# EUROMOD

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# INTEGRATING OUTPUT IN EUROMOD: AN ASSESSMENT OF THE SENSITIVITY OF MULTI-COUNTRY MICROSIMULATION RESULTS

Cathal O'Donoghue, Holly Sutherland
and Francesca Utili

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# Integrating Output in EUROMOD: An Assessment of the Sensitivity of Multi-Country Microsimulation Results[1]

Cathal O'Donoghue*, Holly Sutherland* and Francesca Utili**

* University of Cambridge; ** University of Rome, "Tor Vergata"

**Abstract**

EUROMOD is a 15-country tax-benefit microsimulation model based on national household micro-data. It is designed to estimate the revenue and distributional effects of national or EU-wide changes in social and fiscal policy. In order to provide European results, and for results at the national level to be comparable, it is necessary to make adjustments to the input micro-data and to adopt assumptions about the relative value of incomes across countries. This paper explores the sensitivity of model results to the choice of these adjustments and assumptions. It focuses particularly on the effects of the treatment of survey non-response and income under-reporting, and on the choice of exchange rates and equivalence scales.

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## 1. Introduction

As European countries integrate their economies more closely, there is a greater interest in comparisons of the operation of policies in different countries, in developing common objectives for national policy and in considering implementing complementary public policies. While microsimulation models are potentially valuable tools for the design and evaluation of policy, to date no Europe-wide model has been available. National tax-benefit microsimulation models have existed for many years to examine country specific issues (for surveys see Merz, 1991 and Sutherland, 1995), but cross country comparisons have been difficult for reasons of lack of comparability between the available datasets and assumptions built into the existing models (Callan and Sutherland, 1997).

The EUROMOD project is building an integrated tax-benefit model covering all 15 European Union countries, focused on social and integration policies and their implications for the economic resources of people who are at risk of social exclusion. The model is designed to examine:

- the impact of national policies within a consistent comparative framework;
- the differential impact of coordinated European policy on individual Member States;
- a Europe-wide perspective on social and economic integration policies that are implemented at national or regional level.[2]

The project is extending an established method in two respects. First, it seeks to overcome differences in modelling assumptions so that comparable analyses can be carried out at the national level. The second task is to be able to conduct policy analyses at the multi-country or European level. This requires the integration of national datasets to form a multi-country database and the integration of outputs so that European results can be obtained.

The main output from a tax-benefit model is a measure of disposable income at the household level. This is computed by making use of the information from a micro-database on the characteristics and pre-tax and transfer incomes of members of the household to simulate the elements of the tax and transfer system for each household. The output income measure is a combination of elements recorded in the database (such as earnings) and elements calculated by the model (such as child benefit or income tax). Changes in policy may be specified by the user of the model, and disposable incomes are re-calculated. Thus for each individual household we have a measure of change in income following the policy change. Once weighted up to the population level and aggregated, these changes can be translated into the national revenue cost of the change. Changes for all households in a representative sample can be analysed by any variables in the database. Typically, we are interested in the impact of policy across the income distribution. So measures of income by which to rank households are required.

Integration of model calculations and outputs involves two things. First, it requires that the income *change* variable is calculated in a comparable manner across countries. This means not only that the income concept should be as consistent as possible but also that the data on which the tax-benefit calculations rely should be comparable. Secondly, the variables that are

[2] For more information, see the report on the EUROMOD Preparatory Project (Sutherland, 1997).

used to *classify* the changes in income need to be comparable. We may group households by many criteria that are of interest in relation to public policy - such as housing tenure, household composition or the employment status of household members - and these criteria should be standardised or harmonised across countries if the cross-country results are to be meaningful. Grouping households by income level is a common output from a tax-benefit model and is necessary if we are to explore the impact of national or co-ordinated policy on the European income distribution. We therefore need a common measure of income across countries. It is this topic that forms the main focus of this paper.

In many respects the income comparability issues that face EUROMOD are the same as those that face comparative studies of income distribution.[3] However, the solutions to problems may not always be the same because of the requirement of tax-benefit microsimulation models to measure income *change* as well as income *level*. Adjustments that improve the characteristics of the default income distribution in comparison with external standards may actually worsen the performance of the simulation model and the precision of estimates of income change (Sutherland, 1991). This paper draws heavily on the literature on comparability of income statistics across countries. It also attempts to highlight the issues that are of particular concern for policy simulation, and to suggest approaches that are appropriate for that task.

Section 2 outlines the main adjustments that may be necessary to improve comparability of output income measures from EUROMOD. Section 3 explains how the numerical illustrations of the effects of various adjustments have been calculated. Sections 4 to 10 examine each type of adjustment in detail. Section 11 summarises the results and the final section concludes with an agenda for further work.

## 2. Adjusting inputs and integrating outputs

There are a number of adjustments which may be necessary to achieve greater comparability.

- To ensure that national datasets are equally representative of their national household populations, the most serious non-response biases are corrected using ***re-weighting***.
- Incomes from different datasets may cover different time periods such as week, month or year. Adjustment to a ***common accounting period*** may be a trivial exercise, or may need to take account of changes that take place within the accounting period (such as changes in employment status).
- Item non-response or under-reporting of incomes may require ***adjustment to the income base***.
- The original datasets were collected at different times. For comparative purposes the data must be adjusted to ***a common point in time***.
- A common currency unit is needed, so ***exchange rates*** must be chosen. Even when a common currency exists, we may wish to adopt exchange rates in EUROMOD that capture price differences (or other aspects affecting welfare) across countries.
- Adjustments to account for the effect of ***non-cash income*** on the ranking of households may be needed if the prevalence and nature of free or subsidised services or the importance

[3] See Atkinson, Rainwater and Smeeding (1995), Smeeding and Weinberg (1998), Harris (1998a).

of owner occupation varies across countries.
- Comparisons of the incomes of households of different types needs account to be taken of economies of scale and differences in household size and composition: ***an equivalence scale*** must be chosen.[4]

In considering the need for each adjustment, we need to be aware of overlaps in their effect: the order of the adjustments is important. Here, we consider the adjustments in the order that seems logical. However it is clear that a different order may be preferred if we have a concern for the comparability of a particular income source. Furthermore, we may have available independent control information that is comparable with some other ordering.

