*ESRC Microsimulation Seminar Series*

**Seminar 2: 'Adding behaviour'**
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# Behavioural Labour Supply Modelling in DWP

**Alan Duncan and Adam Richardson**

**[EDITED TRANSCRIPT]**

*Alan Duncan:*

Thanks very much Paul for inviting us to I think a really great initiative and one I hope will bear tangible fruit.

This is a talk that is joint, myself and Adam Richardson and it relates to some work that's been underway for some time at the DWP, spookily to add behaviour to what is otherwise a static tax microsimulation process that is used extensively in the DWP for policy evaluation. So over the course of this next say half an hour or so we're hoping to bring you up to speed on this development, both from the theoretical underpinnings of the process that we've embedded in the static microsimulation model and some of the practical issues and issues to do with computation, issues to do with limitations to the model as it currently stands and possible extensions on the basic model which is where we're currently sort of at at the moment. So that's what we're hoping to achieve in this presentation. In terms of a division of labour, I'm going to concentrate on setting up the theoretical and structural underpinnings to the particular behavioural model that we've embedded in the DWP tax microsimulation model and then Adam's going to take over and take you through some of the practicalities and the empirical implementation of this idea and draw your attention to some illustrations and extensions that we're looking to address.

So in terms of motivation it's fairly clear, static tax microsimulation models, these are models, for those who are not familiar with the genre, these are models that apply effectively accounting rules to a large and representative sample of households and population in order to evaluate in terms of incomes, net incomes, the effect of a particular tax regime on the population and more particularly the effect in terms of the distribution of incomes of a change in that tax policy regime.

But such a static microsimulation model operates on the premise that individual or household behaviour remains fixed through the process of the policy reform and while such an approach is OK in certain circumstances, for example looking at say marginal tax policy reforms or welfare programme reforms that apply across a large base, for others there are sort of grounds to suspect that such an approach is limited. There are certain policies for example that are specifically designed to induce behavioural change and so the idea of static tax benefit model applies to the analysis of reforms that are designed to change behaviour is clearly limiting.

So that's the jumping off point for this development, MDU, Model Development Unit of DWP initiated the project and brought me to work with colleagues in the DWP to add behaviour to the current DWP static tax microsimulation model which is called Policy Simulation Model or PSM. And the idea is to fill this gap, to respond to the limitation and hopefully by doing so add an extra layer of analysis and evaluation to that which can be achieved with the microsimulation model.

So in terms of adding behaviour, as I say I'm going to talk about the modelling approach that we've used and I'm going to leave Adam to talk about the empirical implementation, but essentially the modelling approach is to empirically implement a structural economic model of household labour supply to the static PSM model. The idea behind this is that we embed within PSM a model that takes as input the incomes that are generated from any tax or welfare policy regime and takes those inputs into a behavioural model that predicts or simulates patterns of behaviours on the basis of that input. And then having taken that input, one can use the static tax microsimulation model to change the parameters of a policy regime and on the underlying assumptions on which the structural economic model is based, we can then use that revised input to model a change in behavioural patterns, behaviour either in terms of changes in participation choices, propensity for individuals or households to participate in the labour market when faced with a certain tax policy regime and conditional on working, choices of the number of hours from a range of alternatives.

So the static microsimulation model, the PSM model is critical in a number of respects to building a behavioural component. First it's required in order for us to generate a set of data, incomes data on which we presume revealed patterns of behaviour are based and on the basis of which we can then estimate or fit a behavioural model that best fits an observed pattern of behaviour.

And the second role of the static microsimulation model is then on the basis of the model just estimated to use the incomes as input into a range of counterfactual simulations, so from some defined benchmark we can explore different policy reforms from the perspective of changes in behaviour.

The one thing I think it's important to emphasise is that in terms of accuracy and in terms of richness of simulated behaviour responses we find it best to use the same static model both for the estimation of the behavioural model and for the simulation of reforms on, given a large and representative sample of data. The reason we find that helpful is because we can then, well effectively we place less emphasis or we place less reliance on the process of calibration and more reliance on a proper fitting of the model to an observed set of circumstances.

So that's the basic modelling approach. I'm going to take you through perhaps three basic features of the model.

