# The Public Policy Preference Calculator (TriplePC): Developing a comprehensive welfare policy microsimulation

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## Abstract

Prospective welfare policies have often been assessed on their financial impacts – net household incomes, marginal and average tax rates, and the like. However, welfare policies can have a substantial effect on population health and wellbeing. In addition, politicians must consider the electoral implications of policies that would affect large sections of the population.

In this paper we describe a new microsimulation model with a public-facing user interface, the Public Policy Preference Calculator (TriplePC), which enables automated assessment of economic and health impacts as well as public preferences over possible welfare policies. TriplePC uses data from, and regressions based on, major UK sources such as the Family Resources Survey, Understanding Society: The UK Household Longitudinal Study (UKHLS) and the Wealth and Assets Survey, alongside our own conjoint experimental surveys on public preferences. We find that model produces estimates that are within reasonable bounds compared with existing models. Though not without its problems, Triple’s ability to simultaneously model the financial, health and political implications of a policy is, we believe, unique.

*Keywords: Welfare policy, polling, public user interface, conjoint analysis*

## Introduction

In this paper, we describe the Public Policy Preference Calculator (TriplePC), a new microsimulation model that seeks to extend the microsimulation art in two ways.

Firstly, as well as modelling the outcomes of a policy in the conventional way, our model uses Conjoint Analysis to give an indication of the policy’s popularity. This is novel and important. There are measures that in principle should bring benefits to almost everyone which policy makers have been unwilling to touch for fear of their electoral consequences. Perhaps the best example from UK history is the SDP/Liberal Democrat’s “Dead Parrot” merger manifesto of January 1988 ((Gourley, n.d., )Crewe & King, 1995), which proposed the abolition of Child Benefit and the imposition of a uniform rate of Value Added Tax (VAT) to raise money for an anti-poverty program. Although this had been modelled in detail, fear of the electoral consequences amongst Members of Parliament meant the manifesto was abandoned within a day; the resulting confusion and indecision arguably caused long-lasting damage to centrist politics in the UK(Crewe & King, 1995). The UK’s zero-rating for food and children’s clothing remains politically untouchable to this day despite the orthodox economic arguments in favour of a uniform rate (Crawford et al., 2010). But would VAT extension really be unpopular, especially if it was part of a package that used the money raised for poverty reduction or other appealing policies? Our approach allows us to address questions like this.

Secondly, we integrate health outcomes into the model. There is strong evidence that welfare policies can have a substantial effect on population health. A stark reminder of the real impact of worsening population health can be seen in the proportion of the UK population with a long-standing illness, disability or impairment which causes substantial difficulty with day-to-day activities. This is estimated to have risen from 19% in 2011/12 to 24% in 2021/22, an increase of 3.9 million people (Department for Work and Pensions, 2023). Indeed, the estimate increased from 14.1 million in 2019/20 to 16.0 million in 2021/22 (Department for Work and Pensions, 2023). Interestingly, the proportion among state pension age adults has remained the same between 2011/12 and 2021/22 at 45%, whereas for working-age adults it has increased from 16% to 23% and for children the figures are 6% to 11%. This suggests that increases in prevalence are not simply the effect of an ageing population (Department for Work and Pensions, 2023).

In that context, it is essential that policymakers invest real thought in realising the Government’s prevention agenda (Department of Health and Social Care, 2018), which was incorporated into the 2019 NHS England Long Term Plan (NHS England, 2019). Forty-three years on from the Black Report which highlighted the role of material circumstances on health inequalities (Working Group on Inequalities in Health, 1980), 13 since the Marmot Review (Marmot et al., 2010) and three since its 10-years-on update (Marmot et al., 2020) which highlighted worsening trends in inequalities, there is good reason to examine and tackle social determinants of health.

Some of the authors of this paper (Johnson et al., 2022) have called for trials of cash transfers, in particular Basic Income, as an upstream intervention to mitigate poverty, inequality and insecurity as social determinants of mental and physical ill-health. Systematic reviews of cash transfer schemes that resemble Basic Income, such as Gibson, Hearty and Craig’s (Gibson et al., 2020), have indicated positive impacts on mental and physical health, hospital attendance and health related behaviour, such as alcohol and drug use. In contrast, conditional, means- and needs-based welfare systems in high-income countries are associated with below average health outcomes (Shahidi et al., 2019) and increased psychological distress prevalence (Wickham et al., 2020). We have suggested several explanations (Johnson et al., 2022): schemes are ‘insufficient to offset the negative health consequences of severe socioeconomic disadvantage’ (Shahidi et al., 2019); conditionality and assessment inflicts stress (Dwyer et al., 2020) and creates perverse incentives for health-diminishing behaviour (Johnson et al., 2022); and focusing on the poorest fails to mitigate broader determinants that affect society as a whole (Marmot et al., 2010).