Some of these adjustments are likely to be necessary and common for all analyses using EUROMOD. For example, we are always likely to want to adjust for non-response bias in the original data source. However, other adjustments depend on the application of the model and on the interpretation we wish to put on the results. Choice of exchange rates, point-in-time adjustments, equivalence scales and treatment of non-cash income all come into this category. EUROMOD will offer the user choices in these adjustments and indeed, it is expected that applications of the model will include examining the effect of changes in assumptions about between-country differences, as well as changes in policy.

## 3. Method

Illustrations of the effect of the various assumptions are provided by applying them to the output from a prototype model, Eur6. This is based on microdata from six countries: Belgium, France, Germany, Ireland, Italy and the UK. Sub-samples of approximately 1,000 households have been drawn from each original survey.[5] In each of the six countries the following tax-benefit instruments are simulated in Eur6:
- social insurance contributions on wages (paid by employers or employees), on self-employment income and on other incomes;
- income tax and other taxes on labour incomes;
- family benefits: child benefits, housing benefits, out-of-work and in-work means-tested (social assistance) benefits.

Household disposable income is made up of these elements that are simulated for the 1994 financial year, plus employee and self-employment earnings, investment and other capital income, occupational and public pensions, unemployment benefits and other non means

[4] This list is intended as a guide to the multiplicative or additive adjustments that may be made to simulated income. It is not a comprehensive list of all the aspects that must be considered in making national model outputs comparable and capable of being aggregated. Two additional factors, which are not addressed, stand out: the unit of analysis over which income is aggregated, and the cash income definition itself. See Callan and Sutherland (1997) and Sutherland (1997) for a general discussion of these issues.

[5] The *Panel Study of Belgian Households* (1994), the French *Enquête sur le Budget des Familles* (1989), the *German Socio-Economic Panel* (1995), the Irish *Survey on Income Distribution, Poverty and the Usage of State Services* (1987), the Italian *Survey of Household Income and Wealth* (1993) and the UK *Family Expenditure Survey* (1991). These sub-samples, although no replacement for the full samples, appear to be adequate for the purposes of the illustrations presented here. After standard grossing up procedures, we find that mean disposable incomes, taxes and benefits fit satisfactorily well with what is observed in the original full samples. For more information see Bourguignon et al (1998), O'Donoghue (1998) and Evans and O'Donoghue (1998).

tested benefits taken from the database and updated to 1994.

Table 1 is an example of output from a "default" run of the prototype model, in which no policy change is simulated. It shows the country composition of each decile of the six-country "European" income distribution under prevailing policy in 1994. It also shows the mean of incomes in each decile using the same income measure that is used for ranking. This is the situation using the minimum and simplest integration methods. In the ranking of households the following applies:

- No differential weights are applied to adjust for sample bias: uniform weights are used to bring the national sub-samples up to national population levels.
- All incomes are assumed to apply to the whole of the year 1994.
- No allowance is made for under-reporting of incomes or differences in coverage in the national income bases.
- All incomes are updated to 1994, but otherwise no adjustment is made for different timing.
- Household disposable incomes in each country are converted to Ecu using the average market exchange rates for 1994.
- No adjustment is made for non-cash incomes.
- Household incomes are arbitrarily equivalised using the square root of household size.[6] Households are counted once (not weighted by the number of individuals).

Table 1 shows that households in Ireland, the UK and Italy tend to be disproportionately concentrated at the bottom of the Eur6 income distribution, while Belgian, German and French households tend to be concentrated at the top.[7] The following seven sections examine the possible effects of adjustments on the country composition of the "European" distribution. In cases where suitable external information is readily available, we illustrate the effects by re-calculating the distributions shown in Table 1. The country composition is not the only dimension in which we believe the European distribution of income will be affected by alternative adjustment and integration factors. However, our choice of characterising model output in this way is in part due to the novel nature of these statistics. The relative position of countries is likely to be a high-profile aspect of EUROMOD output, so it is important to understand the sensitivity of these results to the assumptions that may be used.

## 4. Non-response bias

As the datasets used in our comparison are all based on voluntary sample surveys, the characteristics of the samples may not be representative of the household populations in each of the countries. For example in the UK it is thought that there is an over-representation of households with children and an under representation of single person households in the Family Expenditure Survey (Kelmsley, Redpath and Holmes, 1980). To correct for this, grossing-up weights are usually applied. Thus households types which are under-represented will have higher weights.

[6] So if a one-person household has an income of 100 Ecu they are assumed to be at the same point in the income distribution as a four-person household with an income of 200 Ecu.

[7] It is important to emphasise that the output from Eur6 is based on small sub-samples designed to be used for illustrative exercises. The results shown should not be treated as final estimates of the national or 6-country income distributions.

Table 2 shows, in the same format as Table 1, the effect of using weights to adjust for non-response in the Eur6 datasets. Here we can see that the impact is generally quite small at the extremes. In the centre of the distributions, Belgian and German households tend to move up the distribution, while UK and Irish households move down. Italian households tend to move from the centre to the extremes, whilst French households gradually shift upwards.

A potential source of lack of comparability arises from the type of non-response bias weights used. The UK data in Eur6, taken from the Family Expenditure Survey (FES), are grossed up to account for differential non-response by family type and age. However, there is also evidence to show that non-response to the FES is more likely among households recorded as belonging to ethnic minorities, and among those living in older local authority housing and young people sharing accommodation (Harris, 1998b). Thus the weights that are used do not directly correct for all aspects of differential response. They may - in an indirect fashion - either improve or worsen the representation of groups not controlled for. Thus in general there is no guarantee that all non-response bias has been dealt with, nor that the weights that have been used have not introduced new biases. Similar problems are likely to apply to the weights used to gross-up the datasets for other countries and we cannot be sure that the extent of the adjustments is comparable across countries.

