^{B} \left[\hat{\theta}^*(b) - \sum_{b=1}^{B} \hat{\theta}^*(b)/B \right]^2 \Bigg/ (B-1) \right\}^{1/2}.$$

(4) And the confidence intervals as $[\hat{\theta} - z^{(1-\alpha)} s\hat{e}_B; \hat{\theta} + z^{(\alpha)} s\hat{e}_B]$ where z^{α} is the αth percentile of the standardized normal distribution.

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