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Back to the Future - Decomposition Analysis of Distributive Policies using Behavioural Simulations

Olivier Bargain, University College Dublin

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Back to the Future – Decomposition Analysis of Distributive Policies using Behavioural Simulations

Olivier Bargain*

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Abstract

For policy makers and analysts, it is important to isolate the redistributive impact of tax-benefit policy changes from changes in the environment in which policies operate. When actual reforms are motivated by work incentives, it is also crucial to evaluate behavioural responses and the distributional consequences thereof. For that purpose, we embed counterfactual simulations in a formal framework based on the Shapley value decomposition and quantify the relative roles of (i) tax-benefit policy changes (direct policy effect), (ii) labour supply responses to the policy reforms (indirect effect) and (iii) all other factors affecting income distribution over time. An application to the UK shows that the redistributive reforms of the 1998-2001 period have offset the increase in inequality that would have occurred otherwise. They also contribute to a strong decline in child poverty and poverty amongst single parent households. In the latter group, a third of the headcount poverty reduction (and half of the reduction in the depth of poverty) is on account of the very large incentive effect of policy changes.

Key Words : Tax-benefit policy; inequality; poverty; Shapley value decomposition; behavioural microsimulation, labour supply.

JEL Classification : H23, H53, I32

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1 Introduction

The decomposition of differences in household income distributions across countries or over time has received renewed attention in the recent years. For instance, some authors have relied on the micro-simulation of household behaviour to extend the simple framework of Mincer's wage regression model to additional factors like changes in occupational status or household composition (see Bourguignon et al., 2001, 2007, Hyslop and Maré, 2004).[1] Importantly, these techniques overcome some of the limitations of traditional approaches like the decomposition by subgroup or by income sources (see Cowell, 1998, for an overview). They refer to the distribution as a whole and isolate the effects of particular variables in a well-defined way thanks to counterfactual simulations. In contrast, decompositions by subgroup are often confined to inequality/poverty indices with particular decomposability properties and suffer from the fact that the effects of correlated variables cannot be disentangled in the necessarily coarse population partitions used in practice.

Similar limitations apply to the traditional decomposition of inequality indices by income components when trying to isolate the role of taxes or social transfers (Shorrocks, 1982). Firstly, conventional procedures often place constraints on the types of poverty and inequality indices which can be used. Some indices require the introduction of a vaguely defined 'interaction' term in order to maintain the decomposition identity. Secondly, they do not allow disentangling the pure effect of policy changes from their interaction with the underlying population. For instance, they cannot identify whether an increase in social assistance income is due to increased generosity of benefit payments or from an automatic increase in the incidence of transfers as unemployment rises.[2] Counterfactual scenarios obtained by tax-benefit microsimulation techniques can be used to overcome these limitations. They allow analyzing changes of the disposable income distribution as a whole (instead of focusing on specific aggregate measures) and make it possible to disentangle the pure effect of a policy change from changes in the environment in which the policy operates, and in particular changes in market income inequality. While the

[1] This type of approach is computationally demanding, which explains why decompositions of differences in the *household income* distributions are not so frequent, at least compared to those concerning the distribution of *wages* (for instance the many extensions of the Oaxaca–Blinder approach to the whole wage distribution following the seminal work of Juhn et al., 1993, and DiNardo et al., 1996).

[2] The approach sometimes referred to as the 'actual payments' method is used by Jenkins (1995) and Goodman et al. (1997) to analyse inequality trends in the UK. Their finding that the tax-benefit system of the late 1980s was not less redistributive than that of the late 1970s is partly due to the fact that they do not account for changes in the underlying market income distribution. Jenkins indicates that decomposition results differ when used with different inequality indices, especially when the indices are sensitive to extreme income observations.

number of policy studies using these techniques is growing exponentially,[3] counterfactual simulations are rarely embedded in a formal decomposition framework. Yet quantifying the relative effect of tax-benefit policy changes on inequality/poverty trends is all the more important as this factor, among all factors influencing household income distribution, is directly relevant to policy makers.

Recently, Bargain and Callan (2008) have suggested a decomposition based on Shorrocks (1999)'s reinterpretation of the Shapley value decomposition and on the construction of suitable counterfactual distributions.[4] This decomposition relies on static policy effects, however. Actual reforms are motivated by labour supply incentives, as was the case in the UK with the introduction of the Working Families Tax Credit (WFTC) in 1999. Addressing behavioural effects is therefore important when such motivations are part of the policy measure. In countries like the UK, work incentives are higher up on the agenda when discussing distributional effects of tax-benefit policies, especially for certain groups characterized by both high risks of poverty and low employment rates (e.g., single mothers). Against this background, the present note suggests estimating labour supply behaviour to extend the Shorrocks-Shapley decomposition to three factors: (i) direct effect of tax-benefit policy changes, (ii) indirect effect due to the labour supply responses to these policies and (iii) all other effects affecting the income distribution. Note that the measurement of policy impacts may depend on the underlying population used to evaluate policy changes and behaviour, either the base-period or the final-period data. The Shorrocks-Shapley decomposition method essentially involves averaging over these cases, but it is possible to examine the potential sensitivity of results to this issue. This is of particular interest when, for example, attempting to assess potential/future policy changes, for which end-period data are by definition not available.[5]

[3]These studies focus on the distributional impact of tax-benefit reforms using static simulations (e.g., Decoster and Van-Camp, 2001) or behavioural simulations (e.g., Aaberge al., 1995, Creedy and Kalb, 2005). They may analyse the redistributive potential of existing systems (e.g., Fuest et al., 2009) or of hypothetical reforms like a flat tax system (e.g., Fuest et al., 2008).