The first is the structural nature of the model that we've chosen to build. And the model that we've chosen to build here exploits a structural economic process, a structural decision making process. The reason we do that, whilst recognising that you know it is inevitably subjective, nevertheless the use of a structural model gives us the capacity to explain patterns of behaviour rather than just simply describe those patterns. Alternative to the structural approach is the use of what's called reduced four models. These are simply descriptive associations between outputs and inputs, but where there is no characterisation of those outputs as being driven by some economic decision making process, and the result is in reduced form we tend to have models which more describe rather than explain how decisions are made. So that's the first feature, it's a structural model.

The second feature is that we've chosen for a variety of reasons to model patterns of behaviour using a discrete rather than a continuous approach. What that means is that in modelling choices of participation hours we use, rather than model across the full continuity of hours, instead we choose to model choices across a discrete and finite number of distinct hours alternatives, including non participation. The reasons for that are both in terms of practicality and flexibility: practicality in the sense that using the discrete approach we can deal much better with complications such as you know difficult and complex tax and welfare regimes in estimates; flexibility in the sense that on the basis model we can add layers of behavioural complexity, adding different decisions other than simply choices of hours, for example incomplete welfare programme participation, choices of other goods like childcare in addition to decisions on how many hours to supply. So the discrete approach has unlocked our capacity to add layers to the basic what was otherwise a continuous approach of the 1980s and 90s.

The third feature of the model is that effectively the simulation of the underlying engine, the simulation routine generated probabilistic response to a thought policy reform. What that means is that for a given reform to a tax or welfare system, we simulate not for a given observation or sample a single response, but instead we simulate a probabilistic response to that stimulus, and that's perfectly reasonable when you consider that each observation in a sample is not a representation of an individual so much as a representation as a class of individuals, some of whom may respond differently to others when faced with the same policy stimulus. And so the probabilistic approach allows us to account for what's called preference heterogeneity in the model responses that we can generate.

I'm going to take you through a few of the details behind those three basic features now.

First of all the nature of the structural economic model, as if! 'As if' is not me being truculent like my teenage son, rather as if is related to the concept of *ceteris paribus* in economics where we imagine people that behave 'as if' they are corresponding or behaving along a certain rational line, it's not necessarily the case people do, but for the purpose of building of a model we need to have some structure until the empirical results break the assumption of *ceteris paribus* then that's we're going to progress with. So on the basis of this 'as if' argument we're going to characterise behaviour, in the first instance employment choices, so I'll show how the behaviours can be generalised as if those decisions are driven by what's called, there's a classic rational economic model of household rate supply. The economic foundations of such a model are that households or more accurately tax units, because we tend to model distinctly integrated tax units within single households. We take households

and allocate to them a preference function, which essentially ranks choices over a range of working hours and household or tax unit net incomes in terms of the degree of utility or happiness that is visited upon them by making such choices. Decisions on that basis are therefore assumed to be driven by a maximisation of that preference function, subject to the constraints that link the choice of hours to the amount of tax units net income that can be taken home. The important thing to note there of course is that income is affected not only by the choice of hours but by the complexities of the tax and transfer system and so the decisions that people would like to take are constrained by that tax and transfer regime. So the structure of the decision making process we presume is rational in the sense that the outcome that's chosen yields the greatest degree of utility or preference or happiness.

That's the economic foundation of the basic model, but we can add layers to that basic model, for example to account for income welfare programme participation or take up, that is to say situations where individuals do not or are observed not to take up a benefit to which they are in principle entitled on the basis of their observed characteristics because of, for whatever reasons, hassle costs, stigma costs, ignorance, there are a range of characterisations of why people don't take up benefits to which they're entitled. There are facilities to add that layer to the basic approach. Other issues are childcare demand, we can simultaneously model people's choices over labour supply including participation and also decisions to, for example, take up childcare in order to facilitate if the tax unit is a tax unit with dependent children. And these are not the only layers but these are the two principle layers that have been studied by us and also others in the past and currently.

So the basic model says you take a characterised and parameterised preference function as a function of the income that a household or tax unit enjoys, given either a single hours, in the case of a single adult's tax unit, or the combination of hours of all members of a multiple adult tax unit household. Any choice of hours will imply a certain net income through what we call a budget constraint, and that's the thing that says OK, at a wage of £10 per hour and given the full complexity of the tax and transfer system, if I worked 20 hours per week at a wage of £10 per hour, take home this amount of money because I have to pay this amount of tax, I receive these benefits. And that budget constraint is fiendishly complex potentially, particularly for those on lower hours. So that's the principle difficulty when implementing this model, when estimating a structural model this form and then when simulating the response to a change in any of these tax parameters in terms of labour supply hours.