An issue that is related to the question of non-response bias is the coverage of the household population in the survey dataset. Household surveys only cover people who live in households and ignore people living in institutions such as the elderly, students, the military and the homeless. Little is known about the economic circumstances of these groups in European countries or their differential importance across countries.[8] However, it is clear that EUROMOD should not attempt to include them in its frame of reference. It would be misleading to base the characteristics of the non-household population on the characteristics of people living in households. Furthermore, the social policy that EUROMOD aims to simulate is likely to apply in a very different way to those living in institutions. However, reconciliation of EUROMOD output with other sources should take account of the fact that part of the population is not represented in its database.

## 5. Accounting period adjustment

The accounting period adopted in the datasets can also be a source of comparability problems. In general, the longer the accounting period used, the lower the level of income inequality. Income measured over a year will smooth the weekly or monthly variations that these shorter accounting periods will capture. Three different accounting periods are used by the surveys that make up the Eur6 database. In Belgium, Germany and Italy respondents are asked about annual income (income received over a year in the past). In France most of the income questions refer to a month. In Ireland and the UK questions relating to some elements of income may refer to a period as short as a week.

Clearly, a minimum necessary adjustment is to bring all the income measures to the same

[8] Evans (1995) considers the size of these groups in the UK and France.

period in arithmetic terms. (Eur6 uses annual income.) These trivial transformations are all that is necessary in the case of people with no change in circumstance over the year. However, further adjustment to account for differences in the reference period of the data might be considered for people whose circumstances do change within the year. Since it is difficult to envisage the form of a single adjustment factor for this purpose, a more fruitful approach is to either attempt imputation of an annual income base from shorter periods or to impute a monthly or weekly base from information on a year.

## 6. Income under-reporting adjustment

Surveys may underestimate aggregate household income, even once survey non-response has been accounted for. If the degree of underestimation differs across countries then it will bias any inferences made about the relative position of households in the different countries. External sources of information about household sector income are needed with which to validate the EUROMOD database. Clearly a major requirement is that these external sources are themselves comparable across countries. National accounts household income is a potential source for comparison. Aggregate household disposable income in the Eur6 database is shown in Table 3 as a percentage of national accounts household disposable income.[9] Although low, the ratios are similar to those found in other studies. What is noticeable is the difference between the UK with over 80 per cent of national accounts disposable income and the continental countries with around 60-70 per cent.[10] Clearly if national accounts data represents the true level of national household income then, without adjustment, UK households will tend to be higher up the European income distribution than if adjustments are made.

Table 4 shows the impact on the Eur6 income distribution of using a simple multiplicative adjustment such that the aggregate income in each country matches that given by the national accounts figures in Table 3. The effect of this adjustment is to shift up the distribution the countries which have the biggest proportional shortfall between survey disposable income and national accounts. The UK, with the highest ratio of survey income to national accounts shifts down the most, while Belgium shifts up the most.

Although this simple adjustment will maintain existing national distributional characteristics, it also assumes that all incomes are under-estimated to the same extent. This is most unlikely since, for example, a person reporting receipt of the maximum amount of a social assistance benefit cannot be *under*-reporting this income. Applying a uniform adjustment factor to all incomes will result in an *over*-estimation of incomes for households in receipt of such benefits. Studies described in Atkinson, Rainwater and Smeeding (1995) indicate that the degree of under-reporting varies by income source and that it is self-employment and investment income that tend to be particularly under-represented in survey data. The implications for cross-country comparisons may be serious even if the degree of under-

[9] The national accounts figures are calculated from total national accounts household income less employer pension contributions, imputed rent, non government current transfers and direct taxes taken from the OECD national accounts (OECD, 1997).

[10] Interestingly, the UK Family Expenditure Survey has a lower overall response rate than is typical for income surveys in other countries (Harris, 1998a). This suggests that response rate itself is not necessarily a good indicator of general data quality or representativeness.

reporting of self-employment income is comparable, since the incidence of this source of income and the prevalence of self-employment itself varies across countries.

Lack of comparability between national accounts aggregates and the concepts that can be readily measured using household micro-data poses significant problems for the use of national accounts to validate or adjust the income base in the model. For example national accounts may include income from non-profit organisations in the personal sector accounts (Atkinson Rainwater and Smeeding, 1995). They include income from the non-household population, which is naturally not captured by household surveys. Furthermore, the reliability of some of the components of income in the household sector accounts - particularly self-employment income and investment income - is not thought to be good. For example, total interest payments may be known from institutional sources, but the share received by the household sector may in effect be determined by rules of thumb (see the discussion of Van der Laan, 1998). Thus we cannot regard national accounts information as necessarily being the "true" level of income to which the survey base should be adjusted.

Two further aspects deserve attention. First, the extent of under-reporting may vary by household type. There may be reasons why certain types of individual under-report income. A simple multiplicative factor will not capture these. Secondly, multiplicative adjustments do not deal with the fact that there may be zero-reporting of certain income types (when, in fact, some amount of income is received). An attractive solution is to re-weight households to account for differences between the numbers of income recipients in the survey and those who actually exist in the population. Typically, this information is available for benefit incomes from administrative statistics. However, adopting this approach in EUROMOD would need to be part of a general strategy for re-weighting that took account of the limited number of dimensions of adjustment that can usefully be accomplished simultaneously using grossing-up. EUROMOD has to depend on relatively small samples from survey sources and a large number of simultaneous adjustments would lead to some observations having very high weights. Model results would then be overly sensitive to simulations which affect these few households.

## 7. Common point-in-time adjustment

It is clear that EUROMOD will update the national datasets to a common point in time. This procedure will introduce a degree of error since typically only aggregate indices of income change are available and structural shifts in population characteristics and changes in the distribution of incomes are ignored. However, there is no reason to believe that updating procedures *necessarily* damage the degree of comparability across countries.