[4]The general Shorrocks-Shapley decomposition method has been applied in several contexts, including the decomposition of changes in inequality trends (see Mookherjee and Shorrocks, 1982, for the UK and Cowell and Jenkins, 1995, for the US, or more recently Peichl et al., 2009, for Germany), in poverty trends (into components due to income growth and to inequality, as for instance in Kolenikov and Shorrocks, 2005) and in income mobility indices (see van Kerm, 2004).

[5]This issue has been investigated in the literature on tax progressivity (see Lambert and Thoresen, 2009, for a recent investigation) but has received less attention in policy evaluations (an exception is Clark and Leicester, 2004). Jenkins and van Kerm (2005) analyse inequality changes in the UK in the 1980s and discuss the choice of weights used in the decomposition, either base-period values, end-period values or the Shapley value.

Our empirical application revisits the role of tax-benefit policies implemented in the UK over 1998-2001. This period is particularly interestingly for several reasons.[6] Firstly, this corresponds to a time of economic upturn accompanied by an increase in market income inequality. It also coincides with the first term of the New Labour government (1997-2001) characterized by a series of very important welfare reforms. In addition, several reforms, like the WFTC, were intended to increase financial incentives to work. Our results show that these policy changes have just offset the rise in inequality that would have occur without them. Policy reforms are also the main contributor to a strong decline in child poverty and poverty amongst single parent households. In the latter group, a third of the headcount poverty reduction (and half of the reduction in the depth of poverty) is on account of the strong incentive effects of policy reforms.

The layout of this note is as follows. Section 2 presents the decomposition approach. Section 3 describes the data, the simulation model, the labour supply estimation and the empirical results. Section 4 concludes.

2 Shapley Decomposition with Behavioural Responses

We first introduce some notation and terminology. Matrix y describes the population contained in the data, i.e., each row contains all the information about a given household (various income sources and socio-demographic characteristics). Denote d the 'tax-benefit function' transforming, for each household, gross incomes and household characteristics into a certain level of equivalised disposable income.[7] Tax-benefit calculations depend also on a set of monetary parameters p (e.g., maximum benefit amounts, threshold level of tax brackets, etc.). Thus, the distribution of disposable income is represented hereafter by $d_i(p^j, y^l)$, for a hypothetical scenario including the population of year l, the tax-benefit parameters of year j and the tax-benefit structure of year i. In the empirical part, we shall be interested in relative inequality/poverty indices I, computed as a function $I\left[d_i(p^j, y^l)\right]$ of the (simulated) distribution of disposable income.[8] Policy changes under study possibly

[6] See the companion paper Bargain (2009) for a static decomposition and for an analysis of alternative uprating factors used to assess the policy effect in the UK.

[7] We denote by household 'gross income' or 'market income' the total amount of labour income, capital income and private pensions before taxes and benefits. 'Disposable income' is the household income that remains after payment of taxes/social contributions and receipt of all transfers, as widely used to measure poverty and inequality. We consider that the link between contributions and the value of benefits is loose enough in the UK so that earnings-replacement incomes provided by the state (job seeker's allowance, basic pension, disability benefits) can be treated as part of the redistribution function.

[8] These measures allow writing the decomposition in a simple and clear way. Yet, as stated in the introduction, we are not confined to specific indices with particular decomposability properties and could

combine changes in policy structure d and changes in parameters p (the 'uprating policy').

Next, we consider the possibility of constructing counterfactual scenarios. To apply the tax-benefit system of year 1 on data of year 0, we must nominally adjust income levels by the uprating factor α^1, i.e., the income growth rate between year 0 and year 1. This leads to the counterfactual distribution $d_1(p^1, \alpha^1 y^0)$ where $\alpha^1 y^0$ retains the structural characteristics of the population in year 0 (in particular the wage distribution and labour supply choices) but adopts the nominal (market) income levels prevailing in year 1. Symmetrically, we may evaluate the distribution obtained with the initial policy applied to the new population. Yet a measure $d_0(p^0, y^1)$ would not be consistent since base-period parameters would be artificially applied to end-period income levels. For instance, previous tax band thresholds would be applied to new and possibly higher income levels, thereby generating artificial 'fiscal drag' (see Immervoll, 2005). Hence tax-benefit parameters must be uprated using the same factor α^1 as used to scale up the distribution of market income between years 0 and 1. This yields the counterfactual $d_0(\alpha^1 p^0, y^1)$ where the nominally adjusted tax-benefit parameters $\alpha^1 p^0$ differ from the *actual* set of parameters p^1 in force in year 1.[9]

We are interested in characterizing the total change Δ in the inequality/poverty index I between initial period 0 and final period 1 as:

$$\Delta = I\left[d_1(p^1, y^1)\right] - I\left[d_0(p^0, y^0)\right].$$

Let us first consider the decomposition without behavioural effects. The Δ can be decomposed into the contribution of the change in the tax-benefit policy ('policy effect') and the contribution of changes in the underlying population ('other effects'). The former component corresponds to a shift from $d_0(p^0, \cdot)$ to $d_1(p^1, \cdot)$ while the latter is simply a move from base year data y^0 to final data y^1. Thus the decomposition consists in a shift in data conditional on the initial policy, followed by a change in policy evaluated on final data (decomposition 1). Or, alternatively and symmetrically, a change in policy evaluated on base year data, followed by a change in underlying data conditional on the new policy (decomposition 2). In these decompositions, we must be careful to use

produce decompositions results for the whole distribution.