There are existing health simulations for the UK. Public Health Scotland’s Informing Interventions to reduce health Inequalities (Triple I) tools focus on comparing the effects and costs of a range of tax-benefit (including a Basic Income) changes as well as non-economic programmes such as a lifestyle weight management service, 20 mile per hour speed limits or Alcohol Brief Interventions. Effects and costs modelled are based on premature deaths, years of life lost and hospital stays, with changes population health and inequalities as the key measures. It does not model the economic impacts on household types nor public preferences.

Most other health microsimulations tend to model the economic effects of health, rather than the other way round (Schofield et al., 2017). There are some that model the effects of, potentially economic, interventions on health, particularly with regard to extrapolating from childhood and adolescence, for example, the University of York’s LifeSim (Skarda et al., 2021)

We therefore decided to create microsimulation with a public-facing user interface – the Public Policy Preference Calculator (TriplePC) – that would enable automated assessment of economic and health impacts as well as public preferences between different welfare and tax policies. The Triple model project therefore had three strands:

1. Estimating the likely electoral popularity of possible policies; and
2. Deriving relationships between income and health, in a form suitable for use in a microsimulation;
3. The integration of 1) and 2) into a microsimulation tax-benefit model.

We discuss these in turn.

## 2 Policy Popularity - Conjoint Analysis

Conjoint analysis (Hainmueller et al., 2013) is a survey-based technique originally developed as a market research tool, to examine how consumers value characteristics (sweetness, colour, alcohol content, etc.) of goods. Recently, the technique has become popular as a method for discovering the public’s relative valuations of competing economic or social policies(Bremer & Bürgisser, 2023). In these studies, respondents are repeatedly invited to choose their preferred option from a pair of policies. The policies vary in terms of a series of attributes (tax rates, benefit levels, etc.) whose levels are randomly permuted. This allows researchers to estimate the average impact of any particular feature attribute-value on preference for the policy. Critically, the strength of preference or dis-preference for several different policy attributes can be simultaneously estimated and measured on comparable scales. This allows computation of Average Marginal Component Effects (AMCEs) (Hainmueller et al., 2013) from linear probability models. The AMCE for a given level of an attribute can be interpreted as the marginal effect on the probability of choice of the attribute being at that level compared to the reference level, averaging across the possible levels of all other attributes. Research comparing conjoint survey experiments to actual votes has shown that the conjoint results are good predictors of voting outcomes (Bansak et al., 2023).

For the present study, we recruited 800 UK resident adults through the Prolific online platform. Participants were told they would be asked, several times, to choose their preferred welfare policy from sets of two. Instructions explained that participants might prefer some features in one policy and some in the other, but they needed to consider which policy they preferred overall. The attributes on which the policies varied were explained in greater depth prior to the first choice task, and then described just with brief phrases during the choice tasks themselves.

Each participant completed 15 choice tasks. Each option within each task was defined by 10 attributes. Each attribute had between three and nine possible levels. All options were fully randomly generated from the possible combinations.

All scenarios envisaged a hypothetical basic payment, differentiated only according to whether the recipient was a child, working age adult or pensioner. The size of the payment constituted the first attribute. The next attribute specified a range of personal income tax rates that would come into force. A separate attribute proposed several other funding methods, including increasing government borrowing, abolishing the personal income tax allowance, wealth and carbon taxes. Four attributes covered the consequences for, respectively: poverty; inequality; life expectancy (as an index of physical health); and anxiety and depression cases (as an indicator of mental health). For these attributes, the reference category was always the status quo, and the other levels represented increases or decreases of varying magnitudes. The remaining three attributes cover the institutional design features: whether universal to all residents, or more restricted; whether means tested; and whether conditional on having or seeking work. Table 1 gives the full list of attributes and levels.

