A lifetime perspective on the distributional aspects of the tax system

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Motivation

• Transfer systems aim to reduce inequality
  – Tax reforms often motivated by will to shift tax burden
  – While minimising efficiency costs

• Inequality typically viewed from a static annual perspective
  – Different in nature from lifetime inequality
  – Mixes predictable lifecycle changes, decisions motivated by dynamic considerations and transitory shocks with true permanent individual differences
  – Inequality exacerbated when viewed from annual snapshot
Motivation

- Common practice: tax design and assessment relies on annual descriptions of behaviour and income distribution
  - May shift attention from those most in need
  - Distortions in the value of certain actions like labour supply or education mismeasured as these are (partly) driven by dynamic considerations
  - Confounds redistribution across individuals with individual transfers across periods of the lifecycle

- The redistribution and efficiency effects of a policy may look different from a LC perspective
  - Depending on whether it tackles permanent differences between individuals
  - And whether it has long-lasting effects
Motivation

• Moreover most assessments of tax reforms take isolated view of an instrument
  – Impacts may depend on the overall tax system
  – With interactions happening contemporaneously and over the life-cycle

• Consequences for welfare analysis
  – Role of public insurance
  – Redistribution assessed on the basis of life snapshots
  – Limited interaction between policy instruments affecting different stages of LC
  – Disregard for anticipation behaviour
Inter vs intra personal transfers implied by the tax system

Most empirical studies find that a large proportion of the taxes levied in modern social transfer systems end up redistributing income across life-cycle periods (Bovenberg et al., 2008; O’Donoghue, 2001)

But some studies excluding retirement transfers conclude that most redistribution is interpersonal (van de Ven, 2005)

The impact of transfers systems on income distribution

Simulation studies find that lifetime inequality is larger than annual inequality while modern tax systems do reduce lifetime inequality but to a less extent than annual inequality (Liebman, 2002, Bjorklund and Palme, 1997)

Annual versus lifecycle tax progressivity

Annual progressivity higher than lifetime progressivity (Bengtsson et al., 2011)
Potential efficiency gains in exploring dynamic links in individual decisions or making the transfer system dependent on age


Dynamic links in individual behaviour rarely explicitly considered in the (empirical) study of welfare system

(Haan et al., 2010)

Transfer system seldom considered as such when assessing the impact of specific reforms

(Mirrlees Review; Blundell and Shephard, 2009; Bovenberg and Jacobs, 2005)
Some questions

• How redistributive is the UK transfer system from an annual and lifetime perspectives? How progressive is it?

• What are the effects of tax reforms over the 90s and 00s on tax progressivity and inequality?

• How much of these changes are due to behavioural responses to incentives?

• What are the main sources of lifetime inequality (innate differences, education, earnings process)?

• How does the transfer system change the importance of these sources of inequality?

• What are the implied levels of redistribution and insurance of the UK tax system and how did they change over time?
What we do

• Develop a simulation model of the UK tax system including personal taxation and benefits
  – Focus on earned income
  – Analysis relevant for the bottom 90%-95% of the population
  – Exclude retirement pensions: education and working life
  – Include tax reforms occurring between 1991 to 2006

• Combine the tax simulation model with a lifecycle model of women educational choices and labour supply
  – Exogenous family formation
  – Focus on women, for whom behavioural responses more important
  – But consider distributional and incentives questions from a family perspective (where a woman is present)
What we do

- After estimation, use simulations of lifecycle profiles to measure lifetime and annual inequality and how the tax system affects it
  - Tax progressivity and how it changed over time
  - Inequality in equivalised income and its sources
  - Changes in inequality induced by tax reforms if they were to affect individuals throughout their lives
  - Compare lifetime and annual measures of inequality
UK personal tax system

- Microsimulation model includes information on
  - Earnings taxation, social insurance and local taxes
  - Personal benefits including income support, unemployment insurance, tax credits, housing and council tax benefits, child benefits