Even if data are collected for a common time, differences in living standards may be partly due to the fact that all countries are not necessarily in the same phase of the economic cycle. For example, there may be more or less unemployment or payment of bonuses. Figure 1 shows the growth rate of total household income (income before taxes and contributions) in the period 1984-1994 in Italy and the UK. Although in general at similar growth levels, the peaks and troughs of the business cycle do not coincide in the two countries, with Italy appearing to operate with a time lag. In terms of total income, Italians would therefore appear

to be poorer relative to the British if the countries were compared in 1990 than if they were compared during the following few years because of higher growth rates in Italy; and yet relatively richer than in the previous years because of higher growth rates in the UK during that period.

Furthermore, if the degree of national income inequality is itself related to national economic cycles, we would expect mis-matches in points in the cycle across countries to have additional effects on the country composition of the European distribution, due to differences in within-country inequality, as well as those due to differences in mean incomes.

## 8. Exchange rate adjustment

Using nominal exchange rates to convert national components of EUROMOD output to a common currency does not account for different prices of goods and services in different countries. If goods cost relatively more in one country than in another, then its inhabitants will seem to be better off in money terms than they are in terms of actual living standards.

Studies which have compared living standards across countries such as Atkinson (1996) and Hagenaars, De Vos and Zaidi (1994) have used purchasing power parity (PPP) exchange rates. Eurostat estimate PPPs for each of 29 consumption groups as well as for investment, government consumption, and trade (Eurostat, 1996). These are then aggregated using national expenditure weights to produce an average PPP measure for the whole country.

Table 5 shows that the ratio of PPP exchange rates to nominal exchange rates varies widely across the six countries considered. Belgium, France and Germany all have PPP exchange rates higher than their nominal exchange rates, whereas the other three countries have PPP exchange rates that are lower. The difference between the highest ratio and the lowest ratio is large: Italians who appear to have the same incomes as Germans on a nominal rate basis, would be 30 per cent better off using PPP rates.

Table 6 describes the Eur6 income distribution using purchasing power parity exchange rates rather than market exchange rates to convert national currencies into Ecu. Germany, France and Belgium tend to shift down the distribution relative to the others due to having PPP rates that are higher than market rates. Germany has the biggest positive differential and therefore moves down most, whereas Italy has biggest negative differential and moves up most.

However, PPP exchange rates based on the whole economy are not necessarily appropriate for comparing household sector incomes. Purchasing power parities based on household sector consumption weights may be more appropriate (Brungger, 1996). Furthermore, even within the household sector, consumption patterns can vary systematically with income. Poorer households tend to spend a larger share of their budgets on food and energy than richer households. In principle, the derivation of appropriate exchange rates depends on the interpretation we wish to place on the model results. At one extreme, the *revenue* effect on national budgets of a policy change needs to be expressed in terms of unadjusted national currency (or the Euro, using market exchange rates where necessary). At another extreme, when making welfare comparisons between households in different circumstances, we may

wish to take account of price and consumption differences by income group, or by other characteristics such as region within countries. In this case we can construct national exchange rates based on a weighted average for the various groups or we can apply a variety of exchange rates *within* a country, depending on each household's particular circumstance. In this latter case, the "exchange rate" would begin to take on a similar role to the equivalence scale, which is the subject of the next section.

## 9. Equivalence scales

As with the choice of exchange rate, the choice of equivalence scale depends on the interpretation we wish to place on the model results. In our analysis so far we have made use of a simple but arbitrary scale which adjusts household incomes by the square root of household size. A commonly-used alternative is the OECD scale which distinguishes between children and additional adults.[11] The purpose of such scales is to allow the incomes of households of different sizes and composition to be compared. They can be placed within a general framework which provides a parametric approximation of equivalence scales (ES), based on a suggestion in Buhmann et al. (1988):

$$ES = S^e$$

where S is household size and e represents the equivalence elasticity and can take values between 0 and 1. The larger the value of e, the smaller the assumed economies of scale. Thus a value of e = 1, implies that there are no economies of scale and is the same as measuring income per capita. The extreme value of e = 0 ignores the size of the household and is equivalent to measuring income per household. When simply concerned with the aggregate revenue effect of a policy change, we typically use e = 0, or alternatively e = 1, but with each household weighted by the number of people in it.

Table 7 reports the mean equivalised disposable income (and also the rank) for each of the six countries using four values of e: 0.5 (the scale used in Tables 1, 2, 4 and 6); the OECD scale (approximately 0.7); 0 (per household); and 1 (per capita) with each household weighted by its size. The table also shows the mean household size for the samples for each country. The ranking of the countries can vary quite significantly with the choice of equivalence scale. For example, Germany with a low average household size moves from being ranked number 6 for unadjusted household income to 2 using the OECD scale. Ireland, with the highest average household size moves in the opposite direction from rank 3 in terms of unadjusted household income to rank 6 when using the OECD scale. The ratio of average equivalent income with the lowest assumed economies of scale to that with the highest assumed economies of scale is greatest for countries with the smallest average household size. Weighting by the number of people, rather than the number of households, increases the relative importance of large households. The effect on mean income depends on the position of large households in the income distribution.

The country composition of the Eur6 income distribution using per capita income weighted

[11] The OECD scale gives weight of 1 to the household head, 0.5 to each child (aged under 14) and 0.7 to other people in the household.

by the number of people is shown in Table 8 and can be compared with the effect of our previously defined e=0.5 (each household counting once) in Table 6. The principal effect is to move countries with the most large households - Ireland and Italy - down the distribution. Not only does the per capita scale take no account of economies of scale within these households, but they also appear more frequently in the distribution.[12] The proportion of German households in the bottom Eur6 decile falls from 29 per cent in Table 6 (using the square root scale) to 10 per cent in Table 8. In the same comparison, the proportion of Italians more than doubles. However, it is interesting to note that while the composition of the top half of the Eur6 distribution is affected to some extent, the effect is much less dramatic. For example, the proportion of German households in the top 30 per cent increases from 28 to 29 per cent and the proportion of Italian households in the same group falls from 22 to 20 per cent, comparing the assumptions used in Tables 6 and 8. Among the better off, household sizes vary less both across country and within country.