Through randomization and a high number of such pairwise comparisons, this allows us to quantify the causal effect of including specific levels of individual reform elements on the support for the entire reform package, compared with the support for a reform package that contains the baseline level (status quo) of this particular reform element (Nettle et al., 2023).

|  |  |
| --- | --- |
| Attribute | Levels |
| Payment size | * Child - £0; Adult - £63; Pensioner - £190 * Child - £41; Adult - £63; Pensioner - £190 * Child - £0; Adult - £145; Pensioner - £190 * Child - £41; Adult - £145; Pensioner - £190 * Child - £63; Adult - £145; Pensioner - £190 * Child - £63; Adult - £190; Pensioner - £190 * Child - £95; Adult - £190; Pensioner - £230 * Child - £41; Adult - £230; Pensioner - £230 * Child - £95; Adult - £230; Pensioner - £230 |
| Income tax | * Basic rate - 20%; Higher rate - 40%; Additional rate - 45% * Basic rate - 30%; Higher rate - 50%; Additional rate - 60% * Basic rate - 40%; Higher rate - 60%; Additional rate - 70% * Basic rate - 48%; Higher rate - 68%; Additional rate - 78% * Basic rate - 50%; Higher rate - 70%; Additional rate - 80% * Basic rate - 65%; Higher rate - 85%; Additional rate - 95% |
| Other funding | * Removal of income tax-free personal allowance * Increased government borrowing * Corporation tax increase * Tax for businesses based on carbon emissions * Tax for individuals based on carbon emissions * Tax on wealth * VAT increase |
| Poverty | * Decreased by 100% * Decreased by 75% * Decreased by 50% * Decreased by 25% * Decreased by 10% * Decreased by 5% * Increased by 5% * Increased by 10% * Increased by 25% * Increased by 50% |
| Inequality | * Decreased by 50% * Decreased by 25% * Decreased by 10% * Decreased by 5% * Increased by 5% * Increased by 10% * Increased by 25% * Increased by 50% |
| Life expectancy | * 0 more or less years on average * 5 fewer years on average * 3 fewer years on average * 1 less year on average * 1 more year on average * 3 more years on average * 5 more years on average |
| Anxiety and depression | * Same number of cases * 50% fewer cases * 25% fewer cases * 10% fewer cases * 5% fewer cases * 5% more cases * 10% more cases * 25% more cases * 50% more cases |
| Conditionality | * People in and out of work are entitled * People who are not disabled are required to look for work * Only people in work are entitled * Only people out of work are entitled |
| Means testing | * People with any or no amount of income are entitled to the full benefit * Only those with incomes less than £20k are entitled to the full benefit * Only those with incomes less than £50k are entitled to the full benefit * Only those with incomes less than £125k are entitled to the full benefit |
| Universality | * Anyone residing in the UK for more than six months are entitled * Only citizens and permanent residents are entitled * Only citizens are entitled |

Note that only one option from each group could be chosen. This is a problem for the ‘other funding’ group, where a respondent might prefer a mix of policies, but can only choose one. Note also tax and benefit levels are grouped as single choices.

A companion paper (Nettle et al., 2023) discusses the results of the Conjoint analysis in full. In summary:

* more generous payments were more preferred than less generous ones;
* decreases in poverty (compared to the status quo) were strongly preferred;
* preferences on tax rates depended on the broad effects of the policy package. Increasing personal income tax rates were popular if the package they were part of also decreased poverty, and unpopular otherwise;
* a wealth tax, carbon taxes, and increased corporation tax, were all preferred to increased government borrowing;
* there was a significant positive effect of a large reduction in inequality, and a significant negative effect of a large increase in inequality. However, the effects were weaker than for poverty;
* other health and well-being consequences also had some significant marginal effects above and beyond those of poverty and inequality: an increase in life expectancy of five years was significantly preferred to the status quo, and a decrease in life expectancy of five years significantly dispreferred;
* increased rates of anxiety and depression was dispreferred relative to the status quo, and there was a slight preference for policies that decreased them sharply;
* there was no strong preference for or against means-testing or other restrictions on eligibility.

There were differences between left- and right- supporting participants, in the expected directions, but these differences were mild; there was no significant variation by gender or between rich and poor. The elderly were significantly less keen on high income tax schemes and, curiously, less concerned with heath consequences.