[9] In practice, the backdrop used to evaluate the actual uprating policy is often based on price inflation. However, Clark and Leicester (2004) show that this actually captures only part of the uprating practices of the past decades in the UK. A benchmark based on *earnings* growth is recommended by several authors as the appropriate one for the purpose of evaluating the distributional effect of policies as compared to other changes in underlying data. Indeed, it is the only one that provides a "distributionally-neutral" backdrop (Callan et al., 2006) or "constant progressivity" counterfactual (Clark and Leicester, 2004) against which actual policy changes can be evaluated. See the extensive discussion in Bargain (2009).

(a) nominally-adjusted tax-benefit parameters $\alpha^1 p^0$ when simulating the old policy on the new data y^1 and (b) nominally-adjusted market income $\alpha^1 y^0$ when applying the new policy on base-year data. With these necessary adjustments, decomposition 1 is written:

$$\begin{aligned}
\Delta \;=\; & \left\{I\left[d_1(p^1,y^1)\right] - I\left[d_0(\alpha^1 p^0,y^1)\right]\right\} && \text{(policy effect)} \\
& + \left\{I\left[d_0(\alpha^1 p^0,y^1)\right] - I\left[d_0(\alpha^1 p^0,\alpha^1 y^0)\right]\right\} && \text{(other effects)} \\
& + \left\{I\left[d_0(\alpha^1 p^0,\alpha^1 y^0))\right] - I\left[d_0(p^0,y^0)\right]\right\} && \text{(income growth).}
\end{aligned} \tag{1}$$

The first term captures the effect of the tax-policy change conditional on final year data. Conditional on the policy structure of year 0, and for nominal levels of year 1, the second term gauges the other changes in the underlying population (ex: labour supply adjustment to the policy over the period, changes in wage inequality, demographics, etc.). Symmetrically, decomposition 2 can be written:

$$\begin{aligned}
\Delta \;=\; & \left\{I\left[d_1(p^1,y^1)\right] - I\left[d_1(p^1,\alpha^1 y^0)\right]\right\} && \text{(other effects)} \\
& + \left\{I\left[d_1(p^1,\alpha^1 y^0)\right] - I\left[d_0(\alpha^1 p^0,\alpha^1 y^0)\right]\right\} && \text{(policy effect)} \\
& + \left\{I\left[d_0(\alpha^1 p^0,\alpha^1 y^0))\right] - I\left[d_0(p^0,y^0)\right]\right\} && \text{(income growth).}
\end{aligned} \tag{2}$$

with the end-period policy evaluated on nominally-adjusted base-period data.

In both decompositions, the last term simply captures the effect of nominally adjusting base-year data. If the tax-benefit system is linear and continuous in p and y, which is the case in many countries including the UK, a simultaneous change in nominal levels of both incomes and parameters should not affect the relative location of households in the distribution of disposable income (see Bargain and Callan, 2008), that is:

$$d_i(\alpha p^j, \alpha y^l) = \alpha d_i(p^j, y^l),$$

and the last term of the decompositions should be zero. We shall test this linear *homogeneity* property empirically but assume for now that it holds in order to simplify the following notations.

Next, we acknowledge the fact that changes in tax-benefit policies may induce labour supply responses and hence an indirect (but possibly intended) effect on the distribution of market income. Denote y_k^l the population of year l making labour supply choices as if living under the policy regime k. That is, we can estimate a behavioural model on base-period data and simulate the market incomes of the base-period population after adjustment to the new policy (y_1^0) or, inversely, estimate the model on end-period data and simulate the market incomes under the "old" policy (y_0^1). We are free to construct all types of counterfactuals, for instance a distribution $d_i(p^i, y_k^l)$ for the population of year l

under the policy of year i and with labour supply choices adjusted to the policy of year k. The situations where labour supply is static, i.e., y_k^l with $k = l$, are those used in previous decompositions and simply written y^l to simplify notations. Then, we can account for the three effects (policy, behaviour, other) which give nine permutations and in principle nine decompositions. In fact, the "other effects" and behavioural effects must be positioned consecutively since they correspond to a split of the former "other effects" in primary decompositions 1 and 2. Hence we have only four decompositions. In the first two, labour supply behaviour is estimated on base-period data and the behavioural effect is simulated under the old policy regime:

$$\begin{aligned} \Delta \;=\; & \left\{I\left[d_1(p^1,y^1)\right] - I\left[d_0(\alpha^1 p^0,y^1)\right]\right\} && \text{(policy effect)} \\ & + \left\{I\left[d_0(\alpha^1 p^0,y^1)\right] - I\left[d_0(\alpha^1 p^0,\alpha^1 y_1^0)\right]\right\} && \text{(other effects)} \\ & + \left\{I\left[d_0(\alpha^1 p^0,\alpha^1 y_1^0)\right] - I\left[d_0(\alpha^1 p^0,\alpha^1 y^0)\right]\right\} && \text{(behavioural effect)} \end{aligned} \tag{I}$$

