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1. Introduction

The total effects of a change to fiscal policy can typically be disaggregated into direct (or impact) effects and indirect (or behavioural) effects. The first can be thought of as the “morning after” effects of a reform: the deterministic impact of the change in the rules, when applied to the same population, with unchanged characteristics. The latter consider how individuals might react to the changed incentives provided by the tax-benefit system and can be usefully thought of as incorporating adjustments over the medium term (a few months). Direct effects are often the prime focus of interest in public policy debate. That said, the importance of accounting for behavioural responses when analysing the likely effects of fiscal policy reform scenarios has received much recognition.

Tax-benefit models have been growing in scale and sophistication since at least the personal-computing revolution in the 1980s and are now an essential tool underlying the evolution of national transfer systems. The structure of such models is typically comprised of a tax-benefit calculator that projects the impact of selected payment rules on individuals described by a reference database.¹ This simple analytical structure is designed to enhance transparency of model projections, while permitting programme evaluation over a wide range of dimensions of practical policy relevance, including the incidence of poverty, inequality, and associated implications for the public purse.

Tax-benefit models generally consider only direct “morning after” effects of policy changes – they are static and non-behavioural. In contrast, behavioural responses to policy are a key focus of the wider economics literature. Much attention has been paid by this literature to labour supply responses, reflecting the salience of work incentives in shaping employment choices both at the extensive and intensive margins.² This chapter discusses a simple approach for extending existing tax-benefit models to project (labour supply) behavioural responses.

Traditionally, (static non-behavioural) tax-benefit models have been used as inputs for structural labour supply models.³ This approach is typically based on a complex procedure involving multiple calls to the underlying tax-benefit calculator that test the appeal of alternative employment decisions. We return

¹ Other forms of tax-benefit modelling exist, ranging from highly stylised case-study analyses to full dynamic microsimulation modelling accommodating forward looking behavioural responses to policy alternatives. This study is exclusively concerned with cross-sectional tax-benefit microsimulation models as they are described here.

² Other choices could also be impacted, such as those related to education and fertility.

³ See the discussion in Blundell and MaCurdy (1999); Keane (2011); Aaberge and Colombino (2018).

to describe such approaches in Section 4. Such procedures can be difficult to handle for non-specialists, including policy analysts from diverse fields. The approach set out in this chapter is designed to cut through the complexity by drawing on results reported in the wider literature. Shifting from micro-simulating choices to applying exogenously given elasticities is gaining traction as a simpler alternative for calculating behavioural effects of policy changes. Recent applications include Finland (Ollonqvist et al., 2024) and Norway (Jia et al., 2026). However, the underlying models are not freely available to external users. To the best of our knowledge, UKMOD is to date the only freely accessible model with a behavioural component. Although the chapter is framed around implications for UKMOD most associated discussion is generalisable to the wider literature of tax-benefit microsimulation, and to EUROMOD models in particular.

UKMOD (Richiardi et al., 2021) is an open-source tax-benefit microsimulation model developed for the UK as part of the EUROMOD family (Sutherland and Figari, 2013). There exist several variants of the reference database for UKMOD – all provided to users upon request. They draw respectively from publicly available releases of the Family Resources Survey (FRS), Household Below Average Income (HBAI), and Understanding Society (UKHLS, see Bronka et al., 2023). UKMOD is based upon the EUROMOD software, which is open-source, freely available, and actively developed by the Joint Research Council of the European Commission. The software is designed to facilitate experimentation of alternative tax and benefit policy rules by analysts who have little or no programming expertise. Since 2023, UKMOD includes a behavioural add-on (BVR) that evaluates incentive changes from simulated policy counterfactuals, applies externally estimated elasticities (from the literature) and adjusts behaviour accordingly to distinguish between direct (arithmetic) and indirect (behavioural) effects of policy changes.

The rest of the chapter is structured as follows. Section 2 begins with a brief review of the historical context, which provides useful background for interpreting the contemporary literature discussed in Section 3. Methods for projecting behavioural responses in tax-benefit models are outlined in Section 4, before discussing in Section 5 the approach followed in UKMOD. A summary of key observations and potential roadmaps for future development are provided in a concluding section.