The Conjoint analysis was conducted ahead of the construction of the microsimulation model. As we discuss below, some of the measures in table 1 (income tax, benefit levels, poverty and inequality rates) are reasonably straightforward to model (though there are issues around definitions). Others, such as the Other Funding options and the relationship between income and health, are harder.

## 3 Modelling Health

We model two health measures: mental health and life expectancy. We build a model relating SF-12 scores (Ware, 2002) to income and demographic characteristics. SF-12 is a widely used measure of an individual’s health-related quality of life, with two summary scores: the Physical Component Summary (PCS-12) and the Mental Component Summary (MCS-12). The model is estimated over 12 waves (2009/11-2020/22) of the UK Understanding Society (US) (Institute for Social and Economic Research, 2023) panel data. Another companion paper (Reed XXX, forthcoming) discusses this modelling in detail.

### 3.1 Health Modelling Strategy

Our health model is estimated using a fixed effects ‘within-between’ model, which combines the effect on health of both an individual’s income in one wave vs their average across waves, and their average across waves compared with the sample average. Lagged health outcomes are used to disentangle the relationship between mental and physical health and:

1. within-individual variations of income at one time point compared with their average across the waves; and
2. between-individual differences in income averaged across survey waves.

The model is a reformulation of the standard Mundlak model and has a significant advantage in being able to retain the flexibility of random effects models while reducing concerns about bias that fixed effects models address.(Bell et al., 2019; Bell & Jones, 2015). We believe that this model captures several key income-based drivers of health, including:

* temporary income shocks (within component), which see individuals’ income increase or decrease in one wave compared to their average;
* permanent income shocks (between component), which see an individual’s average income either be closer to or further away from the population average;
* objective inequality (between component), which see differences between individuals’ average income, which is calculated over a longer, enduring, period; and
* subjective social status inequality (between component), which is the psychological phenomenon driven, in part, by income inequality.

It does not, however, capture what we anticipate through our model of impact to be very substantial benefits from systems such as Basic Income of increased security of income and protection from destitution for a very large proportion of the population in even relatively highly paid jobs.

Appendix 1 shows our main SF-12 regression.

We also estimated a random-effects logistic regression, with a dichotomous health variable created from continuous scores using clinically significant thresholds used to indicate the presence of depressive disorders (Reed 2023©), but this was not used in the TriplePC model.

### 3.2 Mental health

We create a binary variable for cases of depressive disorder which takes the value of 1 if the individual’s imputed MCS-12 score is ≤45.6 and 0 otherwise (Vilagut et al., 2013).

### 3.3 Life expectancy

We impute life expectancy from SF-12 in three steps:

1. firstly, we convert SF-12 scores to SF-6D (Brazier et al., 2002), using software from QualityMetric (QualityMetric, 2022). SF-6D is a preference-based measure of health;
2. we then use the SF-6D score to calculate quality-adjusted life years (QALYs). QALYs are a widely recognized standardised measure of health outcomes commonly used in health economics (Drummond et al., 2015; Kaplan & Hays, 2022);
3. finally, we calculate life expectancy, from the QUALYs, using multipliers (conditional on gender and age. The multipliers are derived from (McNamara et al., 2023).

## 4. Microsimulation – The TriplePC model

As we saw in our discussion of Conjoint analysis above, the respondents have preferences over instruments (tax rates, benefit levels, etc.) and outcomes (poverty and inequality levels, numbers of mental health cases, etc.). We use microsimulation to bridge between them.

The analysis uses a heavily adapted version of Scotben (Stark 2023a), an open source microsimulation model of Scotland written in the Julia programming language. Scotben is a conventionally structured static tax-benefit model, in the family of models branching out from the Institute for Fiscal Studies’ TAXBEN (Johnson et al 1990) of which two of this paper’s authors (Reed and Stark) were developers. For this project the scope we extended the scope of the model to Great Britain[[1]](#footnote-1)using a single 2021/22 Family Resources Survey (FRS) dataset (DWP, 2019).

The outcome questions - poverty, inequality, health and so on - are phrased as changes - "50% fewer cases" for mental health, "Increased by 50%" for poverty and so on. A particularly tricky question arising from this is establishing a baseline for comparison: changes from what? The conjoint survey had no 'keep things as they are' option for the tax and benefit instruments, so we have two options:

1. using a tax-benefit system some way from the current one as baseline and assuming that the outcome changes represent changes in poverty, health, etc. from that point, rather than changes from the actual current situation; or
2. using the current system as the baseline - but if we do that the default output will have significant deviations for the outcome variables.