or under the new one:

$$\begin{aligned} \Delta \;=\; & \left\{I\left[d_1(p^1,y^1)\right] - I\left[d_1(p^1,\alpha^1 y_1^0)\right]\right\} && \text{(other effects)} \\ & + \left\{I\left[d_1(p^1,\alpha^1 y_1^0)\right] - I\left[d_1(p^1,\alpha^1 y^0)\right]\right\} && \text{(behavioural effect)} \\ & + \left\{I\left[d_1(p^1,\alpha^1 y^0)\right] - I\left[d_0(\alpha^1 p^0,\alpha^1 y^0)\right]\right\} && \text{(policy effect).} \end{aligned} \tag{II}$$

In the two next decompositions, labour supply is estimated on end-period data and the behavioural effect is assessed under the old regime:

$$\begin{aligned} \Delta \;=\; & \left\{I\left[d_1(p^1,y^1)\right] - I\left[d_0(\alpha^1 p^0,y^1)\right]\right\} && \text{(policy effect)} \\ & + \left\{I\left[d_0(\alpha^1 p^0,y^1)\right] - I\left[d_0(\alpha^1 p^0,y_0^1)\right]\right\} && \text{(behavioural effect)} \\ & + \left\{I\left[d_0(\alpha^1 p^0,y_0^1)\right] - I\left[d_0(\alpha^1 p^0,\alpha^1 y^0)\right]\right\} && \text{(other effect)} \end{aligned} \tag{III}$$

or under the new one:

$$\begin{aligned} \Delta \;=\; & \left\{I\left[d_1(p^1,y^1)\right] - I\left[d_1(p^1,y_0^1)\right]\right\} && \text{(behavioural effect)} \\ & + \left\{I\left[d_1(p^1,y_0^1)\right] - I\left[d_1(p^1,\alpha^1 y^0)\right]\right\} && \text{(other effects)} \\ & + \left\{I\left[d_1(p^1,\alpha^1 y^0)\right] - I\left[d_0(\alpha^1 p^0,\alpha^1 y^0)\right]\right\} && \text{(policy effect).} \end{aligned} \tag{IV}$$

As argued by Shorrocks (1999), the Shapley value procedure can be employed whenever one wishes to assess the relative importance of the explanatory variables. In particular, the decomposition of a poverty/inequality statistic I can be carried out by considering the marginal effect on I of eliminating each of the contributory factors in sequence, and then assigning to each factor the average of its marginal contributions in all possible elimination sequences. In particular, the direct *policy effect* under the Shapley decomposition is obtained by averaging the contributions from the four decompositions set out above. Since the effect is identical in I and III and in II and IV, this is simply:

$$\frac{1}{2}\left\{I\left[d_1(p^1, y^1)\right] - I\left[d_0(\alpha^1 p^0, y^1)\right]\right\} + \frac{1}{2}\left\{I\left[d_1(p^1, \alpha^1 y^0)\right] - I\left[d_0(\alpha^1 p^0, \alpha^1 y^0))\right]\right\}.$$

3 Empirical Application

3.1 Data, Labour Supply Model and Simulations

The base and end period data are drawn from the Family Expenditure Surveys (FES) and contain $6,797$ and $6,637$ households respectively. The uprating factor α^1, calculated as the growth rate of average gross income over the 1998-2001 period, is 6.8%. It is computed as an average of all market incomes (incl. labour income, capital incomes and private pensions). Tax-benefit simulations of disposable income are performed for all the representative households of each dataset using the tax-benefit calculator EUROMOD. The robustness of these simulations is extensively discussed in Bargain (2009).[10] Household disposable income is equivalised using the modified OECD scale and poverty measures rely on a poverty line fixed at 60% of the median equivalised income.

Labour supply is estimated (and behavioural responses predicted) on three selected subgroups of base- and end-period data separately. In each sample, we keep households where adults are aged between 18 and 59 and available for the labour market, i.e., neither disabled nor retired nor in education. The self-employed and farmers are excluded as their labour supply decisions are probably very different from those of salary workers. The selected samples drawn from the base-period (resp. end-period) data comprise $2,020$ couples, 740 single women and 424 single men (resp. $1,849$, 774 and 442).

We rely on a discrete choice model of household labour supply (multinomial logit). The approach has become relatively standard and we refer to Aaberge et al. (2005) or Blundell et al. (2000) for a detailed exposition. The model is based on the assumption that a household i choosing the discrete option j obtains a utility level:

$$V_{ij} = U(H_{ij}^f, H_{ij}^m, C_{ij}) + \epsilon_{ij}.$$

with spouses' worked hours H_{ij}^f, H_{ij}^m for that particular choice j and the corresponding level of disposable income C_{ij} (equivalent to household consumption in such a static framework). Each discrete bundle of working time and disposable income provides a

[10] It would be interesting to study a longer period. This was not possible using the current version of EUROMOD as both policy and data are required at each period. Nonetheless, the important policy changes in 1998-2001 make this period worth focusing on.