2. Analytical Foundations

Interest in the behavioural implications of income taxes has persisted as long as taxes have enjoyed popular support. Historically, consideration of the behavioural responses to income taxes was limited to theoretical studies due to the absence of associated data sources. The early theoretical literature focussed on the influence of income taxes on the trade-off between leisure and income (e.g. Pigou, 1920; Knight, 1921; Robbins, 1930; Hicks, 1939).⁴ These studies emphasize the countervailing impact of the “income” and “substitution” effects. As income tax rates increase, after tax income tends to fall for any given private income. This decline in disposable income tends to motivate increased labour supply, an incentive response that is commonly referred to as the *income effect*. At the same time, an increase in marginal income tax rates reduces the change in disposable income that is associated with a small change in private income. This decline in the marginal return to private income tends to motivate lower labour supply; commonly referred to as the *substitution effect*. The countervailing nature of income and substitution effects in relation to a change in income tax rates means that it is not possible to say *a priori* whether a rise in rates will motivate more or less work effort, much less

⁴ For a recent review, see Nadirov and Dehning (2023).

provide a gauge to the scale of associated responses. Recognition of this identification problem continues to feature prominently in the contemporary literature.

Early work addressed the need for empirical analysis by eliciting information from survey respondents concerning how income taxes affected their willingness to work. This literature produced mixed results. The Royal Commission on Taxation of Profits and Income (1954), for example, reported that income taxation tended to reduce labour supply. About the same time, a series of studies of middle to higher income earners reported that labour supply was broadly insensitive to income taxation (Sanders, 1951; Break, 1957; Barlow et al., 1966).⁵

However, studies conducted in the 1970s suggest that incentives to work were also negatively affected by income taxes among higher income workers (Fields and Stanbury, 1971; Holland, 1977).⁶ It is noteworthy that income tax rates evolved rapidly during this period: the top rate of income tax in the UK, for example, fell from a peak of 97.5% in 1952 to 60% in 1979.⁷

3. Econometric Findings

How people say they would react to a hypothetical counterfactual can be different from their decisions in practice. The increasing availability of detailed survey microdata from the 1960s, combined with the advance of econometric methods and availability of personal computing, supported a proliferation of empirical studies that measure observed behavioural responsiveness to taxation in general, and labour in particular. For useful reviews of this vast literature, see Keane (2011) updated by Keane (2022).⁸

The sensitivity of behaviour to tax and benefits policy is typically assessed by the empirical literature by evaluating elasticities. For example, a primary focus of the literature concerns the elasticity of labour supply, describing the percentage change in labour supply (e.g. hours of work) associated with a percentage change in disposable income.⁹

A host of difficulties have been identified by the literature relating to empirical identification of labour elasticities. Keane (2011) goes into great detail describing multiple considerations including issues of endogeneity (wages, non-labour income, simultaneity); measurement error (wages and non-labour income), and the dynamics of viewing labour-supply in a life-cycle context (e.g., if current experience influences future wages).

The reviews cited above provide lucid descriptions for recognised complications in measurement, and analytical methods that have been developed to address them. What is important here is that each estimation method considered by the extant literature addresses an incomplete subset of the

⁵ Sanders (1951) was based on survey responses of 160 US business executives, most of whom were salaried employees of large corporations. Break (1957) was based on survey responses of 306 solicitors and accountants who were either partners or owners of their respective organisations. Barlow *et al.* (1966) surveyed 957 citizens of the United States with annual incomes exceeding \$10,000.

⁶ Fields and Stanbury (1971) replicate the work of Break (1957) surveying 285 solicitors and accountants in the UK. Similarly, Holland (1977) reflected the earlier work of Sanders (1951), surveying 125 US business executives.

⁷ Tax rates for a single man without exemptions.

⁸ For further reviews of the early literature, see Killingsworth (1983), Hausman (1985), Pencavel (1986), Killingsworth and Heckman (1986), Blundell and MaCurdy (1999), and Meghir and Phillips (2010), cited by Keane (2011).