We opted for 1) on the grounds that it makes the conjoint popularity output much easier to understand. So the model starts from some distance from where we currently are.

### 4.1 Income Tax Taxes

The conjoint experimental survey has six tax rate options of the form:

Basic rate - 20%; Higher rate - 40%; Additional rate - 45%

See table 1. The first of these are the current non-Scottish UK income tax rates, which we take as the base[[2]](#footnote-2); all other options represent rate increases. We assume the corresponding thresholds are as present. Since we have to remain consistent with the Conjoint analysis the six groups in table 1 only tax rate options presented to the user, though the model can handle any combination of rates and thresholds. We assume no behavioural responses to changing tax rates and make no corrections for underreporting of incomes beyond that embodied in the FRS sample weights.

### 4.2 Benefits

The benefit questions in the conjoint survey were about a hypothetical system of payments that most closely reflects the simplicity of Basic Income. There were also questions about eligibility, means-testing and citizenship; see table 1 above. It is not clear how this proposed system of cash transfers should interact with the existing tax and benefit system, especially bearing in mind that the question is not how an expert believes they should interact, but what was most likely in the mind of the respondents. We follow our recent analysis (Johnson-Reed) and assume:

1. means-tested benefits are retained[[3]](#footnote-3);
2. most other benefits, including the state pension and Child Benefit, are abolished and replaced by the cash transfers.
3. Needs-based benefits such as those based on sickness or disability, like Personal Independence Payment (PIP), are retained.

The least generous set of options: Child - £0; Adult - £63; Pensioner - £190 are taken as the base values. Compared to the actual system, this means that we’re starting from a social security system that’s considerably more expensive (because of the adult payments), but where pensioners are usually slightly worse off (£190 vs £203.85 for the new State Pension and where families with large numbers of children not on means-tested benefits are worse off, since the cash transfer to children is zero in the default case and the payments to adults are not always enough to compensate. We do not adjust taxes to meet these extra base costs. For eligibility, means-testing and citizenship options, it seemed plausible that at least some of the respondents might be aware of the means and eligibility tests from existing benefits. Consequently, we model the eligibility rules that apply to the ‘legacy’ UK benefits - Working Tax Credit and Income Support/Employment Support that are in the process of being phased out, and the means-tests are taken from the new Universal Credit[[4]](#footnote-4).

### 4.3 Modelling Other Funding Options

Table 1 includes a number of “Other Funding Options” that are worth discussing briefly. There is ambiguity in some of these options: a wealth tax or carbon levy could be implemented in many ways, for instance. We make what we hope are reasonable assumptions for these cases, but for the microsimulation to be fully consistent with the conjoint survey we'd have to know what was in the mind of the respondents. This section discusses how we tackled modelling three of these options.

#### 4.3.1 ‘Increase in VAT’ (Value Added Tax)

Our FRS dataset has no expenditure data. The main UK source of household expenditure data is the Living Costs and Food Survey (LCF) (Office for National Statistics, 2019a). To model the complex set of VAT exemptions and zero rated goods[[5]](#footnote-5), we therefore have three choices:

1. Switching the primary dataset to be the LCF. LCF[[6]](#footnote-6) was the primary dataset of all UK Tax Benefit Models until it was supplanted by the FRS - LCF remains the source used in the Treasury’s IGOTM model (Brice, 2015). But to model other options such as wealth taxes we would need still other datasets; switching between multiple different datasets, and hence slightly different base outcomes, depending on which options were being modelled, could be confusing;
2. Imputing expenditure data onto the FRS via a demand system. This seems appealing: the model would be consistent with economic theory, expenditure could vary with tax rates, and in principle we could use the demand system to calculate changes in economic welfare rather than just estimate cash changes. But it’s infeasible to build a demand system with fine enough detail to adequately model the complex set of exemptions and zero-rated goods.
3. Assigning LCF records to our primary FRS dataset using data matching. This was the option we chose Since it’s important to capture the relationship between income and expenditure, we performed the matching in two steps, first selecting a candidate group of LCF donors in the conventional way matching on age, sex, tenure, etc, and then ranking amongst those candidates by income.