But the economic decision rule adheres to a standard characterisation where individuals choose hours to maximise this utility function subject to budget constraint. So it's what you see in an economics textbook. There's the complexity of the budget constraint. This is hours on the horizontal axis, this is net tax unit income on the vertical, I've chosen a single adult household here just to allow me to draw one of two dimensional screen for budget constraint. The kinks and discontinuities, these are associated with elements and structures in the UK tax and transfer system, that little jump at 16 hours, that vertical jump is at 16 hours a week, that relates to in work benefits that we have in the United Kingdom, there are other jumps, this is stylised rather than actual. And the way that we characterise a decision is that for a preference function we can allocate individuals to a point on the budget constraint that confers upon them the maximum level of preference or happiness. And so the chosen hours would be that point there. That's the underlying structural model. So I'm not going to go into too much detail into how we generalise and taken account of household decision making, how we deal with other complexities in the estimate process, but that's the basic idea.

In estimation, again there's stuff that you need to know and stuff that I won't divert you from. The estimation process essentially fits the model parameters, that preference function. Patterns of observed choices revealed in a large and representative sample of data. So we have the family resource survey, we observe people's choices, we know from the static tax benefit model, if you like their opportunity sets, the alternatives that they could have chosen, and on the basis of us observing somebody to choose or the group of FRS data, to choose a certain level of labour supply across the range of alternatives, we can use that if you like revealed preference to fit the parameters of the preference function. And so in estimation essentially what you're doing is you're adjusting the parameters of your total function to rationalise as best you can observed patterns of behaviour.

There are lots of complexities in estimation, how you do it, OK, how you deal with, what does that say? ?? Thank you, I've left my spectacles on there! So there are lots of complexities in estimation, again I don't need to divert you from the intuition, there are any number of papers that we can point you to in terms of characterising how this estimation process proceeds, for example a paper that we did in 99/2000 in fiscal studies, characterises the sort of basic estimation process.

We're given parameterisation of preferences, we basically use the data to fit as best we can the parameters of utility function to rationalise observed choices. We can allow the parameters of that utility function, this is important, to vary with both observed characteristics and also random or observed preference heterogeneity. That is to say we know that different types of households differ in their behavioural patterns, but we also know that observational equivalent households exhibit a variety of responses through unobserved differences in their preferences. And so the combination of both observed and unobserved heterogeneity is important in parameterising a model such as this.

In actual fact when modelling choices across a set of alternatives, we choose instead of modelling over a continuum of hours, to restrict attention to a finite number of hours alternatives, a discrete set of hours alternatives where the choices are to a degree subjective, but hopefully sufficiently flexible to capture observed patterns that exist for different basic demographic groups.

On the basis of that the economic model still persists, it doesn't matter if you're optimising over a discrete set of choices or over a continuum of choices, we still act to optimise, choose that alternative which confers upon the household the greatest level of happiness or satisfaction.

Now the discrete approach is valuable for a range of reasons. It facilitates when adding behaviour the simplified incorporation of taxes and transfers in estimation. It facilitates an empirical model of household decision making, decisions on hours and participation at the level of the household rather than the individual, and in doing so unlocks the process of behavioural microsimulation compared with earlier brands of microsimulation on continuous choices. So the discrete approach explicitly facilitates household decision making which is important to this particular model and approach. It also facilitates a modelling of take up, adding of childcare, again that's, I haven't got enough time to go through all of those. It also allows for a general form of parameter and preference heterogeneity to enter into the preference function, so you can allow for that variation in patterns of behaviour for a given set of observed characteristics. The fact that we embed that random preference heterogeneity into the structural model is what effectively gives us the capacity to model not just a single modelled choice of hours, but instead a probabilistic distribution of hours choices across a range of distinct alternatives when faced with any tax and transfer system, conditional on a set of observed and unobserved characteristics that are built into the model.