⁹ Three alternative elasticities are commonly discussed in the literature. Frisch (constant marginal utility of wealth) elasticities measure the sensitivity of shifting labour to periods of high wages. Hicks (constant utility) elasticities measure the strength of substitution effects. Marshall (constant wealth) elasticities reflect income and substitution effects.

recognised problems associated with identifying labour elasticities. This means that there currently exists no “correct” approach for the measurement of labour elasticities, and all existing estimates are subject to critique in one way or another.

Another key point made by contemporary literature reviews is that, as estimation methods and analytical focus have evolved, so too have consensus estimates for labour elasticities. The review by Keane (2011), for example, notes that male labour elasticities estimated during the 1970s and 1980s, generally reported very low values. These increased appreciably in the subsequent literature, however, as estimations methodologies were adjusted to account for the possibility of forward-looking labour decision making.

The extent of uncertainty in the associated literature is made clear by differences in interpretation reported by Keane (2011) and Bargain and Peichl (2016) cited above. Keane (2011) emphasises the importance of methodological differences underlying the diversity of the reported estimates. In contrast, Bargain and Peichl (2016) focus on the potential role of changing social preferences and “domestic technologies”, finding “less compelling evidence that the choice of estimation method explains much variation in estimates”.

Literature during the last two decades has emphasised population heterogeneity of labour supply elasticities, which are exaggerated when estimates allow for dynamic decision making (Keane, 2011, Bargain and Peichl, 2016, Keane, 2022).¹⁰ Specifically, elasticities have been found to vary with a range of characteristics including gender, education, age, marital status, and dependent children.

4. Microsimulation Modelling

There are two principal approaches that are adopted to analyse behaviour in economics. These are typically referred to as “reduced form” and “structural” methods respectively.¹¹

A reduced form approach describes the relationship between an endogenous (affected) variable, and a set of exogenous (affecting) variables. “Endogenous” denotes “inside the model” – it could represent labour supply in the current discussion. Similarly, “exogenous” denotes “outside the model” – it might represent characteristics described by a microsimulation model’s reference database, the assumed policy parameters governing simulation of tax and benefit payments, or random error terms. In general, no further limitation is imposed by reduced form analytical approaches beyond the basic premise of an intelligible connection between the subjects of interest (policy parameters) and the issues of concern (behaviour).

Reduced-form models of behaviour have many desirable properties. They are highly flexible, can be simple to specify, and can enhance transparency of results. Indeed, the advent of reduced-form modelling has been recognised as “a major force in the transformation of economics from a discursive discipline into a model-building discipline” (Solow, 2004, p. 159).¹² Furthermore, reduced-form

¹⁰ A basic distinction in the analysis is between static and dynamic behavioural responses. Static analyses are concerned with short term trade-offs between income and leisure. In contrast, dynamic analyses take into account intertemporal considerations; for instance, the (real or perceived) temporary nature of announced changes to tax and benefit systems. Reflecting the static approach of most tax-benefit calculators (including UKMOD), discussion focusses in this report on static methods for analysing labour supply behaviour.

¹¹ Current discussion omits quasi-experimental methods – e.g. difference-in-difference or regression discontinuity designs exploiting around income shocks such as lottery wins (Imbens et al., 2001; Cesarini et al., 2017) – as related findings are usually difficult to incorporate within a microsimulation context.

¹² This quote refers to the pioneering work of Jan Tinbergen in the development of “econometric” macro-economic models.

modelling remains popular to the present day. In context of the econometric literature discussed in Section 3, for example, it is concerned with methods that describe labour supply as a function of observable variables, which usually include the after-tax wage rate and non-labour income.¹³

The growing influence of reduced-form modelling on the policy reform process during the 1960s motivated critical appraisal of the approach. This line of enquiry culminated in recognition of the limitations of reduced-form specifications for forecasting the effects of policy counterfactuals, especially from the mid-1970s (Conant and Ashby, 1970; Lucas, 1976; Campbell, 1979; Goodhart, 1984).

The primary critique levelled at reduced-form models focussed on the plausibility of the premise that estimated parameters describing arbitrarily postulated relationships between endogenous and exogenous variables are invariant to changes in the policy environment.¹⁴ A vivid example of this problem was witnessed in the 1970s with identification of a fundamental flaw in government policy based on a simple reduced form specification.