#### 4.3.2 `Tax on wealth`

Modelling wealth is tricky for three reasons:

1. Our primary FRS data data has limited wealth data, mainly intended to help model benefit eligibility tests, so, as with VAT simulation, we need to augment our dataset;
2. The form this wealth tax should take is not specified;
3. Wealth Taxes are held to be especially easy to evade or avoid ((Scheuer & Slemrod, 2021)

To solve 1), we impute data from the Wealth and Assets Survey (WAS) (Office for National Statistics, 2019b) onto the FRS households. We chose to do this using a simple linear regression of three categories of wealth (pensions, housing and financial and other assets) against household characteristics that are both in the FRS and WAS. A regression was chosen over data matching because we thought it would be useful for modelling evasion; in the event we lacked both time and a good theoretical model of avoidance/evasion, so no modelling of evasion was done; in retrospect, therefore, matching might have worked better.

For the form of the tax, we were guided by the Wealth Tax Commission (Advani et al., 2020): we followed their recommendations of excluding pension wealth, having an allowance of £500,000, and having the tax payable over five years, though we deviated from the Commission in applying the tax to aggregate household wealth rather than individual wealth (Chamberlain, 2020)**.**

To ensure that the tax is set at the right level to meet the costs of any benefit increases, a simple root finding module[[7]](#footnote-7) was integrated into the model. This searches for the rate that sets the net cost of the scheme to zero. In practice this is overkill: in the absence of evasion, a simple division of the wealth tax base by the required revenue would produce the right value, but many other use cases of this module are non-linear, for example adjustments of tax allowances, or changes in rates where there is a behavioural response.

Even when payable over 5 years, the payments from wealth taxes needed to pay for some of the more generous benefit schemes can exceed net income for many families, especially elderly families who have high housing wealth. Most likely the scheme would need to be augmented by an income-related rebate scheme, or some scheme to defer until death.

#### 4.3.3 Corporation Taxes

Building a plausible micro-data based model of Corporation Tax(CT) is difficult and not something that could be contemplated for this project. In any case, for a household based microsimulation model, what matters is the incidence of the tax on the households: this could be on profits, or passed on in price increases or real wage reductions, (Harberger 1962, Atkinson and Stiglitz (2015). If we make a simple ‘small country’ assumption: that the rate of return on capital and the price of tradeable goods are set exogenously on world markets, then Corporation Tax is ultimately incident on (private sector) wages and self-employment income. This is what we model: we calculate the tax increase needed to meet the costs of the benefit increase and reduce the wage bill by that amount. Note that as the wage bill falls, direct tax revenues also fall, but in a non-linear way because of the tax allowance and progressive tax rate structures, so finding the correct CT increase requires the use of our root-finder. In practice the CT rates needed for the more generous benefit increases can be implausibly large, exceeding in some cases total UK Corporation’s Gross Profits.

## 5. Model flow

Putting all this together, a model run has five main stages:

1. the user selects from the Payment size, Income tax, Other funding, Conditionality, Means testing, Universality options from table 1;
2. the model then calculates net incomes for each person in the FRS households given these choices;
3. these net incomes are in turn plugged in to the equations discussed in section 2 above to give us our estimates of changes to the prevalence of depressive disorders and mortality;
4. the model next calculates gainers and losers, revenues and costs, and changes poverty and inequality;
5. finally, the model calculates conjoint public preferences based on 1 to 4 above and displays the results.

The model has a simple single page web interface, publicly available at: [pppc.virtual-worlds.scot](https://pppc.virtual-worlds.scot/). Figure 1 below shows this in action. The user has selected a relatively generous benefit increase (top left panel), partially paid for by income tax increases (top centre). The bottom half of the screen shows the results, relative to the base discussed in section 3 above. Health results are in the bottom row, showing small mental health improvements. The net cost of this scheme is £118bn (right middle panel). Poverty and inequality are both reduced (centre left panel). The Conjoint analysis is in the centre: the scheme is more popular by 4.7 points than the baseline due to the popularity of the poverty and inequality reductions and the benefit increases, though this is partly offset by unpopular tax increases.

## 6. Lessons Learned

One important lesson for future work in this spirit is the need for good coordination between the Conjoint analysis with the microsimulation modelling.