So the discrete approach explicitly facilitates this probabilistic model of labour supply but also more particularly a probabilistic distribution of hours responses to any tax policy or reform because once we've parameterised and estimated this model we can alter the tax and transfer system, we can change the configuration of the parameters and tax and transfer system, and on that basis model what are called probabilities of transition. So we for example would model the probabilistic distribution of choices across a range of distinct hours alternatives under some base or benchmark tax and transfer policy regime, and then in changing the tax and transfer parameters, we can then model using the same behavioural parameters, the probabilities of transition, for example from one to another of the range of discrete hours alternatives. So this transition matrix, it's familiar I'm sure to a number you in different contexts, you may for example have seen mark off change for the sort of the process of simulating reform on where you paramaterise effectively exogenously or you can parameterise exogenously these transition probabilities, bear in mind that these probabilities are endogenous, they depend upon characteristics, they depend upon tax parameters, they depend upon the parameters of the preference function.

Last thing, there are a number of other things I want to talk about but I don't want to steal Adam's thunder, so the last thing I want to address before I switch over to Adam's bit is to emphasise the need for the process of calibration or alignment in these sorts of models, from a practical perspective. The idea behind calibration again, probably speaking to the converted here, but the idea behind calibration is that we can allow by calibrating a behavioural simulation to be compared with a static microsimulation benchmark. The process of calibration or alignment guarantees that wherever possible the model predictions are lined up with the observed patterns of responses under a base or benchmark policy regime. So that when one then adds the layer of behavioural response to a static microsimulation, you're comparing two sort of forms of analysis on the same single benchmark. The important thing here is that we need to be careful because the worse the model, the harder the calibration needs to work to align your predicted model, your simulation model to observe patterns of behaviour. And indeed in looking at the process of calibration we can diagnose whether or not the model performs well or badly for a particular demographic. But the basic approach requires that you draw all of those elements of unobserved heterogeneity, not from the unconditional assumed distribution but from a conditional distribution which guarantees that you replicate the observed decisions wherever possible. The effect on the transitions

matrix, the simulated probabilities of transition from any one choice to any other choice is to move from this sort of transitions matrix which is uncalibrated to, for a given observation where it was observed that that observation works for 16 hours a week, the calibrated transitions matrix is one which guarantees 100% wherever possible the choice under the base tax regime to be equivalent to the observed decision.

So calibration forms an important part of the addition of behaviour to the otherwise static PSM model for the purpose of comparability because if you're trying to report up to the Minister what added effects behavioural responses add to a particular policy reform, if you start from a different point to that which is started from in a static microsimulation, it becomes much less convincing, the comparison that you're trying to make.

Lots of other issues but probably will defer those to maybe the end of the presentation and I will concede the floor to Adam who is going to take you through the practical implementation of this model.

*Adam Richardson*:

OK, thanks Alan.

So I'm Adam Richardson and I work in the MDU at DWP. I doubt I've got much thunder to steal from Alan but I'll just talk for sort of 5 minutes on our perspective of how the work's gone. So just to start of, the way we develop models at DWP is we have MDU where I work, so the development work and maintenance of the models goes on there. And then in terms of the actual use, sort of day to day policy decisions or evaluation takes place by other analysts spread across the department, working on their own individual bits.

So for this presentation I'm just going to really quickly run over the PSM which is the static model and then talk a little bit sort of as I go along about the tricky bits that are involved in adapting it to work with the behavioural modelling. And I'm going to sketch through a couple of examples, really brief results that we can get from the model and then talk a little bit about where we're at and where we're going and then I guess we can finish with questions for both of us at the end.

So the policy simulation model is, as Alan said, the static microsimulation model of the GB tax and benefits system. It's based mainly on the family resources survey, although we do use a little bit of admin data that we draw on from internal DWP sources as well. And it's uprated to the current year, so financial amounts are uprated, sorry, because the survey is typically 2 years old, so if we want to use the current year we need to uprate it for that. So we adjust for things like the sort of benefits people receive in the survey being different in the next couple of years, so for instance people are floating off IB and moving on to ESA and things like that. Also we do the grossing or weighting to reflect the demographics of the year that we're interested in.

So from a practical point of view it's written in SAS which is a sort of structured database language, which probably lots of you are aware of, and it's pretty quick, being a static model and as I say it's used by analysts across DWP so the day to day work isn't done by me or my team. But as Alan pointed out the big sort of caveat about it is that it doesn't account for behavioural responses, so if you want to change something like WTC which is designed specifically to encourage people… or to effect their decisions about working it doesn't really get you very far.