We have applied the same equivalence scale in each country. It is quite possible that the appropriate scale is in fact different across countries. We can view the choice of equivalence scale to be quite analogous to the choice of exchange rate (see Section 8). Indeed, when we consider exchange rates that vary within countries together with equivalence scales that vary between countries, we can see that they have a common purpose within the EUROMOD framework.

## 10. Non-cash incomes

Non-cash benefits can have an important role to play in redistribution within countries and if the size of these benefits is different across countries then comparing relative living standards will not be the same as comparing relative cash incomes. Two households in similar circumstances, where one has access to free health care and the other does not, may have very different living standards. A similar problem arises in comparing the incomes of households whose rents are subsidised with those who receive cash housing benefits (Gardiner et al, 1995). Table 9 shows the proportion of non-cash to total (cash plus non-cash) social expenditures is in fact quite stable for the six countries that we consider, varying from 40 per cent in Belgium and Italy to 43 per cent in West Germany and Ireland. Thus we would not expect the ranking of countries by mean incomes to change much, if non-cash benefits were incorporated. However, Smeeding et al. (1993) in studying the incidence of non-cash social expenditures (health, education and housing) in seven countries found that the amount of redistribution accomplished through these welfare services was different across countries. Inclusion of non-cash income does potentially have implications for the composition of countries in the EUROMOD income distribution as well as the ranking of households in within-country distributions.

As well as social expenditures, other sources of non-cash income may be considered when ranking households by income. For example, the value of owner occupation and own production both have a significant impact on income distributions in some countries in the EU. However, it is not straightforward to extend the definition of income to include non-cash

[12] This is apparent when comparing the share of total Eur6 population in Tables 6 and 8: for example, Irish households make up 1.1 per cent of all households, but Irish individuals comprise 1.6 per cent of all individuals.

elements. On the one hand, valuation may be problematic. On the other hand, information about the incidence of income in kind is typically not available in micro-data sources. In either case, the impact on the income distribution may be very sensitive to the assumptions used in any imputation.

**11. How sensitive are the results?**

Choices made in the selection of adjustment factors can influence both relative mean incomes across countries and the distribution of income within countries. The interaction of these two effects determines the impact on the country composition of households in the European distribution.

The effect of adjustment factors which mainly affect relative mean incomes is generally transparent: if the mean income of a country shifts relative to the means of other countries, then all households from that country will shift within the Eur6 income distribution in a corresponding manner. For example, the biggest impacts on the country composition in our illustrations arise from the income under-reporting adjustment and the purchasing power parity adjustments to exchange rates. These two adjustments, as implemented in the examples, work in opposite directions. Comparison of Tables 2 and 4 shows that countries with the greatest shortfall in national accounts income shift up the most when the adjustment factor is applied (Belgium, France and Germany). Households from these same countries shift down the distribution with the use of (higher) PPP exchange rates which reduce the relative value of their incomes (compare Table 4 with Table 6). Ireland, Italy and the UK, with lowered average exchange rates, move up the distribution. Comparison of Table 6 with Table 2, before either adjustment, shows that the combination has little overall effect on the position of Belgian and Irish households in the distribution. It shifts German households down the distribution, and to a lesser extent does the same to UK households. The opposite happens to French households, and more dramatically to Italian households, who are shifted up the distribution.

It is of particular interest to examine in more detail the effects of those shifts on the bottom of the distribution. Figure 2a, taking as a baseline the choice of adjustment factors used in Table 2, shows the country composition of the lowest European decile relative to the average. The numbers on the diagram represent the percentage of units (households or individuals) in each country in the lowest Eur6 decile. A value of 10 in each country (indicated by the grey hexagon) represents the hypothetical situation of perfect cross-country equality where each Eur6 decile contains 10 per cent of the inhabitants of each country. For example, using the baseline (solid line), over 20 per cent of Irish households are in the bottom decile, compared with Belgium at the other extreme which has less than 5 per cent of its households in this low income group.

The dotted line in Figure 2a shows the composition of the bottom decile using the National Accounts income under-reporting adjustment (Table 4). As expected, this adjustment increases the proportion of the populations of UK and Ireland in the bottom decile, while the proportions of Italians, French and Germans are reduced. The cumulative effect of adding the PPP exchange rate adjustment is shown in Figure 2b. The effects of the National Accounts

adjustment (solid line) are substantially smoothed, if not reversed, when adjustment for purchasing power is added (dotted line).

Adjustment factors which mainly influence the within-country income distributions have a less predictable effect. They will not necessarily have a noticeable impact on the country composition *per se*, although they may alter the composition significantly in other respects. For example, the choice of differential non-response bias weights, has the smallest impact on the country composition of the Eur6 distribution (compare Table 1 and Table 2). However, equivalence scales can have a major effect on both the within- and between-country distributions. In the example we have focused on, the use of per capita income (weighted by persons) concentrates large households at the bottom of the Eur6 distribution, compared with a scale that assumes some economies of scale. On the other hand, countries with small average household sizes make up a lower proportion of the aggregate population when household incomes are weighted by the number of people. The combined effect is to alter substantially the composition of the bottom of the Eur6 distribution, leaving the top less affected. The changes are largest for those countries where the average household size differs most from the Eur6 average. Figure 2c illustrates the cumulative effect on the bottom decile of using per capita income and weighting by the number of people (dotted line), compared with simply using the adjustment shown in Figure 2b and Table 6 (solid line). It shows strong movements in the opposite directions for Ireland and Italy on the one hand and Germany on the other. The change in the UK is smaller, and is negligible in France and Belgium.

Interestingly, the cumulative effect of the three adjustments (dotted line in Figure 2c) produces a picture of the bottom Eur6 decile that is most similar to the baseline case (solid line in Figure 2a). However, although the proportions of households that end up in the bottom Eur6 decile are similar to those at the starting point, it should be clear that they are not necessarily the *same* households using the two sets of assumptions.

## 12. Concluding comments

All of our results and much of our discussion has been in terms of the impact of assumptions on the way households are ranked to form the existing "European" distribution. Also of concern is the measure of income that is used to determine "gain" or "loss" following a policy change, and these final comments focus on some of the issues that are involved.