- Most significant reforms over this period:
  - 1999 reform: FC replaced by WFTC
    - More generous maximum award
    - Higher earnings threshold
    - Lower withdrawal rate
    - Subsidy for childcare expenditure (instead of earnings disregard)
  - 2003 reform: WFTC (and other bits) replaced by WTC and CTC
    - Many of poorest households better off
    - Families without children eligible for WTC
    - Support extended further up income distribution

- Both reforms increased number of families entitled and generosity
### Uk personal tax system: tax credit award
couple or lone parent with one child (aged 4)

<table>
<thead>
<tr>
<th></th>
<th>April 1999 (FC)</th>
<th>April 2002 (WFTC)</th>
<th>April 2004 (WTC and CTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic award</strong></td>
<td>£64.95</td>
<td>£88.95</td>
<td>£131.82</td>
</tr>
<tr>
<td><strong>30-hour premium</strong></td>
<td>£11.05</td>
<td>£11.65</td>
<td>£12.31</td>
</tr>
<tr>
<td><strong>Earnings threshold</strong></td>
<td>£80.65</td>
<td>£94.50</td>
<td>£97.31 and £961.54</td>
</tr>
<tr>
<td><strong>Taper rate</strong></td>
<td>70% of net earnings</td>
<td>55% of net earnings</td>
<td>37% and 6.67% of gross earnings</td>
</tr>
<tr>
<td><strong>Help with childcare</strong></td>
<td>Disregard up to £60 childcare expenses</td>
<td>Maximum award increased by 70% of childcare expenses up to £135</td>
<td>Maximum award increased by 70% of childcare expenses up to £135</td>
</tr>
</tbody>
</table>

Note: Families with children are eligible if at least one adult works 16+ hours. Help with childcare requires all adults to work 16+ hours. The increase in generosity between WFTC and WTC/CTC is exaggerated because the reform also incorporated elements of other benefits.
Budget constraint: 1 child aged 4, £50 childcare

Single

Net income (£pw, Jan 06 prices)

Wage = £4.60ph

Hours (pw)

Couple

Net income (£pw, Jan 06 prices)

Wage = £4.60ph

Hours (pw)

1999 (FC) 2002 (WFTC) 2004 (WTC+CTC)
Existing empirical evidence on effects of tax credits

• Perceived to effectively move unskilled workers with high working costs into work and out of poverty

• Empirical evidence for the UK: 1999 WFTC reform
  – employment rates among lone parents may have increased by 2 to 7% (Brewer et al., 2006; Blundell et al, 2004; Francesconi and van der Klaauw, 2004)
  – Other groups may have benefited by less: +0.6% in couples with one earner and -0.2% in couples with 2 earners (Brewer et al., 2006)

• Empirical evidence for the US: 1998 EITC reform
  – 3 to 4% increase in employment rates among unskilled lone parents (Eissa and Liebman, 1996; Liebman, 1998; Meyer and Rosenbaum, 2000)
  – small negative effects on employment rates of second earner in couples (Eissa and Hoynes, 2004)

• SSP in Canada: +ve effects on job takeup of welfare recipients (Card and Robins, 2005; Michalopoulos, 2002)
The model: overview

• Life-cycle model of female human capital, employment and savings with exogeneous family formation

• Education and working life in three stages
  – Early years, up to 22: investments in education
    • Three possible levels: below A-levels, A-levels or vocational, university degree
  – Working life: from moment leaves education till retirement
    • Absorbing state
    • Three labour supply points: unemployment, part-time and full-time employment
    • Human capital accumulates while working but depreciates with age
  – Retirement: happens deterministically at the age of 60
The model: overview (2)

• Dynamic links
  – Family and working life run in parallel: family composition changes stochastically
  – Human capital formation happens during course of life, with education, on the job learning and depreciation
  – Productivity (health) is a persistent process

• Other features
  – Heterogeneity and heterogeneous preferences
  – Income risk and risk aversion (Low, Meghir and Pistaferri, 2008)
    • Savings and human capital as private insurance vehicles
    • Role of public policy in mutualising risk
  – Credit constraints
  – Detailed policy environment