OK, so now we go through using the PSM and working with it to incorporate behaviour into the model. The first step as Alan talked about is producing the budget constraints, so we can crank through the PSM all the different possible hours choices that people might have and for each of those hours choices we can produce an income. So that already is sort of pushing the model in terms of how quickly it runs. It takes several hours to produce that, we basically manipulate the data going in several times and then run it all though lots of times, especially for couples so you get, you know because you've got 8 hours choices, you end up with 64 different combinations for couples. And one of the points about that is requiring that we modelled entry wages for the unemployed because we don't observe what their wages might be in the data and that's part of the work that Alan's done with us as well.

So then we hand over our data to Alan for the estimation process and then he hands us back, just like that(!), the set of preference functions which we can use for the calibration process, as Alan talked about, you sort of redraw sets of error terms until you get a set of error terms that matches, which brings your modelled choice to where you observe the person to be, or the tax unit, to be in the base case. And so this is where we get some complications about where it takes us some time to incorporate things, although conceptually the process isn't

really, you know once you've got your head around it, it's not really that complicated in terms of practical terms of writing it into the model but it's quite detailed, there's lots of loops within loops and interactions and you've got to keep track of the draws and how things are going and stuff like that. So that takes a little bit of time to develop and then in terms of running it, it takes 30 or 40 minutes so it means we don't really want to have to do that for every time we have a new policy, so we typically have a base model that we agree on and we just do the calibration once per version of the PSM, so per year I guess.

And then we can go ahead and do simulation which is reasonably quick, so it's just applying the calibration factors and the preferences and seeing what pops out of your change that you made to the static model and so that gives you probabilistic distributions of where people might go to, and the results. So it's the core results of these big transitions matrices which gives you all the information basically which you can then extract lots of different information from. So, people moving in and out of work or changing their hours are the obvious ones, and then you can move on to what their entitlement to the income related benefits will be and following on from that into what the total Government revenue change might be, given people's behavioural responses.

And then there's obviously a process of validation of the model as well which Alan's done and we can also do some of that in terms of looking at results and if they're what we expect, and also maybe comparing with other indicators of work incentives like replacement rates or effect of marginal tax rates.

So I just thought I'd just really quickly run through a couple of the sort of results you might get out of it, and there's obviously loads and loads of different that you can pull out, so I've just picked out a few examples.

So for this example I just increased the level of out of work benefits by £20 a week to see what would happen, so I guess we would expect you're making not working relatively more attractive than working, so presumably we're going to see people moving out of work, which is what we do. But interestingly even at this sort of simple level you see that it's affecting different groups differently, so even at the top level you're already getting what might be quite interesting results that you can dig down into to see what's going on. And so then you can work out what the impact would be on spending on benefits, so that's IS, housing benefit, council tax benefit, WTC, CTC and then all of them added up. So you can see obviously the benefits you can get out of work which is the first three and CTC all increase as you'd expect, there's a slight offset because people have moved out of work, so they're not eligible for WTC any more, but nevertheless in this case it clearly doesn't counteract the overall picture.

And then underlying that, so here's an example of one of the transition matrices, so on the diagonal you've got people who don't move, so this is just, for this one it's just the lone parents so you can see there's lots of lone parents that don't work in the base case and in fact still remain not working in the reform, unsurprisingly. And anywhere below the diagonal line is people working less, so you can see where they're moving from and whatever their base hours to their new hours, and you can see that shift in a bit more detail in the summary chart that I showed you at the beginning.

OK, so in terms of where we are now, we've got a little bit more validation to do of the base model, and then, but hopefully within the near future, within weeks or maybe a month we're planning to roll it out to be available for use for other analysts in the different policy bits of the department. So that will be interesting because they're going to be able to do lots of different policies and reforms and real things that they're thinking about or have happened already, so that will be interesting to see what results we get out of it and really how useful it is for our colleagues. And then in the slightly longer term I would imagine, Alan mentioned briefly a few of the things that we can do to improve and extend the modelling, in particular at the moment the model only concentrates on the core demographic group of people that we feel fairly comfortable with modelling their behavioural responses, so it's sort of, I think it's between 25 and 55, so you've not got retirement situations entering in too much, and it doesn't include the disabled and for technical reasons it doesn't include houses with more than one benefit unit in, so where you've got several families living in one household. So there's lots of scope to move into those areas with our priority at the moment being to include the disabled in the model because that's a key policy area for the DWP and so that's what we'd like to be able to explore, how it works with them. And there's other interesting modelling things we can work on, like including the childcare and imperfect take up of benefits. So there's lots of potential still to do more stuff.