Specifically, in 1958 Philips reported a strong negative relationship between the unemployment rate and wage growth observed during the preceding century in the UK (Philips, 1958). This stable relationship provided an apparently appealing new policy lever: unemployment could be reduced by increasing the rate of inflation. This, culminated in the “stagflation” episodes of the 1970s: stagnant growth, combined with high rates of inflation and unemployment. The Lucas critique provides a rationalisation for this change in the economic context, which led to a shift from the 1980s in favour of structural model specifications that are plausibly invariant to the evolving policy environment.

There is appreciable confusion in public discourse concerning the distinction between reduced form and structural models, which may be partly attributed to relationships between the two concepts. Specifically, as noted above, a reduced-form specification is limited to describing endogenous variables in terms of exogenous variables. In contrast, a structural form makes explicit interdependencies between endogenous variables. Note, however, that it is often possible to derive a reduced-form from a structural-form: this is the case, for example, whenever a system is comprised of two equations with two endogenous variables (i.e. two equations in two unknowns).

Where a reduced form is derived from a structural form, it is typically referred to as a “structurally derived reduced form”, or “structural model” for short. In this context, the term “reduced form model” is typically reserved for descriptions of relationships between endogenous and exogenous variables that are not based on any underlying theoretical foundation. In contrast, structural models are usually specified to reflect some underlying theoretical description for the way that the world works. Such theoretical descriptions are typically specified to be “structurally invariant” to changes in the policy environment, which is the motivation for use of the term “structural”.

As noted above, the concern associated with use of reduced form models to analyse behavioural responses to policy is that such models may vary with changes to the policy environment. In econometrics, this type of model sensitivity is generally characterised as “specification error”. Common forms of specification error include omission of relevant variables, inclusion of irrelevant

¹³ The method was used extensively in the early literature, following seminal work by Hall (1973) and Hausman (1981), with later work in this vein exploring methods to address some subset of the regression challenges discussed in Section 3.

¹⁴ This critique was anticipated by Keynes (Keynes, 1939, p. 567), who noted “the main *prima facie* objection to the application of the method of multiple correlation to complex economic problems lies in the apparent lack of any adequate degree of uniformity in the environment.”

variables, incorrect functional forms, measurement error, simultaneity, and incorrect assumptions concerning residuals. A vast literature has evolved to mitigate these complications, which is beyond the scope of the current chapter.¹⁵ What is worth noting here is that such remedial measures are all imperfect, which is the motivation underlying interest in structural modelling approaches.

The most popular structural theory of behaviour adopted in economics assumes that decisions are made as if to optimise an individual's utility. While the decision-making context may change, the description of utility – including an assumed functional form and associated preference parameters – is assumed to be held “structurally” fixed. The theory is designed to translate incentives into decisions, thereby identifying what is in the “best interests” of the decision-maker in context of a potentially changing policy environment.

Behavioural responses can be included in a static tax-benefit microsimulation model using either reduced-form or structural methods. Each of these alternatives is discussed in turn.

Structural methods

Structural approaches to modelling labour supply responses in economics are typically based on analytical descriptions for preferences. These preferences are often evaluated at the benefit unit (nuclear family) level, reflecting the assessment unit of contemporary tax-benefit systems and the plausibility of resource sharing between household members (however imperfect).

A common class of assumed preferences are referred to as Random Utility Models (RUMs). In these models, labour supply alternatives are discretised. Given estimated wages, gross labour income is computed for each potential labour choice of each adult in a benefit unit and then transformed into disposable household income using a tax-benefit calculator. Preference parameters over income and leisure are estimated to reflect observed choices in context of a description of prevailing tax-benefit policy. As their name implies, an important feature of RUMs is that the assumed utility functions include random components that facilitate reflection of behavioural differences between observationally identical households. Distributional assumptions concerning random components help to obtain analytically tractable formulations for the implied probabilities associated with alternative labour supply choices.