• X: state space

Family composition (male and child), female education, human capital, productivity and preferences, tax schedule and prices
The model: family composition

• Exogenous family formation

• Child
  • Characterised by age, \( a^k \)
  • 1 child model: Arrives to a woman with probability \( p^k(X) \) where \( X \) includes age of youngest child in household; it is assumed that only the age of the youngest child is relevant for the decision process
  • And depart with certainty when 18

• Males
  – Characterised by \( (s^m, l^m, w^m) \): education, employment status and earnings
  – New couple with male of education \( s^m \) formed at rate \( p_0(s^m; X) \)
  – On-going couple dissolution: \( p_1(s^m, X) \)
The model: family earnings income (1)

- Male’s employment and earnings: reduced form selection model
- Employment selection

\[ l_{ia}^m = \begin{cases} 
40 \times 1(\varepsilon_{ia} > H_0(a, s_i^m)) & \text{new couples} \\
40 \times 1(\varepsilon_{ia} > H_1(a, s_i^m, l_{ia-1}^m)) & \text{ongoing couples}
\end{cases} \]

- And earnings

\[ \ln w_{ia}^m = \ln W_{s_i}^m + \alpha_{s_i}^m \ln(h(a)) + v_{s_i}^m \]
\[ v_{s_i}^m = v_{s_i}^{m, ia-1} + u_{s_i}^m \]
\[ u_{s_i}^m \sim N(0, \sigma_{u,s_i}^2) \]
\[ v_{s_i}^{m, ia} \sim N(0, \sigma_{v,s_i}^2) \]
The model: family earnings income (2)

- Female’s employment: endogenous
- Female’s earnings and human capital after leaving education

\[
\begin{align*}
  w_{sia} &= \ln W_s + \alpha_s \ln l_{ia} + 1 + v_{sia} \\
  e_{ia+1} &= e_{ia} - \delta_{sU} l_{ia} = 0 + \delta_{sp} l_{ia} = 20 + \delta_{sF} l_{ia} = 40 \\
  v_{sia} &= \rho v_{sia-1} + u_{sia}
\end{align*}
\]

- \( w \): female earnings
- \( W_s \): market wage for skills (education) \( s \)
- \( e \): working experience
- \( l \): hours of work (0,20,40)
- \( (v,u) \): persistent productivity and innovation
The model: budget constraint after education

\[ k_{ia+1} = Rk_{ia} + y_{ia} - c_{ia} \]

\[ y_{ia} = l_{ia}w_{ia} + d_{ia}m_{ia}l_{ia}w_{ia} - T(X_{ia}) - C_{ia}(a_{ia}^k) \]

\[ k_{ia+1} \geq \min\{0, Rk_{ia}\} \]

\[ k_A \geq 0 \]

- \( k \): savings
- \( y \): total household income
- \( (d^m, s^m, l^m, w^m) \): partner information
- \( T \): tax/benefit schedule
- \( C \): childcare costs
The model: utility after education

- Women choose consumption and employment to maximise lifetime utility
  - Subject to the budget constraint and dynamics of state variables
  - As well as terminal conditions

\[
U(c_{ia}, l_{ia}; X_{ia}) = \left( \frac{c_{ia}}{n_{ia}} \right)^{\mu} e^{\left( \bar{u}(l_{ia}, d_{ia}^{m}, d_{ia}^{k}, d_{ia}^{k}) + \theta_i(l_{ia}) \right)}
\]

\[
V_a(X_{ia}) = \max_{[c,l]_{a,...,A}} E \left( \sum_{\alpha=a}^{A} \beta^{a-\alpha} U(c_{i\alpha}, l_{i\alpha}; X_{i\alpha}) \mid X_{ia} \right)
\]

- \(X\): state space, including prices, observed and unobserved characteristics
- \((c,l)\): decision variables – consumption and labour supply
- \(n\): equivalence scale for family dimension
- \(\Theta\): unobserved heterogeneity in tastes for working (correlated with initial productivity)
- \(\beta\): discount rate
The model: education decisions

- Education investments decided at 17 on expected life time utility depending on personal tastes, assets, parents' assets and its cost.