In our case, the conjoint analysis was conducted ahead of microsimulation modelling work. Consequently microsimulation requirements were largely fixed by the questions in the Conjoint survey. This has a number of consequences:

* the model could present only a very limited set of options for taxes and benefits compared to the model’s underlying capabilities. Slightly re-worked questions, for example asking about basic and higher tax rates individually, could have allowed much more flexibility;
* The meaning of options such as ‘Tax on Wealth’ need to be made clearer. It wasn’t always clear that we were simulating the things that were in the survey participant’s minds;
* Co-development of the conjoint survey and microsimulation might have allowed respondents could see immediately the consequences for incomes and health of their choices;
* Some of the options in the survey, such as VAT increases, were quite burdensome to model in the time available. To get any useful results for some options requires very strong assumptions;
* Careful thought needs to be given to the definition of the base case the model is comparing against.

There are also interesting questions about how best to present results of a model with such diverse outputs: for instance: can we count payments by a household from a wealth tax in the same way as a payments for income tax? Should we be imputing a monetary value to any health improvements?

It’s also worth mentioning the software development process here. Building TriplePC, including the user interface, took under 6 weeks. In the code, emphasis is put on modularity and careful encapsulation of the key data structures: households, tax systems and so on[[8]](#footnote-8). TriplePC is developed ‘Test First’ (Beck, 2003) Google, Inc., n.d.) : tests of the functionality in a module (‘unit tests’) are written before development of the module itself, and only the code needed to pass the tests is written[[9]](#footnote-9). Modularity and test-driven development are excellent investments. The modular organisation makes it easy to bolt together variants of the model for different purposes and continually running test suite during development minimises the chances of introducing new errors. The development phase of the TriplePC model took just 6 weeks in total. The clean design makes it much easier to add these things as needed.

## 7. Conclusion

We’ve presented here TriplePC, a new microsimulation model with novel but important features. We’ve established the importance and practicality of using Conjoint analysis to provide instant analysis of the political implications of welfare packages, but also learned some important lessons on how best to conduct integrated microsimulation and Conjoint analysis. We’ve also estimated new measures of the relationship between income and health and shown how these, too, can be integrated into the model. TriplePC is available online and its source code is released under an open-source licence.