Having empirically identified the parameters of a RUM, projecting labour supply decisions under counterfactual policy contexts is straightforward. Specifically, the utility associated with each discrete labour alternative under a tax-benefit policy context of interest is evaluated – up to the random component. The density function of that random component then gives a probability distribution over the labour supply alternatives considered. In practice, this approach involves evaluating tax and benefit payments multiple times, once for each labour alternative available to each simulated household.¹⁶ As

¹⁵ In the context of labour supply modelling, for instance, the actual marginal tax rate that an individual faces – a crucial policy parameter – potentially depends on how much a person chooses to work. Specific techniques (e.g. use of instrumental variables) have been advocated for attenuating the implied simultaneity problem. In reduced form estimates of labour supply behaviour, simulated instruments have been proposed to control for the endogeneity of the marginal tax rate, whereas the instruments are constructed by calculating the change in the net-of-tax share that would have occurred if the individual had maintained the behaviour he or she exhibited in the initial period (Gruber and Saez 2002).

¹⁶ Expected *simulated* choices will typically be different from *observed* choices even under an unchanged policy landscape, due to the stochastic nature of the model and to the influence of specification errors and parameters uncertainty. Computation of behavioural responses then requires comparing *simulated* choices under a reform scenario with *simulated* choices under a baseline scenario.

such, this approach can considerably increase simulation run-times, relative to non-behavioural (static) alternatives.

A further drawback of RUMs is that non-employment (i.e. 0 hours of work) is typically included as one of the discrete labour alternatives from which households may choose. Allowing for (involuntary) unemployment in this context typically involves consideration of a more sophisticated class of models proposed in the literature, where the choice set that each household faces is itself random, and depends on household characteristics. These models are typically referred to as Random Utility Random Opportunity (RURO) models. Unemployment is then interpreted as a situation where the unit has no options for positive hours of work, distinguished from inactivity where the unit chooses 0 hours against options with positive hours. While theoretically appealing, use of RURO models has been limited due to the increased demands they make on data, and associated instabilities of model parameter estimates. Use of RURO estimates to compute behavioural responses is analogous to RUMs, with the only difference that the choice set for each decision-making unit is itself endogenous to the model.¹⁷

Reduced-form Methods

As discussed in Section 3, the sensitivity of behaviour to tax policy is typically assessed by evaluating elasticities for relevant population sub-groups — conventionally defined by partnership status (couples versus singles) and, for single individuals, by gender. These elasticities are measures of behavioural sensitivity and may be derived from empirical specifications that are either structural or reduced form in nature.¹⁸ It is important, however, to be precise about what elasticities represent and what inferential weight they can bear, regardless of how they are estimated.

In a RUM/RURO framework, the expected hours of work for a given individual are a probability-weighted sum of hours across discrete alternatives, where each choice probability is a smooth function of the net-of-tax wage and virtual income associated with each alternative — themselves determined by the tax-benefit schedule and individual characteristics. Elasticities correspond to the derivatives of this expected hours function with respect to net wages or income, evaluated at the prevailing budget set. As such, they constitute a first-order Taylor approximation to the behavioural response implied by the structural model: they are locally accurate summaries of individual behavioural sensitivity, but they are evaluated at a particular point in the budget set and condition on the full prevailing configuration of wages, non-labour income, tax-benefit parameters, and individual characteristics. It is the underlying preference parameters — not the elasticities derived from them — that are genuinely invariant to policy; elasticities are environment-dependent objects and are therefore less structural than the utility function parameters from which they are constructed. For sufficiently large, non-marginal reforms, this first-order approximation degrades, because the relative utility scores across alternatives shift in ways that the local derivative cannot capture. In practice, however, for reforms of moderate magnitude the approximation error at the individual level is typically small.

The more consequential limitation arises from aggregation. Applying individual-level elasticities — preserving the full distribution of estimated preference parameters, wages, hours choices, and household configurations — is formally equivalent to the first-order Taylor approximation described above, and yields results that closely approximate those obtained by micro-simulating the structural model directly (that is, recomputing utility scores for each labour supply alternative and deriving the implied changes in expected hours) for all but the most radical reforms. Averaging elasticities over

¹⁷ See Aaberge and Colombino (2018) for a review of the RUM and RURO approaches.