- Working life: starts at 19 (low/medium education) or 22 (university)

\[
U(c_{ia}, l_{ia} = S; X_{ia}) = \frac{c_{ia}}{\mu} e^{(S(l_{ia} = S, 0, 0, 0) + \theta_i(l_{ia} = S))} \\
V_s(X_{i,17}) = \max_{[c,l]_{19, \ldots, A}} \mathbb{E} \left( \sum_{a=19}^{A} \beta^{a-a_s} U(c_{ia}, l_{ia}; X_{ia}) \bigg| X_{i,17} \right) + \omega_{si}
\]

- Female finishes education single with no children.

- Draws her idiosyncratic productivity from taste-dependent distribution.

- And starts working life at age \( a \) with assets:

\[
k_{ia} = R^{a-17} \left( k_{i,17} - \sum_{a=19}^{a-1} R^{17-\alpha} c_{ia} \right) - C_s(k_{i,17}^p) - \pi_{si}
\]
Data: BHPS

Background

• The main UK household panel dataset
• Started in 1991 with around 5,500 households
• 17 waves currently available
• From 2009, part of the new ‘Understanding Society’ survey

Our dataset

• Unbalanced panel of around 5,300 females over 16 waves
  – 12% observed in all 16 periods
  – 56% in 6 or fewer periods
  – 17% observed leaving education and entering working life

• Labour market outcomes during working life, income information, detailed demographics, limited assets information
Estimation

• Use multi-step procedure
  – Calibrate interest and discount rates, intertemporal preferences parameter
  – Estimate exogenous parameters outside structural model
    • Family transitions
    • Childcare costs
    • Male’s employment selection model
  – For all other parameters use indirect inference

• Lengthy procedure: not final estimates yet
  – Explore policy changes
  – Use data moments over 200 moments, mostly education-specific:
    employment rates and hours of work by family characteristics, transition rates by past earnings, earnings regressions and process of earnings residuals, moments for distribution of earnings by working hours, change in earnings by past employment status, moments for distribution of initial earnings, distribution of education, proportion families paying for formal childcare
Estimation: distributional assumptions

- Fully parametric specification
- Family composition: uniformly distributed shocks
- Unobserved heterogeneity in preferences ($\theta$): discrete, two point distribution ($\theta_1$, $\theta_2$, $p$)
- Productivity level and innovation: normally distributed conditional on education and preferences ($\theta, s$)
- Unobserved preferences for education (in excess of $\theta$): normal distribution
- Males productivity and selection into work: joint normal distribution conditional on males’ education
## Estimates: females earnings

<table>
<thead>
<tr>
<th></th>
<th>educ=1</th>
<th>educ=2</th>
<th>educ=3</th>
</tr>
</thead>
<tbody>
<tr>
<td>wage rates</td>
<td>4.38</td>
<td>4.84</td>
<td>6.23</td>
</tr>
<tr>
<td>returns to experience</td>
<td>0.14</td>
<td>0.24</td>
<td>0.27</td>
</tr>
<tr>
<td>persistence of productivity</td>
<td>0.95</td>
<td>0.95</td>
<td>0.92</td>
</tr>
<tr>
<td>se productivity innovation</td>
<td>0.12</td>
<td>0.13</td>
<td>0.11</td>
</tr>
<tr>
<td>mean deviation initial earnings (theta=1)</td>
<td>0.06</td>
<td>0.07</td>
<td>0.19</td>
</tr>
<tr>
<td>se initial productivity</td>
<td>0.30</td>
<td>0.29</td>
<td>0.27</td>
</tr>
<tr>
<td>accumulation experience while on PTE</td>
<td>0.12</td>
<td>0.15</td>
<td>0.13</td>
</tr>
<tr>
<td>depreciation rate</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>
## Estimates: males earnings and employment