And that's all I've got to say, so I guess we can take questions together.

**QUESTIONS**

*Male question* – I'm afraid I have a question about rationale rather than about the model. You started off by saying we're going to assume the economic decision making until the data breaks so ? (37.02) you might think OK well people now take benefits ?? so it's not that rational. Then you said ooh but there are stigma costs and hassle costs, but we don't actually check whether those things really exist, we just use them ?? assumption that people are rational, because if they're not taking benefits they must be doing it for a rational reason. So basically we've got rid of the empirical grounding to this model but just doing economic models because that's what we like. So OK then the question comes what's the test for the model? Well the test is how well it fits as you've discussed. So then the question is is there a whole shoal of other models trying to predict this outcome and how do you know that you've got the best one or even ?? Because you've gone in through stages, you've started off with this kind of quasi empirical justification for this but actually that seems to have sort of disappeared in the small print, and then you've gone to a predictive criteria and I'm now thinking well yeah but you are the DWP, how many people are competing with you to outpredict you on these areas in the UK? So you've ended up with a model that says well this is what it does, it has no competition, it has no empirical basis! Except that it fits.

*Alan Duncan* – Sure, well I think you're being …

*Male question* – A bit simplistic, you're right.

*Alan Duncan* - … a bit simplistic and you're also assuming a little too much about the layers that we add to the model as if you like dealing with sort of variations between the pure and basic rational model and patterns of behaviour that we observe. So the reason I do not buy a basic model which deals only with patterns of behaviour relating to you know rational decision making, perfect information, programme participation 100% and other patterns, other decisions in addition to labour supply being absent in the process. So the structures that I've shown you are structures in order to sell or indicate you know the basic theoretical underpinning behind the model. A proper and more elaborate model will deal simultaneously with patterns of behaviour that we observe, including incomplete processes for taking up benefits. When we then explore whether or not there are explanations other than sort of rational utility maximisation, they give rise to the same patterns of behaviour, then for sure at an individual level we can deal with those, we can perhaps explore whether or not there is a process other than rational utility maximisation that will give to similar patterns. Of course we don't necessarily have the capacity to estimate those models, so you know you're pretty much left with the same problem as you're left with if you start with a behavioural model, you know adhering to the sort of standard neo classical view of preference optimisation. But the alternatives to this which might, well at least in calibration rather than estimation, give rise to a similar pattern of simulated choices between the two.

*Male question* – Right so there's some sort of deal here where it's not necessarily the best model but this is the one we know how to estimate with?

*Alan Duncan* – Well it's the one we can estimate and at least in terms of classes of individuals, rather than you know an individual per se, as a representation of a pattern of behaviour among a class of individuals, you know it's not just us that they're saying this is a reasonable representation until you can challenge us otherwise, it is a whole range of other micro economists and econometricians in areas that they're the supply where sure there are challenges to the neo classical paradigm but you know the lion's share of empirical analysis of labour supply uses this as a reasonable representation until they can be completely refuted …

*Male question* – So you're not actually competing with each other to ?? (41.05) hypothesis, your ? fits reasonably well because your models all fit reasonably well.

*Alan Duncan* – The basic premise is something that occupies a good proportion of empirical economists. Different labour economists have different views of the world, different labour economists will say actually I don't buy that bit of the model, so here is an elaboration which I'm going to look at to respond to such a challenge. But you know we haven't gone backwards, we haven't gone OK this is the end point, we need to represent patterns of behaviour that we observe here and let's move backwards until we've got that sort of sufficient representation of an economic theory that represents those patterns of behaviour. It's a model which has been reasonably tried and tested and there aren't any dominant challenges to this structural model, at least until you can tell me to the contrary! LAUGHS

*Male question* – Yes, I wonder what challenges will be sufficient, but we'll get to that.

*Alan Duncan* – Yeah for sure.