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|  |  |  |  |
| --- | --- | --- | --- |
| Appendix 1: Regression Results  **Dependent Variable: SF-12** |  |  |  |
|  | **Coef** | **Standard Error** | **t** |
| Quintile 2 x log(hh income) | -0.065569 | 0.0104701 | -6.26 |
| ©Quintile 3 x log(hh income) | -0.0412175 | 0.0083636 | -4.93 |
| Quintile 4 x log(hh income) | -0.020758 | 0.0068287 | -3.04 |
| Log household income (before housing costs) | 0.168725 | 0.0648695 | 2.6 |
| Q1xLog: change since t-1 | -0.0625272 | 0.107147 | -0.58 |
| Q2xLog: change since t-1 | -0.552859 | 0.167747 | -3.3 |
| Q3xLog: change since t-1 | -0.893208 | 0.162844 | -5.49 |
| Q1xLog: change since t-1 | -0.659554 | 0.158131 | -4.17 |
| log(hh income): change since t-1 | 0.0676555 | 0.0926011 | 0.73 |
| SF12 lagged 1 period | 0.526276 | 0.0015297 | 344.04 |
| Female | -0.799361 | 0.0301345 | -26.53 |
| Race: missing | 0.827287 | 0.260076 | 3.18 |
| Race: mixed | -0.423578 | 0.117867 | -3.59 |
| Race: asian | -0.215313 | 0.0672696 | -3.2 |
| Race: black | 0.855579 | 0.0941759 | 9.08 |
| Race: other | -0.0818178 | 0.198981 | -0.41 |
| Born: missing | -0.441249 | 0.131706 | -3.35 |
| Born: uk | -0.251682 | 0.0552214 | -4.56 |
| Limiting long-standing illness | -1.94819 | 0.0330161 | -59.01 |
| Married or civil partnership | 0.493277 | 0.04302 | 11.47 |
| Divorced or separated | -0.0224856 | 0.0580789 | -0.39 |
| Widowed | 0.493978 | 0.0767766 | 6.43 |
| Age: 25-34 | -0.96693 | 0.0686889 | -14.08 |
| Age: 35-44 | -0.662258 | 0.0701197 | -9.44 |
| Age: 45-54 | -0.204126 | 0.0709515 | -2.88 |
| Age: 55-64 | 0.616918 | 0.0749932 | 8.23 |
| Age: 65-74 | 1.18085 | 0.0934391 | 12.64 |
| Age: 75+ | 1.32779 | 0.105433 | 12.59 |
| Highest qualification: degree | -0.124519 | 0.0595372 | -2.09 |
| Highest qualification: other higher education | 0.0742798 | 0.0635622 | 1.17 |
| Highest qualification: A-level or equivalent | 0.117865 | 0.0589437 | 2.0 |
| Highest qualification: GCSE or equivalent | 0.20755 | 0.0579199 | 3.58 |
| Highest qualification: other | 0.193518 | 0.0661833 | 2.92 |
| Economic Status: employed | 2.58229 | 0.0618956 | 41.72 |
| Economic Status: self-employed | 2.97951 | 0.0795412 | 37.46 |
| Economic Status: looking after family | 2.17912 | 0.0870071 | 25.05 |
| Economic Status: unemployed | 0.550354 | 0.0904333 | 6.09 |
| Economic Status: retired | 3.08754 | 0.0829093 | 37.24 |
| Rural | 0.298794 | 0.0350712 | 8.52 |
| Government Region: North West | 0.145243 | 0.0864176 | 1.68 |
| Government Region: Yorkshire/Humberside | 0.17909 | 0.0895601 | 2.0 |
| Government Region: East Midlands | 0.236059 | 0.090613 | 2.61 |
| Government Region: West Midlands | -0.0172429 | 0.0898078 | -0.19 |
| Government Region: East of England | 0.228228 | 0.0885268 | 2.58 |
| Government Region: London | 0.0892817 | 0.0908445 | 0.98 |
| Government Region: South East | 0.164284 | 0.0845966 | 1.94 |
| Government Region: South West | 0.189835 | 0.0885738 | 2.14 |
| Government Region: Wales | -0.071062 | 0.0921799 | -0.77 |
| Government Region: Scotland | 0.29342 | 0.0880426 | 3.33 |
| Government Region: Northern Ireland | 0.512904 | 0.0951431 | 5.39 |
| Tenure: owned or mortgaged | 0.374875 | 0.0493456 | 7.6 |
| Ten: social rented | -0.275005 | 0.0597592 | -4.6 |
| Constant | 20.01 | 0.538538 | 37.16 |

Number of obs = 315,093

R-squared = 0.3677

Adj R-squared = 0.3676

Root MSE = 8.0594

Estimated with STATA-13 on the 20XX-20XX Check!!! Waves of Understanding Society, Adults only. CHECK

1. We exclude Northern Ireland here because of lack of time to adequately model Northern Irish local taxation – ‘Rates’ and ‘Rate Rebates’. [↑](#footnote-ref-1)
2. Scotland has its own five-rate system. Because of the need to impose a uniform base case, we impose the “Rest of UK” three-rate system as the baseline in Scotland too, so we start there from a position where Scottish low earners pay slightly more than in reality, and high earners less. [↑](#footnote-ref-2)
3. A wrinkle here is that the UK has two means-tested benefit systems operating: the ‘legacy’ tax credit-based system and the new Universal Credit (UC) that is gradually supplanting it. For simplicity, in our modelling we assume all households have been transitioned to UC. [↑](#footnote-ref-3)
4. [↑](#footnote-ref-4)
5. See (HM Revenue & Customs (HMRC), 2022); for general discussions of consumption in microsimulation models, see (Crawford et al., 2010) and (Capéau et al., 2014). [↑](#footnote-ref-5)
6. Then the Family Expenditure Survey (FES) [↑](#footnote-ref-6)
7. https://github.com/grahamstark/ScottishTaxBenefitModel.jl/blob/master/src/TheEqualiser.jl [↑](#footnote-ref-7)
8. The complete set of program modules is available at: https://github.com/grahamstark/ScottishTaxBenefitModel.jl/tree/master/src [↑](#footnote-ref-8)
9. https://github.com/grahamstark/ScottishTaxBenefitModel.jl/tree/master/test [↑](#footnote-ref-9)