¹⁸ Elasticity estimates may also be recovered by exploiting bunching at kink points generated by tax-benefit schedules, following a substantial literature building on Saez (2010).

heterogeneous population sub-groups, however, forecloses this equivalence. A tax reform may have markedly different effects on workers with different wage rates, family structures, or hours of work, and a group-level average elasticity conflates these heterogeneous margins of adjustment. The aggregate predicted response will then diverge from the micro-simulation benchmark not because the structural parameters have shifted, but because aggregation discards precisely the information — about where in the wage, hours, and preference distribution different individuals are located — that the first-order approximation requires to remain accurate. The loss of precision from using a first-order approximation at the individual level is typically negligible; the loss from replacing individual-level derivatives with coarse group averages is not.

For these reasons, the use of estimated elasticities to evaluate behavioural responses is inherently a reduced-form exercise, irrespective of the estimation framework from which those elasticities are derived. An increasing scope of international studies advocates this approach when structural form models are impractical. For example, Jia et al. (2026) propose a reduced-form alternative that would simplify the structural Norwegian LOTTE microsimulation system. The LOTTE-Skatt is a non-behavioural tax-benefit microsimulation model accompanied by the LOTTE-Arbied. The latter is its behavioural counterpart, which estimates labour responses by implementing a job choice framework. The LOTTE-Arbied is, however, noted to be computationally complex due to its structural design. Jia et al focus on individual-level information combined with averaged elasticities extracted from the literature. For the extensive margin, heterogeneity is achieved by obtaining individual measures for changes in the participation tax rate (PTR). At the intensive margin, the effective marginal tax rate (METR) is used. Specifically, Jia et al. use an extensive margin elasticity of 0.2 and at the intensive margin an elasticity of 0.15 for the substitution effect (compensated effect) and -0.05 for the income effect. These elasticities are close to the Danish simulation model (Finansministeriet and Skatteministeriet, 2024).

A very similar approach by Ollonqvist (2024) builds upon the Finnish tax-benefit model SISU. In this study, behavioural responses are also calculated by using the PTR and METR for the extensive and intensive margins to obtain individual response estimates. Ollonqvist chooses a participation elasticity (PTR) of 0.2, which is based upon the survey results of Lundberg and Norell (2020) and is also very close to the estimate for Finland (see Jäntti et al., 2015). At the intensive margin, the elasticity of taxable income (ETI) 0.2 is used, where they implement sensitivity checks using 0.1 and 0.3.

In the UK, most analyses that account for second-order effects in government studies of changes to tax and benefits policy are also based on assumed elasticities. In the case of Department for Work and Pensions (DWP) and HM Treasury modelling, for example, elasticities for labour supply responses draw upon related empirical studies conducted by the Institute for Fiscal Studies (Adam and Phillips 2013; Meghir and Phillips, 2010). A similar approach has been applied to taxable income by the Scottish Government (2020) and Scottish Fiscal Commission (SFC 2021; SFC 2018).¹⁹ As an illustration of the approach, we refer to the assumptions adopted by the SFC, which have been influential in the UK policy context. The SFC models behavioural responses over four domains, one of which is the “behavioural responses to changes in a taxpayer’s marginal rate of tax”.²⁰ The SFC analyses this domain primarily through the use of Taxable Income Elasticities (TIEs) which is a key parameter in tax policy analysis as they capture all observed behavioural responses (hours worked, participation, effort etc.) as an aggregated reduced-form object. TIEs estimate the percentage change in total taxable incomes in response to a one per cent change in the net-of-tax rate. Given the prevalence of this methodology,

¹⁹ See also Saez et al. (2012).

²⁰ The four considered domains are: responses to changes in both marginal and average effective tax rates; additional intra-UK migration responses; and short-term forestalling responses; Scottish Fiscal Commission (2021), 5.13.

we provide further detail, focussing on the (documented) assumptions employed by the Scottish Fiscal Commission.²¹

In 2025/26 the UK administered a multi-step income tax schedule comprised of four discrete rates: a zero rate for individuals with taxable income below their Personal Allowance, a basic rate (20%), a higher rate (40%), and an additional rate (45%). A 5% increase in the basic rate of income tax would affect the marginal effective tax rate – the rate paid on the last £1 earned – of basic rate taxpayers only. In contrast, this change would affect the average effective tax rates – the ratio of total tax paid to total taxable income earned – for all people with taxable incomes above the Personal Allowance.