*Data quality*

It is particularly important for policy simulation that the underlying data on income by source provide a good representation of reality in combination with the other characteristics necessary to simulate tax-benefit rules. The main problem associated with validating survey data in this respect is the lack of independent information that is comparable. Outside Nordic countries, where register data provide a rich source of control information, there is certainly very little multi-dimensional information (such as self-employment income by marital status) that is not itself drawn from survey sources.

A particular problem arises for policy simulation if survey incomes are adjusted to national accounts levels on an aggregate basis. In EUROMOD we discard the recorded amounts of

elements of the tax benefit system that we simulate. Thus, for example, social assistance payments will not be adjusted by the aggregate adjustment factor, but will be simulated using the appropriate adjusted income base (earnings, social insurance benefits and so on). The larger the income base, the smaller will be simulated entitlements to social assistance. Thus the more we correct for general under-reporting, the more we *reduce* our estimates of aggregate social assistance. The implications for this are two-fold. First, aggregate income adjustment may be inadvisable. Secondly, the strategy for adjustment that is adopted should be assessed in terms of its effect on the *simulated* components of income, as well as those drawn directly from the original dataset.

There is some scope for moving beyond the use of national accounts data for external comparison in countries where administrative micro-data (eg. tax record data) or published tables (eg. counts of benefit recipients) are available in a suitable form. In these cases, validation and adjustment are essentially national processes since the comparability of administrative statistics across countries raises quite different questions than the comparability of survey data.

It is likely that EUROMOD will rely on a strategy of making under-reporting adjustments to particular income sources, combined with re-weighting to correct for non-response by recipients of certain sources of income. Comparability of aggregate income estimates as well as distributional information will remain an issue, and the solutions that are adopted will draw on work being done by the Canberra Group (see Harris, 1998a) and others. However, it is clear that adjustments to the income base and representativeness of survey data should be considered within a perspective that is cautious about our ability to unambiguously improve the quality of the original data.

*Sensitivity in other dimensions*

We have illustrated the effect of alternative adjustments and integration assumptions on the country composition of decile groups in the "European" income distribution. Our choice of characterising model output in terms of country composition is in part due to the novel nature of these statistics. It is also the case that the country composition will underlie all the European results, since existing national policy will be the starting point for all the simulations. However, when we simulate the effects of policy changes, we will find that other dimensions of composition will also be important. For example, the location of children, pensioners or the unemployed in the national distributions will influence the impact on the income distribution of reforms targeted on these groups. We would expect the adjustments we have considered which affect the within-country distributions to affect the location of these groups in the national distributions. Once we mix the national distributions in the European distribution, the location of the groups for each country will influence the distributional effect of policy changes considered at the European level. Thus a direction for further development will be a sensitivity analysis of the composition of the European distribution by characteristics of households that are of interest from a policy point of view.

*Interpretation of results*

In an effort to apply various definitions of income equivalence across countries we have explored the effect of exchange rates and equivalence scales on the ranking of households

from different countries. Whether the same adjustments should be applied to the measure of income change depends on the interpretation we wish to place of the results of the model. In evaluating the relative changes in *welfare* across countries, consideration needs to be given to the appropriate adjustments to cash income change. An example of the problem that the EUROMOD user faces, is how to compare a loss of £1 by a single pensioner living in local authority accommodation in London, with a loss of 10,000 Lire by a couple with two children living and working on a farm in southern Italy. The intention is to offer a wide range of choice in these matters and to provide an assessment of the sensitivity of results to the choices that are made. This paper represents a first step in that process.

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**Table 1 Country composition of households in each decile of Eur6 disposable income**

Uniform national weights
No income base adjustment
Market exchange rate
Equivalence scale: square root of household size
Households counted once

| Decile | Mean income (Ecu /year)[1] | Belgium | France | Germany | Ireland | Italy | UK | Total |
|---|---|---|---|---|---|---|---|---|
| 1 | 4233 | 0.4 | 18.7 | 19.3 | 2.3 | 28.8 | 30.5 | 100.0 |
| 2 | 6525 | 2.7 | 19.6 | 30.7 | 1.1 | 18.6 | 27.3 | 100.0 |
| 3 | 8075 | 3.3 | 24.0 | 35.0 | 1.0 | 16.7 | 20.1 | 100.0 |
| 4 | 9628 | 4.2 | 23.9 | 30.3 | 1.0 | 20.0 | 20.5 | 100.0 |
| 5 | 11233 | 4.1 | 29.6 | 29.9 | 0.9 | 17.9 | 17.6 | 100.0 |
| 6 | 12910 | 4.2 | 25.0 | 32.8 | 0.7 | 19.5 | 17.8 | 100.0 |
| 7 | 14777 | 5.4 | 22.1 | 30.7 | 0.7 | 19.4 | 21.7 | 100.0 |
| 8 | 17360 | 6.4 | 20.1 | 34.0 | 0.9 | 14.2 | 24.4 | 100.0 |
| 9 | 21337 | 6.5 | 18.6 | 35.0 | 0.8 | 12.1 | 27.1 | 100.0 |
| 10 | 38299 | 4.7 | 19.1 | 36.2 | 0.6 | 15.7 | 23.6 | 100.0 |
| total | 14444 | 3.9 | 21.9 | 30.7 | 1.1 | 19.0 | 23.4 | 100.0 |