Male question 2 – Could I ask the same question in reverse I guess, which is I kind of imagine that the heterogeneity in the model allows you to capture on rational responses of people, so they should decrease their labour supply given the change in tax policy but blow me down some of them actually increase their labour supply, can you capture that in the model?

*Alan Duncan* – There are two components of heterogeneity in the model. One component is heterogeneity in the preference function itself, so one rationalises the decision on the basis of that random preference heterogeneity simply by recognising that there a distribution of say paramaters in the preference function which can represent a range of responses. And so it's not that we're breaking the rational assumption, we're just saying that in order to fit this model of rationality, we need to add heterogeneity to some of the parameters or all the parameters of the preference function. There's a second element of heterogeneity which is what's more called a surprise function, and that's the element of heterogeneity added to the utility function, sorry this is getting very technical I apologise! There's a sort of surprise heterogeneity that's added to each of the utilities, state specific heterogeneity added to each distinct as alternative. And what that does is it says OK when you made the decision to work 20 hours you thought you'd be this happy, but surprise you are slightly more or less happy than you thought you would be at 20 hours. And so that's the one that slightly breaks into the sort of rationality to accommodate other unanticipated components to how you enjoy a particular state of the world. So there are as I say complexities, I didn't want to spend too much in going to these sort of levels, but there are complexities which do allow you to break in some degree the pure adherence to rational in terms of ? (44.20)

*Male question 3* – But that's quite interesting because if you're prepared to counter and ? additional ? the idea that people might discover after the fact that they're not as happy as they thought they were going to be, why present that as a kind of a bolt on rather than for example trying to model people's adaptive behaviour right from the outset, rather than going straight from 48 hours a week to 16 week, which must be pretty rare, why not just allow them to try it?

*Alan Duncan* – Yeah I mean it is …

*Male question 3* – I find it interesting that you've taken a view that people are basically rational but then there will be various twiddles and sort of indeces on tops.

*Alan Duncan* – There is no time component, yeah, these are counter factual models rather than models where you simulated process by which you get from one point to another point, so we don't choose to model the bit in between, that sort of process of evolution, which is of course that's a challenge, there are many challenges to these models, you know I didn't show up the slide which says OK this is what the model does and these are the limitations, it's absolutely critical for us to accept limitations behind our model, and our model is limited in the sense of it not for example accommodating other sides of the labour market and supply sides of the labour market, our model doesn't accommodate properly the process of involuntary unemployment. So there are some limitations, sure there are limitations but I bet we could take everybody's model in here and point at limitations inherent in their models as well.

*Male question 3* – But then we need to have a principled discussion about how we ?? (45.54) the differences.

*Alan Duncan* – For sure, yeah absolutely.

*Male question 3* – Does it then just come down to prediction?

*Alan Duncan* – Yeah, well no I think you have to, some adherence to a justifiable view of the world, and this is one of the reasons why we don't just put together a completely subjective model and then line it up with an observed pattern of behaviour because in doing so you could throw any old nonsense at the data and get it to replicate. This is the concept of validation that we're talking about. If our model performs well, if the population behaves as if our model is a good characterisation of their behavioural processes, then we should be able to throw different scenarios at the simulation model and the results broadly will conform to what we might understand from other forms of evaluation of the same policies. So we spend you know a good amount of time trying to validate what our model says against patterns that are sort of evaluated using other techniques than what we prescribe for our model. And you know therein lies a legitimate discussion, you know how can we

properly validate? The other element in validation of course is for you to estimate the parameters of the model over a series of reforms, so that you embrace within the information used to estimate the model parameters exogenous reforms which are likely to have influenced behaviour and can therefore be accommodated and preference plans (?47.24) come up with. So sure there are challenges but I defy anybody to, at the micro level, do better for the particular purpose for which this model is required than the structural process of household decision making.

*Male question 4* – I have a question about benefit data holding, I understood that that's at least not ?? included in the labour supply ? What about the static baseline? ????

*Adam Richardson* – Yeah we have, when we run the model we have an option that we can choose which adapts the take up, this is fairly sort of simplistic, it's just a little regression that we add to the bottom of each module for each income related benefit, it's just a fairly simple regression which gives you a probability of taking up the benefit you're entitled to.

*Male question 4* – OK but then your labour supply extension is that based on …

*Adam Richardson* – No it's not, it's based on full take up.

END OF RECORDING