<table>
<thead>
<tr>
<th></th>
<th>Below A-levels</th>
<th>A-levels and vocational</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wage rates (logs) (female aged 19)</td>
<td>1.792 (0.133)</td>
<td>1.865 (0.138)</td>
<td>2.033 (0.139)</td>
</tr>
<tr>
<td>Returns to experience (ln(a))</td>
<td>0.242 (0.087)</td>
<td>0.422 (0.086)</td>
<td>0.689 (0.132)</td>
</tr>
<tr>
<td>SE innovation productivity</td>
<td>0.184 (0.009)</td>
<td>0.146 (0.008)</td>
<td>0.095 (0.015)</td>
</tr>
<tr>
<td>SE initial productivity</td>
<td>0.192 (0.072)</td>
<td>0.192 (0.072)</td>
<td>0.192 (0.072)</td>
</tr>
</tbody>
</table>
## Estimates: utility function

<table>
<thead>
<tr>
<th>Term</th>
<th>all work</th>
<th>PTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>low education</td>
<td>-0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>medium education</td>
<td>-0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>kids * low education</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>kids * medium education</td>
<td>-0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>kids * high education</td>
<td>0.04</td>
<td>-0.02</td>
</tr>
<tr>
<td>kid 0-2</td>
<td>0.10</td>
<td>-0.07</td>
</tr>
<tr>
<td>kid 3-5</td>
<td>0.03</td>
<td>-0.05</td>
</tr>
<tr>
<td>kid 6-10</td>
<td>-0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>kid 11-18</td>
<td>-0.11</td>
<td>0.06</td>
</tr>
<tr>
<td>male</td>
<td>-0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>working male</td>
<td>-0.13</td>
<td>0.08</td>
</tr>
</tbody>
</table>
### Estimates: other parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>type 1</th>
<th>type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>preference (distaste) for PTE</td>
<td>0.16</td>
<td>0.26</td>
</tr>
<tr>
<td>preference (distaste) for FTE</td>
<td>0.33</td>
<td>0.60</td>
</tr>
<tr>
<td>mass of type 1</td>
<td>0.51</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>mean</th>
<th>se</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference for medium education</td>
<td>-0.06</td>
<td>1.16</td>
</tr>
<tr>
<td>Preference for high education</td>
<td>1.36</td>
<td>1.12</td>
</tr>
<tr>
<td>Probability positive CC cost</td>
<td>0.46</td>
<td></td>
</tr>
</tbody>
</table>
Model fit

Mean log hourly wage (by education)
Median log hourly wage (by education)
Model fit

p10 log hourly wage (by education)

lpoly smoothing grid
s=1, data  s=1, sim
s=2, data  s=2, sim
s=3, data  s=3, sim

p10 log hourly wage (by education)
Model fit

p25 log hourly wage (by education)
Model fit

p75 log hourly wage (by education, weighted)
Model fit

p90 log hourly wage (by education)
Model fit

Inter-quartile ratio to median: log hourly wage (by education)
Female employment rate (by education)
Model fit

Female employment rate (by education)

Ipoly smoothing grid

s=1, data
s=1, sim
s=2, data
s=2, sim
s=3, data
s=3, sim
## Model fit

### Impact of WFTC reform on employment

#### Combined effect of WFTC and other reforms between 1999 and 2002

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lone mothers</td>
<td>+4.4%</td>
<td>+3.6%</td>
<td></td>
<td>+3.7%</td>
</tr>
<tr>
<td>Women in couples</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>-2.0%</td>
<td></td>
<td>+0.7%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>Partner working</td>
<td>-3.0%</td>
<td>-0.1%</td>
<td>+0.1% to +0.6%</td>
<td></td>
</tr>
<tr>
<td>Partner not working</td>
<td>+4.1%</td>
<td>+2.6%</td>
<td>+3.1%</td>
<td></td>
</tr>
</tbody>
</table>

BBS (2005) = Blundell, Brewer and Shephard (2005); reduced form estimate
FRK (2009) = Francesconi, Rainer and van der Klaauw (2009); reduced form estimate
BDSS (2006) = Brewer, Duncan, Shephard and Suarez (2006); static structural estimate
## Model fit