1. Income definition is that used for ranking.

**Table 2 Country composition of households in each decile of Eur6 disposable income**

***Differential*** national weights
No income base adjustment
Market exchange rate
Equivalence scale: square root of household size
Households counted once

| Decile | Mean income (Ecu /year)[1] | Belgium | France | Germany | Ireland | Italy | UK |
|---|---|---|---|---|---|---|---|
| 1 | 4238 | 0.2 | 18.9 | 20.3 | 2.4 | 28.0 | 30.3 |
| 2 | 6422 | 1.8 | 16.0 | 22.9 | 1.6 | 25.9 | 31.8 |
| 3 | 7987 | 2.7 | 25.1 | 31.2 | 1.0 | 18.6 | 21.4 |
| 4 | 9503 | 3.5 | 24.6 | 34.1 | 1.0 | 16.4 | 20.5 |
| 5 | 11039 | 4.9 | 25.0 | 28.8 | 1.0 | 19.6 | 20.7 |
| 6 | 12838 | 3.9 | 28.8 | 33.2 | 0.6 | 16.8 | 16.6 |
| 7 | 14687 | 4.7 | 21.8 | 33.4 | 0.9 | 18.5 | 20.8 |
| 8 | 17285 | 5.8 | 22.4 | 33.1 | 0.7 | 16.6 | 21.4 |
| 9 | 21415 | 6.8 | 17.6 | 33.7 | 0.8 | 13.4 | 27.7 |
| 10 | 36004 | 4.7 | 19.2 | 36.3 | 0.6 | 15.7 | 23.4 |
| total | 14145 | 3.9 | 21.9 | 30.7 | 1.1 | 19.0 | 23.4 |

1. Income definition is that used for ranking.

**Table 3 Percentage of National Accounts disposable income in Eur6**

| Country | Percentage of national accounts (1) | Adjustment factor (2) = 1/(1) |
|---|---|---|
| Belgium | 64.4 | 1.55 |
| France | 66.5 | 1.50 |
| Germany | 71.8 | 1.39 |
| Ireland[1] | n/a | 1.26 |
| Italy | 73.4 | 1.36 |
| UK | 80.7 | 1.24 |

Source: Eur6 and OECD (1997).

Note 1. As household sector national accounts are not available for Ireland, we make an assumption about the percentage of household national income accounted for by the survey. We do this by comparing with the UK. Assuming the same proportion of national accounts represented as the UK, we find an adjustment factor of 1.24. Alternatively, assuming that the ratio of GDP per capita between countries is the same as the ratio of household disposable income per capita, we find an adjustment factor of 1.27. We arbitrarily assume a factor between the two of 1.26.

**Table 4 Country composition of households in each decile of Eur6 disposable income**

Differential national weights
***National accounts*** income base adjustment
Market exchange rate
Equivalence scale: square root of household size
Households counted once

| Decile | Mean income (Ecu /year)[1] | Belgium | France | Germany | Ireland | Italy | UK |
|---|---|---|---|---|---|---|---|
| 1 | 5480 | 0.1 | 14.5 | 14.1 | 2.6 | 23.9 | 44.8 |
| 2 | 8452 | 0.4 | 12.6 | 23.3 | 1.7 | 26.6 | 35.4 |
| 3 | 10811 | 2.1 | 18.4 | 32.0 | 1.3 | 20.1 | 26.1 |
| 4 | 12889 | 2.6 | 22.3 | 34.1 | 1.0 | 18.0 | 22.0 |
| 5 | 15136 | 4.5 | 24.5 | 30.2 | 1.0 | 20.3 | 19.6 |
| 6 | 17575 | 3.9 | 26.9 | 33.2 | 0.8 | 16.7 | 18.4 |
| 7 | 20159 | 3.8 | 27.1 | 32.2 | 0.5 | 18.8 | 17.6 |
| 8 | 23526 | 5.8 | 24.4 | 34.6 | 0.8 | 15.6 | 18.8 |
| 9 | 29037 | 8.2 | 23.0 | 34.5 | 0.6 | 14.6 | 19.0 |
| 10 | 49377 | 7.7 | 25.4 | 38.7 | 0.4 | 15.0 | 12.8 |
| total | 19250 | 3.9 | 21.9 | 30.7 | 1.1 | 19.0 | 23.4 |

1. Income definition is that used for ranking.

**Table 5 National currency market and PPP exchange rates for Ecu (1994 averages)**

| Country | Market exchange rate | PPP Exchange rate | Ratio |
|---|---|---|---|
| Belgium | 39.7 | 40.1 | 1.010 |
| France | 6.58 | 7.12 | 1.082 |
| Germany | 1.92 | 2.23 | 1.161 |
| Ireland | 0.79 | 0.69 | 0.873 |
| Italy | 1915.1 | 1649 | 0.861 |
| UK | 0.78 | 0.69 | 0.885 |

Source: EUROSTAT (1997)

**Table 6 Country composition of households in each decile of Eur6 disposable income**

Differential national weights
National accounts income base adjustment
***PPP exchange rate***
Equivalence scale: square root of household size
Households counted once

| Decile | Mean income (Ecu /year)[1] | Belgium | France | Germany | Ireland | Italy | UK |
|---|---|---|---|---|---|---|---|
| 1 | 5663 | 0.2 | 18.0 | 28.5 | 2.2 | 16.0 | 35.3 |
| 2 | 8599 | 1.2 | 14.2 | 29.7 | 1.5 | 19.3 | 34.1 |
| 3 | 10612 | 2.2 | 20.8 | 38.3 | 0.9 | 19.6 | 18.2 |
| 4 | 12605 | 3.2 | 23.5 | 32.8 | 1.0 | 15.5 | 23.9 |
| 5 | 14828 | 4.3 | 24.7 | 33.0 | 1.0 | 17.4 | 19.4 |
| 6 | 17113 | 4.1 | 28.1 | 33.9 | 0.9 | 15.6 | 17.5 |
| 7 | 19757 | 4.9 | 27.2 | 26.5 | 0.8 | 19.3 | 21.3 |
| 8 | 23188 | 5.7 | 22.2 | 28.5 | 0.7 | 22.6 | 20.4 |
| 9 | 28511 | 7.1 | 19.8 | 23.8 | 1.0 | 22.4 | 25.9 |
| 10 | 47961 | 6.1 | 20.8 | 31.7 | 0.8 | 21.9 | 18.6 |
| Total | 18892 | 3.9 | 21.9 | 30.7 | 1.1 | 19.0 | 23.4 |