The SFC project behavioural responses in a way that distinguishes between those projected to experience a change in their marginal effective tax rates from those who experience only a change in their average effective tax rates. Each of these alternatives is discussed in turn.

Responses to changes in marginal effective tax rates (METRs)

The latest TIEs associated with a change to METRs published by the SFC (SFC, 2021) are reported in Table 1. These estimates are drawn from the existing literature, where reported estimates generally lie between 0 and 1, with most estimates lying between 0.0 and 0.3 (Neisser, 2017).

Consider the case of an individual earning £200,000, with an assumed TIE of 0.35, whose (top) marginal tax rate increases from 40% to 45%. This policy change represents an 8.33% ($0.55 / 0.6 - 1$) reduction in the “net-of-tax marginal rate”. In this case, a reduction in total taxable income of 2.92% ($0.35 \times 8.33\%$) would be projected, equal to £5,833 ($200,000 \times 2.92\%$). The increase in tax revenue generated by the rise in marginal tax rate would consequently be reduced by £2,625 ($5,833 \times 0.45$) due to projected behavioural responses.

Table 1: Scottish Fiscal Commission’s assumed taxable income elasticities for 2020/21 budget forecasts

Taxable income start (£)	Taxable income end (£)	Taxable income elasticity
Low	Basic rate limit	0.015
Basic rate limit	80,000	0.1
80,001	150,000	0.2
150,001	300,000	0.35
300,001	500,000	0.55
500,001	High	0.75

Source: Scottish Fiscal Commission (2021), Figure 5.3.

Responses to changes in average effective tax rates (AETRs)

The SFC adopts a more stylised approach for simulating behavioural responses for any individual projected to incur a change to their average effective tax rate but not their marginal effective tax rate. This stylised treatment (ostensibly) reflects the relatively thin evidence base for informing the associated approach.

²¹ Note in the discussion that follows that the Scottish Fiscal Commission uses different terminology than is typical in the economic literature. Whereas the Scottish Fiscal Commission uses the term “intensive margin” to refer to behavioural responses to changes in marginal tax rates, the economics literature uses the term to refer to changes in hours of work given employment. Similarly, the Scottish Fiscal Commission uses the term “extensive margin” to refer to behavioural responses to changes in average effective tax rates, rather than the decision of whether or not to work.

Here, the SFC projects behavioural responses by multiplying the change in total net transfer payments of an individual affected by a considered policy reform by an assumed Average Effective Tax Rate (AETR) factor, on the assumption that behavioural responses work to offset the change in policy. Hence, AETR factors can be thought of as discount rates that dampen the budgetary effects of policy change. The factors assumed by the SFC underlying the 2020/21 Scottish budget forecasts are reported in Table 2.

Consider, for example, the case of an individual paying the top rate of tax, whose net tax liability would increase by £400 in 2020/21 following an increase in the basic rate of tax. In this case, behavioural responses are obtained by multiplying the AETR factor by the change in tax liability and inverting the direction. Hence, a £400 increase in tax liability multiplied by an AETR factor of 0.25 would imply a behavioural response that reduced the tax liability by £100 (400×0.25). The net budgetary effect projected for the policy change would consequently be £300 ($400 - 100$).

Table 2: Scottish Fiscal Commission’s assumed average effective tax rate (AETR) factors for 2020/21 budget forecasts

Taxable income start (£)	Taxable income end (£)	AETR factor
Low	Basic rate limit	0
Basic rate limit	80,000	0.06
80,001	150,000	0.06
150,001	300,000	0.25
300,001	500,000	0.25
500,001	High	0.25

Source: Scottish Fiscal Commission (2021), Figure 5.4.

5. Behavioural Projections with UKMOD

The EUROMOD family of microsimulation models is sufficiently adaptable to project decisions using both reduced-form and structural methods discussed above. The choice between these methods depends on the analytical tasks that motivate associated development, as is common in modelling work.

In 2023 UKMOD was adapted to project behavioural responses to changes in the policy environment – the BVR add-on – following the approach adopted by the Scottish Fiscal Commission, as described above. The reduced form approach was selected in preference to structural methods on the basis of three considerations:

1. Consistency;
2. Transparency; and
3. Efficiency

In terms of consistency, it is highly desirable for a static tax-benefit model like UKMOD to adopt methods in common with associated government departments. Beyond this basic consideration, however, basing UKMOD behavioural projections on an assumed set of elasticities helps the model to keep abreast of empirical methods and related considerations of the evolving empirical literature. This is due to the use in the prevailing empirical literature of elasticities as the standard yardstick for comparisons between diverse modelling approaches.