different level of utility so that leisure-consumption preferences, once parameterized, can be estimated by maximization among a discrete set of possibilities $j = 1, ...J$. In fact, an explicit logistic form for the probability of choosing option j is derived from the assumption that random terms ϵ_{ij} are i.i.d. and follow a EV-I distribution, so that the model can be estimated by maximum likelihood. We use the same specification as Blundell et al. (2000), with a quadratic form for the utility function U, fixed costs of work, coefficients varying with taste-shifters (age, family composition, region) and random components. We discretize household budget constraints with $J = 4$ choices ($0, 20, 40$ and 50 hours per week) for singles and the 16 combinations for couples – results do not change significantly with a thinner discretization. The tax-benefit simulator is used to predict disposable income for each discrete hour choice j as a function of gross incomes $w^f H_j^f$ and $w^m H_j^m$ and other household characteristics. Wages w^f and w^m are calculated using observed earnings and work hours for workers and are predicted for non-workers. Because the model is nonlinear, we take the wage rate prediction errors explicitly into account for a consistent estimation. Both types of disturbance terms (random preferences and the wage error term) are integrated out in the likelihood, practically by summing over a tractable number of draws (see Train 2003).

We summarize important information concerning the labour supply estimations in table 1, namely goodness-of-fit measures and labour supply elasticities (detailed estimates of the model are also available from the author). The fit of the model is reasonably good and in line with previous results in the literature (see Blundell and MaCurdy, 1999). Elasticities are obtained by simulating the impact of a marginal increase in gross hourly wages on hours of work and participation.[11] Results show usual results: elasticities are more precisely estimated for couples than for single individuals, are essentially driven by the extensive (participation) margin, are smallest for married men and particularly large for single mothers (see also recent results for the UK in Blundell et al., 2000, 2009). Elasticities decrease over time and especially for the latter group, which is characteristic of the increased in labour market participation of lone mothers over the period. We also find negative and notably smaller cross-wage elasticities for married men and women and income elasticities not significantly different from zero (not reported).

[11]Elasticities (and the policy effects discussed in the next sub-section) are predicted by a calibration method which is consistent with the probabilistic nature of the model at the individual level. It consists of drawing from a $EV - I$ distribution series of pseudo-residuals ϵ_{ij} ($j = 1, ..J$) for each household that generate a perfect match between predicted and observed choices. The same draws are kept when predicting labour supply responses to a shock on the budget constraint (wages increase or tax-benefit policy reform). Averaging individual supply responses over a large number of draws provides robust transition matrices. Confidence intervals are obtained by repetitive random draws of the preference parameters from their estimated distributions and, for each draw, by applying the calibration procedure.

3.2 Tax-benefit Policy Changes and Labour Supply Responses

New Labour came to power after the May 1997 general elections. Important tax-benefit reforms were announced in the Pre-Budget Statement of November 1997 and implemented in 1998 and 1999. Hence the period under investigation here coincides exactly with the policy changes in the first term of the New Labour government. On the tax side, structural policy changes included the abolition of the tax relief on mortgage interest, the introduction of a 10% lower rate and the reduction in the standard rate (from 23% to 22%) in the income tax schedule, the switch from a trigger to a slice structure of Employers' social insurance contributions and the regular increase of council taxes above inflation. Maybe more important are the reforms of the welfare system, characterized by an increased generosity of income support for the elderly (now called 'minimum income guarantee') and for families with children. The latter have also benefited from the replacement of the family credit by the more generous working family tax credit (WFTC) in 1999. In addition, a non-refundable children's tax credit has replaced the married couples allowance (except for the elderly) and the additional personal allowance. Policy changes are described and discussed in detail in Francesconi and Van der Klauuw (2004) or Hills et al. (2009).

As a matter of fact, some of the policy reforms under New Labour were aimed to encourage employment of families with children, notably through the extension of tax credits. The WFTC reform in particular has received a lot of attention. Both ex-ante simulations (like Blundell et al., 2000) and ex-post evaluations (like Francesconi and Van der Klauuw, 2004) agree on the strong incentive effects concerning single women and single mothers in particular. At the same time, in-work transfers which are means-tested on household income are known to discourage the participation of secondary earners. In the case of the WFTC, Blundell et al. (2000) found a withdrawal of 20,000 married women from the labour market and hence only moderate effects to the WFTC reform overall.

Using the labour supply estimates on base-period and end-period data, we predict the behavioural impact of the complete set of tax-benefit policy changes implemented by the first New Labour government. The various reforms have affected work incentives in opposite ways (for single parents, for instance, the WFTC has encouraged participation but income support extensions may have had disincentive effects). Overall, our simulations point to a marginal effect on men and a decrease in the participation of married women of between 8,000 and 16,000. We also find an increase in the participation rate of single women by 55,000 when using estimates obtained on base-period data (38,000 on end-period data). Among those, 90% are single mothers and the participation rate of this group increases by 3.3 points according to estimations on base-period data (2.3 on end-period data).[12] Note however that simulated responses account only for a third (resp. a quarter) of the increase in lone mothers' mean working time (resp. participation rate) over the period. Hence the transformations of the underlying population over time – which are not modelled here – may lead to very different evaluations of the policy effects between decompositions I/III and II/IV. In particular, the change in the wage distribution may have add a substantial effect on participation rates. This can be due to the economic upturn of the period under consideration but also to the introduction of a minimum wage in 1999 (aimed to limit the adverse effects of the WFTC, namely the possibility that employers offset the net gain of the transfer by lowering hourly wages) and its spillover effects on wages above it.