1. Income definition is that used for ranking.

**Table 7 Mean equivalised disposable income in Eur6 by equivalence scale elasticity**

Ecu per year (rank of country)

| Definition of income (e) | Belgium | France | Germany | Ireland | Italy | UK | Total |
|---|---|---|---|---|---|---|---|
| Household income (0) | 37238 (1) | 29634 (4) | 25890 (6) | 30457 (3) | 34468 (2) | 26662 (5) | 29011 |
| Equivalent income : square root (0.5) | 23257 (1) | 18852 (3) | 18530 (4) | 16600 (6) | 20343 (2) | 17607 (5) | 18892 |
| Equivalent income : OECD (≈0.7) | 18663 (1) | 15573 (4) | 16020 (2) | 12419 (6) | 15674 (3) | 14605 (5) | 15611 |
| Per capita income (1), weighted by no. of people | 14448 (1) | 11649 (3) | 13328 (2) | 8588 (6) | 11409 (4) | 11060 (5) | 11935 |
| Average household size | 2.58 | 2.54 | 1.94 | 3.55 | 3.02 | 2.41 | 2.41 |

Note: Incomes are adjusted in the same way as in Table 6.

**Table 8 Country composition of households in each decile of Eur6 disposable income**

Differential national weights
National accounts income base adjustment
PPP exchange rate
Equivalence scale: ***household size (per capita income)***
Households ***weighted by number of people***

| Decile | Mean income (Ecu /year)[1] | Belgium | France | Germany | Ireland | Italy | UK |
|---|---|---|---|---|---|---|---|
| 1 | 3267 | 0.3 | 19.4 | 9.5 | 4.0 | 34.2 | 32.5 |
| 2 | 5354 | 1.5 | 21.9 | 21.4 | 2.6 | 23.7 | 28.9 |
| 3 | 6628 | 2.2 | 24.4 | 28.3 | 2.0 | 22.0 | 21.0 |
| 4 | 7782 | 3.0 | 23.9 | 29.9 | 1.4 | 19.7 | 22.1 |
| 5 | 9073 | 3.2 | 26.1 | 24.4 | 1.1 | 21.7 | 23.4 |
| 6 | 10567 | 5.2 | 23.5 | 20.3 | 1.1 | 26.7 | 23.2 |
| 7 | 12251 | 5.8 | 21.0 | 23.8 | 1.2 | 26.9 | 21.1 |
| 8 | 14498 | 6.3 | 22.8 | 28.4 | 0.6 | 21.6 | 20.2 |
| 9 | 18140 | 8.8 | 23.4 | 30.2 | 0.8 | 17.3 | 19.4 |
| 10 | 31759 | 5.0 | 23.0 | 29.0 | 0.7 | 21.7 | 20.5 |
| total | 11935 | 4.1 | 22.9 | 24.5 | 1.6 | 23.6 | 23.3 |

1. Income definition is that used for ranking.

**Table 9 Cash and non-cash social expenditures (1992)**

| Country | Non-cash social expenditure % of GDP | Cash social expenditure % of GDP | Non-cash as a percentage of total social expenditure |
|---|---|---|---|
| Belgium | 13.0 | 19.6 | 40 |
| France | 14.1 | 19.3 | 42 |
| W. Germany | 12.8 | 16.8 | 43 |
| Ireland | 11.5 | 14.7 | 43 |
| Italy | 11.9 | 17.9 | 40 |
| UK | 11.8 | 16.1 | 42 |

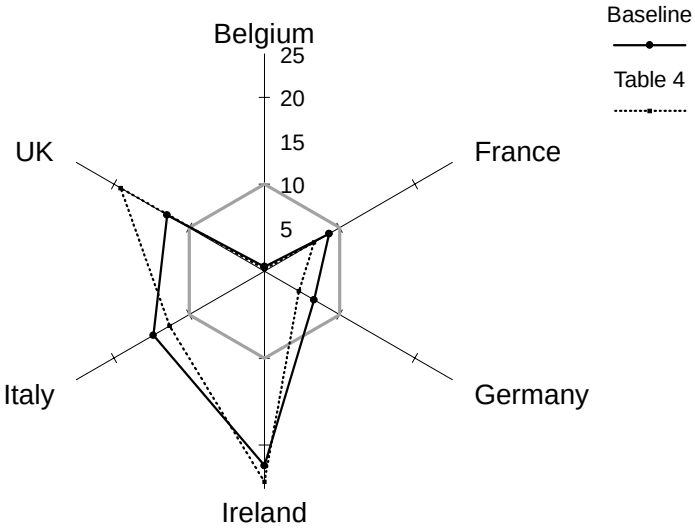
Source: OECD (1996)

**Figure 1 Growth in Total Household Income Italy and UK, 1984-1994**

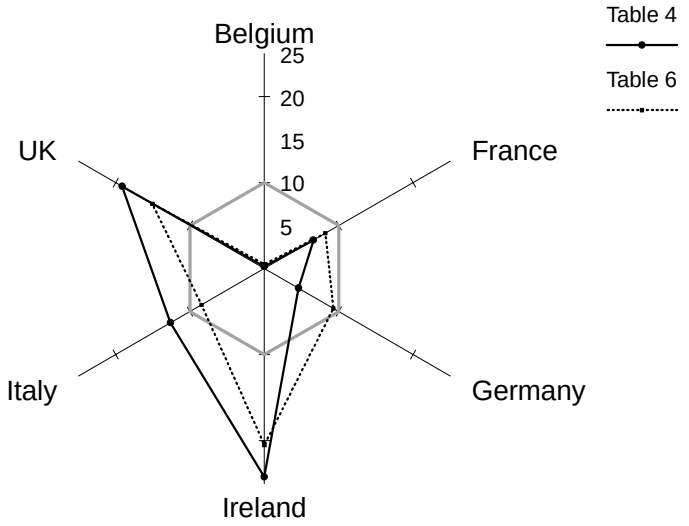

Source: OECD National Accounts (1997)

**Figure 2 Percentages of country populations in the bottom decile of the Eur6 distribution: cumulative effects of adjustments**

(a) Baseline (Table 2) and national accounts adjustment (Table 4)




(b) Table 4 and PPP exchange rate adjustment (Table 6)




(c) Table 6 and income per capita, weighted per person (Table 8)