Transparency of model projections is enhanced by the stylised relationship that elasticities describe between the behaviour of interest and the policy of concern. The stylised form of this relationship also facilitates associated sensitivity analysis, further improving transparency of results. This is in contrast

to structural modelling approaches in which the connection between behavioural parameters and simulation outcomes is often opaque.

Regarding efficiency, a common feature of most methods for projecting behavioural responses to changes in the policy context – both reduced-form and structural – is the need to simulate multiple test cases. With regard to simulations based on assumed elasticities, there typically exists a deterministic (i.e. unambiguous and clearly defined) relationship requiring no more than three simulations: a “base” simulation under the default policy context; a “counterfactual” simulation in which behaviour is unchanged but tax-benefit policy rules are altered; and a “behavioural” simulation that includes behavioural responses evaluated deterministically from comparisons between the base and counterfactual simulations. This is in contrast to structural methods that typically require many more simulation runs to identify behavioural responses.

UKMOD adopts the stylised approach of UK government studies where behavioural responses distinguish between individuals projected to experience changes to their marginal effective tax rates from those that experience only changes to their average effective tax rates. This developmental activity was facilitated by leveraging pre-existing development of the Marginal Tax Rate add-on (MTR), which exists in various forms for many EUROMOD implementations. The MTR add-on evaluates marginal effective tax rates implied by a policy system for every non-zero earner in the input data, thereby supplying a key input for the projection of behaviour as described in Section 4.

Specifically, the BVR add-on builds upon the MTR add-on in four ways: (i) marginal and average effective tax rates are evaluated for the entire population described by the input data; (ii) marginal and average effective tax rates are evaluated separately for five discrete income sources; (iii) behavioural responses projected for net tax burden valued (as described in Section 4); (iv) adjustments to income and employment to reflect the projected behavioural responses.

Computations are undertaken by the BVR add-on by looping over the UKMOD spine seven times. The first loop conducts a standard UKMOD simulation (no add-on). The second to sixth loops evaluate marginal and average effective tax rates by applying small changes to each of the five considered measures of income in turn: earnings, private pensions, taxable property income, taxable investment income, and other income. The final loop draws the computations together to project the effects of imputed behavioural responses. Consistent with the approach of the SFC, behavioural projections prioritise changes to marginal effective tax rates, and only recourse to average effective tax rates if no change in marginal rates is projected.

6. Limitations and scope for model development

As discussed in Section 4, reduced form methods for simulating behaviour are exposed to uncertainty concerning the extent to which the parameters used to evaluate behavioural responses may themselves vary with changes to the policy environment. In the case of UKMOD, one way to mitigate concerns regarding the validity of the reduced-form elasticity approach currently used to project behavioural responses is to add a structural method (such as the RUM/RURO) to the model. This would facilitate extended sensitivity analysis and provide a useful way of sense-checking results.

The elasticity method currently implemented in UKMOD allows behaviour to vary only with respect to taxable income. This reflects the focus on the effects of changes in income tax rates, but is clearly highly restrictive, particularly in relation to simulated benefits policy. Furthermore, as discussed in Section 3, the recent empirical literature highlights heterogeneity of elasticities with respect to a wide range of characteristics including gender, education, age, marital status, and dependent children. Although adapting the model structure to account for greater diversity in elasticities underlying

behavioural responses would be fairly trivial to implement, we are not aware of any up-to-date systematic review of the related literature to help specify and parameterise such an effort.

To conclude, although reduced-form methods have limitations, externally estimated elasticities from the literature are increasingly used in conjunction with static tax-benefit models. In cases where a structural approach is unfeasible, use of external elasticities provides a practical solution that is still flexible and suitable for comparative policy analysis. Implementation barriers are further reduced by extending functionalities of tax-benefit models. The behavioural add-on developed for UKMOD can provide a template for other EUROMOD-based models.

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