3.3 Decomposition Analysis of Distributional Effects

The various counterfactuals discussed in the theoretical section are reported in table 2 while the overall change in inequality/poverty, the homogeneity check and the decomposition results are shown in table 3. We focus on the Shorrocks-Shapley decomposition and compare it to decompositions I and II – the latter is of particular interest since the effect of tax/transfer policy changes extracted from this base-period weighted decomposition is the only measure available when looking at the impact of policy changes in prospect. Thus we shall examine the sensitivity of the results with respect to base-period weighting.[13]

First of all, we test the homogeneity property by reporting in table 3 the difference between $I\left[d_0(\alpha^1 p^0, \alpha^1 y^0))\right]$ and $I\left[d_0(p^0, y^0)\right]$, i.e., the difference between columns indexed (0) and (1) in table 2. It is not significantly different from zero for all poverty/inequality measures and confirms that the property holds. Then we compare the situation in base and end periods as reported by columns (0) and (4). It turns out that changes in inequality measures are not significant (Gini, percentile ratio, Atkinson with moderate inequality aversion). We report the Reynolds-Smolensky index of redistribution, $G_y - G_d$, and a measure of vertical equity, $G_y - C_d$, with G_y the Gini measure of equivalised market income, G_d the Gini of equivalised disposable income and C_d the concentration measure of equivalised disposable income.[14] The measure of vertical equity significantly decreases

[12] Estimates are relatively precise for married couples but less so for single mothers. Bootstrapped standard errors for that latter group give a confidence interval of the net effect of $[30,000; 65,000]$ on base-period data ($[20,000; 50,000]$ on end-period data).

[13] Recall that direct policy effects under decompositions III and IV are identical to those under I and II respectively.

[14] Note that we consider the complete effect of the tax-benefit system and not just the role of taxes as often in measures of progressivity. The redistribution effect and the measure of vertical equity are in line with Immervoll et al. (2006).

over time. We find a significant decline in headcount poverty overall and a spectacular drop amongst families with children and single parent households. The depth of poverty tends to decrease but the reduction is statistically significant for child poverty only.

We decompose the contribution of each effect in explaining the overall trend. We must keep in mind that the policy effect is evaluated against a distributionally neutral backdrop whereby all tax-benefit monetary parameters, including welfare payment rates, are adjusted by the mean income growth. Results point to a significant equalising effect of policy changes in the UK over the period 1998-2001. For instance, without other effects affecting the distribution, the Gini index would have decreased by 5% (1.5 points – in line with Clark and Leicester, 2004), the percentile ratio by 10% (0.4 points) and the headcount poverty by 10% (1.7 points). The redistributive effect of the tax-benefit system and the vertical equity measure would have increased by 8% and 7% respectively. In fact, the substantial increase in market income inequality is just offset by the redistributive policies. The policy effect clearly dominates only in the case of headcount poverty. It is especially strong for households with children and particularly single parent households. It almost entirely explains the 30% drop in child poverty (headcount) and the 34% drop in the intensity of child poverty (FGT1).

The labour supply effect is marginal for all the measures based on the entire population. Yet it plays an important role for single parent households: the strong employment effect of the policy reforms helps to lift single mothers above the poverty line and accounts for around 30% of the total reduction in poverty for that group (2.3 points out of a 7.9 point drop in headcount poverty). It also accounts for almost a half of the decrease in FGT1 (0.4 out of a 0.9 point reduction).

Finally, differences between methods are small (and not statistically significant). An exception is the poverty headcount ratio for households with children and single parent households. For these groups, decompositions II and IV attribute a larger role to the policy impact. This possibly reflects the stronger effect of the income support extensions for families with children when evaluated using the base period when unemployment was substantially higher. This result points to the need for caution when the structure of the underlying population changes rapidly.

4 Conclusion

Relying on microsimulated counterfactual distributions, we decompose the time change in inequality/poverty into three contributions: the direct impact of tax-benefit policy changes, the distributional effect of behavioural responses to these policy reforms and the effect of all other factors (such as changes in market wage inequality). We rely on the Shapley value method as reinterpreted by Shorrocks (1999), i.e., we average the marginal contributions of each effect over the different possible orderings. The method is applied to inequality/poverty changes in the UK over the period 1998-2001. Results confirm that the redistributive measures of the Labour government have reduced the increase in inequality that would have occurred otherwise. Reforms like the extension of income support and the WFTC have contributed to a significant drop in poverty among children and in particular among single parent households, a group showing the highest risk of poverty and social exclusion. Most interestingly, a third of the poverty reduction in the latter group is attributed to the incentive effect of the reforms.

Most of the key results do not reveal a large sensitivity to the population at use to evaluate policy changes, either the base-period data, the end-period data or an average of these two contributions (the Shapley value method). This is reassuring for the many analyses using the "base weighted" measure of policy impact as a first approximation, in particular when evaluating budget propositions for coming years. Yet some differences were observed in the case of the headcount ratio for families with children and single parents (see similar findings for Ireland in Bargain and Callan, 2008). Hence caution is required when transformations in the underlying population are important or affect the groups particularly concerned by redistributive policies.