### Table 8: Wage elasticities of labour supply: simulations of unexpected changes in wages

<table>
<thead>
<tr>
<th></th>
<th>Effect in period wage changes</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>transitory shift</td>
<td>permanent shift</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>participation</td>
<td>hours</td>
<td>participation</td>
<td>hours</td>
<td>LC effect</td>
<td>permanent shift</td>
<td>hours</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td></td>
</tr>
<tr>
<td>Single women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) all</td>
<td>0.62</td>
<td>0.06</td>
<td>0.39</td>
<td>0.05</td>
<td>0.54</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>(2) no children</td>
<td>0.47</td>
<td>0.00</td>
<td>0.29</td>
<td>0.00</td>
<td>0.42</td>
<td>-0.03</td>
<td></td>
</tr>
<tr>
<td>(3) mothers</td>
<td>1.04</td>
<td>0.31</td>
<td>0.69</td>
<td>0.25</td>
<td>0.93</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>Women in couples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) all</td>
<td>0.53</td>
<td>0.42</td>
<td>0.47</td>
<td>0.19</td>
<td>0.26</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>(5) no children</td>
<td>0.40</td>
<td>0.28</td>
<td>0.40</td>
<td>0.11</td>
<td>0.16</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>(6) mothers</td>
<td>0.71</td>
<td>0.70</td>
<td>0.57</td>
<td>0.36</td>
<td>0.47</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>By age when wage changes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) 29 or less</td>
<td>0.75</td>
<td>0.36</td>
<td>0.75</td>
<td>0.18</td>
<td>0.50</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>(8) 30 to 39</td>
<td>0.69</td>
<td>0.30</td>
<td>0.48</td>
<td>0.20</td>
<td>0.26</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>(9) 40 to 49</td>
<td>0.48</td>
<td>0.30</td>
<td>0.34</td>
<td>0.17</td>
<td>0.16</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>(10) 50 plus</td>
<td>0.31</td>
<td>0.09</td>
<td>0.15</td>
<td>0.00</td>
<td>0.13</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>(11) all</td>
<td>0.57</td>
<td>0.27</td>
<td>0.44</td>
<td>0.18</td>
<td>0.34</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>(12) low educated</td>
<td>0.93</td>
<td>0.50</td>
<td>0.73</td>
<td>0.21</td>
<td>0.46</td>
<td>0.19</td>
<td></td>
</tr>
</tbody>
</table>
Simulations

- Simulated life cycle decisions from age 17 till retirement at 59
- Use initial conditions (age 17) as in BHPS
- Allow for possibility of becoming mother and/or finding partner
- Simulate each individual 5 times
- Consider case without rent expenditures
- Income groups defined on equivalised income
METR for working females (no childcare costs)
Model versus BHPS data
METR by family type
1999 tax system

Cumulative distribution for working females

No childcare costs

Varying childcare costs

Proportion

Childless single
Childless couple
Lone parent
Couple parent

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METR by age and education
Varying childcare, 1999 tax system

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PTR for all females (no childcare costs)
Model versus BHPS data
PTR by employment status: full-time work
All females, 1999 tax system
Simulations: ATR in 2003 by income quintile

Comparing ATRs by income quintile: 2003
With childcare costs
Simulations: tax burden over the lifecycle by income quintile: 1993
Simulations: tax burden over the lifecycle by income quintile: 2006

![Graph showing median cross-sectional ATR for working females with childcare costs](image)

- **By cross-sectional income quintile:**
  - Top quintile
  - 4th
  - 3rd
  - 2nd
  - Bottom quintile

- **By lifecycle income quintile:**
  - Median ATR
  - Age

2006: Median cross-sectional ATR for working females with childcare costs.
Simulations: tax progressivity 1993 to 2006

**CS ATR over time, by CS gross income quintile**
Employed females, no childcare costs

**LC ATR over time, by LC gross income quintile**
All females, no childcare costs