Several limitations of the present study should also motivate further research. In particular, we account only for the direct redistributive effect of policy changes and potential labour supply responses. Even if more difficult, it is potentially important to account for general equilibrium effects (see Bhattarai and Whalley, 2008) or at least for the interaction of supply and demand on the labour market (see Peichl and Siegloch, 2010). Other margins than labour supply, like work effort, tax evasion or benefit take-up are not addressed in the present framework. Some of the other behavioural responses may be captured in a more comprehensive way by studying the change in taxable (or means-tested) income (see for instance Thoresen, 2004). Finally, we have considered the distribution of equivalised household disposable income as a proxy of individual welfare. More general, possibly utility-based, measures could be used (see Capeau et al., 2008, for a recent application of alternative welfare measures and a review of existing methods).

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Table 1: Labour Supply Estimations: Fit and Elasticities

	base-period				end-period			
Goodness-of-Fit:	Couples		Single women	Single men	Couples		Single women	Single men
	male	female			male	female		
Nb of observations	2020		740	424	1849		774	442
Log-Likelihood	-4386		-703	-477	-3952		-786	-482
pseudo-R2	0.22		0.31	0.19	0.23		0.27	0.21
Error on participation*	0.2	0.6	1.2	0.2	0.2	0.7	1.8	0.1
Error on hours*	0.1%	0.6%	2.4%	0.5%	0.6%	1.6%	3.3%	0.2%
*Own-wage Elasticity***	married women	married men	singles	lone parents	married women	married men	singles	lone parents
Extensive margin	[0.20,0.30]	[0.09,0.12]	[0.19,0.45]	[0.34,0.57]	[0.08,0.18]	[0.04,0.07]	[0.12,0.33]	[0.17,0.37]
Intensive margin	[0.14,0.26]	[0.09,0.12]	[0.19,0.48]	[0.46,0.67]	[0.06,0.18]	[0.03,0.06]	[0.12,0.32]	[0.26,0.42]

** Prediction errors correspond to (i) the absolute deviation between predicted and observed participation rates (in percentage points), (ii) the relative deviation between predicted and observed mean hours.*

*** Elasticities are calculated by predicting the impact of a 1% wage increase on participation (extensive margin) and average worked hours (intensive margin). Bootstrapped 95% confidence intervals are obtained by repetitive random draws of the preference parameters from their estimated distributions.*

Table 2: Counterfactual Simulations

data year:	0	0	0	1	1	0	0	1	1
uprated to:		1	1			1	1		
with labour supply:	0	0	1	0	1	0	1	0	1
policy year:	0	0	0	0	0	1	1	1	1
uprated to:		1	1	1	1				
	(0)	(1)	(1*)	(2*)	(2)	(3)	(3*)	(4*)	(4)
Inequality									
Gini	31.2	31.2	31.2	32.8	32.9	29.6	29.6	31.5	31.5
	(0.3)	(0.3)	(0.3)	(0.5)	(0.5)	(0.3)	(0.3)	(0.5)	(0.5)
Atkinson 0.5	7.8	7.8	7.8	8.7	8.8	7.0	7.0	8.1	8.1
	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Atkinson 1	16.5	16.5	16.5	18.7	18.7	15.0	15.0	17.3	17.4
	(0.3)	(0.3)	(0.3)	(0.5)	(0.5)	(0.3)	(0.3)	(0.4)	(0.4)
P90/P10	4.1	4.1	4.1	4.4	4.4	3.7	3.7	4.0	4.0
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Redistribution effect	18.8	18.8	18.8	16.8	16.7	20.4	20.4	18.1	18.0
	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
Vertical equity	20.6	20.6	20.8	18.5	18.3	22.1	22.4	19.7	19.6
	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Poverty									
FGT0 (%)	17.3	17.3	17.0	18.2	18.0	14.6	14.4	15.6	15.5
	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.4)	(0.4)	(0.5)	(0.5)
FGT1 (%)	3.1	3.1	3.0	3.7	3.7	2.5	2.4	3.1	3.0
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
FGT2 (%)	0.9	0.9	0.9	1.3	1.3	0.8	0.8	1.1	1.1
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Child poverty									
FGT0 (%)	24.5	24.5	24.2	23.5	23.7	17.3	16.9	17.4	17.7
	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	(0.9)	(0.8)	(0.9)	(0.9)
FGT1 (%)	3.8	3.8	3.7	4.1	4.1	2.3	2.2	2.5	2.5
	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
FGT2 (%)	1.0	1.0	1.0	1.0	1.0	0.7	0.6	0.6	0.6
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Single parents									
FGT0 (%)	43.8	43.8	40.4	43.5	42.0	32.8	29.9	37.4	36.0
	(2.5)	(2.5)	(2.5)	(2.5)	(2.5)	(2.3)	(2.3)	(2.5)	(2.5)
FGT1 (%)	5.6	5.6	5.1	7.4	7.0	2.9	2.6	5.0	4.8
	(0.5)	(0.5)	(0.5)	(0.6)	(0.6)	(0.4)	(0.4)	(0.5)	(0.5)
FGT2 (%)	1.1	1.1	1.0	1.8	1.7	0.6	0.5	1.2	1.1
	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)

Note: Measures are based on equivalised income using the modified OECD scale. The poverty line is 60% median equivalised income. Gini, Atkinson index and FGT poverty measures are multiplied by 100. The Reynolds-Smolensky redistribution effect and the vertical equity measure are calculated as Gy - Gd and Gy - Cd respectively, with Gy the Gini of pre-tax/benefit equivalized income, Gd the Gini of post-tax/benefit equivalized income and Cd the concentration measure of post-tax/benefit equivalized income. Period 0 is 1998 and period 1 is 2001. Scenario 1* and 3* (resp. 2* and 4*) are counterfactuals on data 0 (resp. 1) with labour supply responses to system of year 0 (resp. 1). Bootstrapped standard errors are indicated in brackets.

Table 3: Decomposing Changes in Income Distribution over Time

	Total change	Homogeneity check	Shapley Decomposition			Decomposition I			Decomposition II		
			Policy effect	Behav. response	Other effects	Policy effect	Behav. response	Other effects	Policy effect	Behav. response	Other effects
	(4)-(0)	(1)-(0)				(4)-(2)	(1*)-(1)	(2)-(1*)	(3)-(1)	(3*)-(3)	(4)-(3*)
Inequality											
Gini	0.3	0.0	-1.5	0.0	1.8	-1.3	0.0	1.7	-1.6	0.0	1.9
	(0.6)	(0.5)	(0.0)	(0.0)	(0.6)	(0.0)	(0.0)	(0.6)	(0.0)	(0.0)	(0.6)
Atkinson 0.5	0.3	0.0	-0.7	0.0	1.0	-0.7	0.0	1.0	-0.7	0.0	1.1
	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.2)	(0.3)
Atkinson 1	0.9	0.0	-1.4	0.0	2.3	-1.4	0.0	2.2	-1.5	0.0	2.4
	(0.5)	(0.4)	(0.5)	(0.4)	(0.5)	(0.6)	(0.4)	(0.5)	(0.4)	(0.4)	(0.5)
P90/P10	-0.1	0.0	-0.4	0.0	0.3	-0.4	0.0	0.3	-0.4	0.0	0.3
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Redistribution effect	-0.8	0.0	1.5	0.0	-2.2	1.3	0.0	-2.1	1.6	0.0	-2.4
	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)
Vertical equity	-1.0	0.0	1.4	0.0	-2.5	1.3	0.2	-2.5	1.6	0.2	-2.8
	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
Poverty											
FGT0 (%)	-1.7	0.0	-2.6	-0.2	1.1	-2.5	-0.2	1.0	-2.6	-0.2	1.1
	(0.7)	(0.7)	(0.2)	(0.1)	(0.7)	(0.2)	(0.1)	(0.7)	(0.2)	(0.1)	(0.6)
FGT1 (%)	-0.01	0.0	-0.6	-0.1	0.7	-0.6	-0.1	0.7	-0.6	-0.1	0.7
	(0.2)	(0.2)	(0.0)	(0.0)	(0.2)	(0.0)	(0.0)	(0.2)	(0.0)	(0.0)	(0.2)
FGT2 (%)	0.1	0.0	-0.2	0.0	0.3	-0.2	0.0	0.4	-0.1	0.0	0.3
	(0.1)	(0.1)	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.1)
Child poverty											
FGT0 (%)	-6.8	0.0	-6.6	-0.1	-0.1	-6.0	-0.2	-0.6	-7.1	-0.4	0.8
	(1.3)	(1.4)	(0.6)	(0.2)	(1.3)	(0.6)	(0.3)	(1.4)	(0.6)	(0.2)	(1.2)
FGT1 (%)	-1.3	0.0	-1.5	0.0	0.3	-1.6	-0.1	0.4	-1.5	-0.1	0.3
	(0.3)	(0.3)	(0.1)	(0.1)	(0.3)	(0.1)	(0.1)	(0.3)	(0.1)	(0.1)	(0.2)
FGT2 (%)	-0.4	0.0	-0.4	0.0	0.0	-0.4	0.0	0.0	-0.4	0.0	0.0
	(0.1)	(0.1)	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.1)
Single parents											
FGT0 (%)	-7.9	0.0	-8.6	-2.3	3.7	-6.1	-3.5	1.6	-11.1	-2.9	6.0
	(3.5)	(3.5)	(1.5)	(0.6)	(3.4)	(1.3)	(0.6)	(3.5)	(1.7)	(0.6)	(3.4)
FGT1 (%)	-0.9	0.0	-2.5	-0.4	2.1	-2.2	-0.5	1.9	-2.7	-0.4	2.2
	(0.7)	(0.7)	(0.2)	(0.1)	(0.7)	(0.2)	(0.1)	(0.7)	(0.2)	(0.0)	(0.6)
FGT2 (%)	0.0	0.0	-0.6	-0.1	0.7	-0.6	-0.1	0.7	-0.5	-0.1	0.6
	(0.3)	(0.3)	(0.1)	(0.0)	(0.3)	(0.1)	(0.0)	(0.3)	(0.1)	(0.0)	(0.3)

Note: Period 0 is 1998 and period 1 is 2001. Policy effects in decompositions III and IV (not reported) are identical to those in decompositions I and II respectively. The policy effect under the Shapley value decomposition is the average of (4)-(2) and (3)-(1). The behavioural effect is the average of (1*)-(1), (3*)-(3), (2)-(2*) and (4)-(4*). Bootstrapped standard errors are indicated in brackets.