Education, Labour Supply and Welfare

Richard Blundell, Monica Costa Dias, Costas Meghir and Jonathan Shaw

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There has been a long-standing interest in female labor supply for a number of reasons

1. In general women are thought to be more responsive to incentives, particularly when they have children.
2. Many women end up being single mothers, vulnerable to poverty.
3. The career breaks and the observed male/female wage differentials point towards the importance or otherwise of returns to experience.

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Education, Labour Supply and Welfare
Over the recent decades we have built a welfare system mainly designed to alleviate poverty and encourage women into work. The idea is that by incentivizing women into work even when they have young children they preserve an attachment to the labor market so that their skills do not depreciate.

A key question is how this welfare system affects careers:

- This includes education choice, human capital accumulation over the life-cycle and work behaviour.
We specify and estimate a dynamic model of female labour supply with the following features:

- Education choice is endogenous
- Wages depend on accumulated experience
- Women can work part-time, full time, or not at all
- Marriage, spousal income and children are stochastic (but exogenous)

Use it to assess the impact of the major welfare reforms implemented at the turn of the century in UK
Key references for this paper are:


- Labour supply and taxes: Keane and Moffitt (1995), Blundell, Duncan and Meghir (1998) among many others

## Policy background

### Tax credit award for couples of lone parent with 1 child

**Blundell et al. Female labour supply**

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

**Notes:** All values are on a per-week basis. Families with children are eligible if at least one adult works 16 or more hours per week. Help with childcare requires all adults to work more than 16 hours per week. The increase in generosity between WFTC and WTC/CTC is exaggerated because the reform also incorporated elements of other benefits.
Figure 5: Net income per week by tax regime

Couple, male not working, kid 4 years old, £0 childcare expenses

Notes: Woman earns £4.6 per hour. Fortax simulations.
Figure 6: Net income per week by tax regime

70 100 130 160 190 220
Net income (£pw)
0 10 20 30 40 50
Hours (pw)
1999 (FC) 2002 (WFTC) 2004 (WTC+CTC)

£0 rent pw

£60 rent pw

Couple, male working 40 hours, kid 4 years old, £0 childcare expenses

Notes: Woman earns £4.6 per hour. Fortax simulations.

Figure 7: Net income per week by tax regime

200 250 300 350 400
Net income (£pw)
0 10 20 30 40 50
Hours (pw)
1999 (FC) 2002 (WFTC) 2004 (WTC+CTC)

£0 rent pw

£60 rent pw

Couple, male working 40 hours, kid 4 years old, £0 childcare expenses

Notes: Man and woman both earn £4.6 per hour. Fortax simulations.
Model: female life-cycle

- Life in three stages
  - Three education levels chosen sequentially up to age 18/21
    - secondary, A-levels (high school) or vocational, university
  - working life
    - consumption and asset accumulation
    - labour supply (0, 20 and 40 hours per week) (0-9, 10-24, 25+ in the data)
    - experience accumulation
    - marriage and childbearing
  - retirement: happens deterministically at the age of 60
Model: female earnings

**Wage equation**

\[ \ln w_{sia} = \ln W_s + \gamma_s \ln (e_{sia} + 1) + \nu_{sia} \]

\[ \nu_{sia} = \rho_s \nu_{sia-1} + \mu_{sia} \]

\[ e_{sia} = e_{sia-1} (1 - \delta_s) + g_s (l_{sia}) \]

- \( g(l_{sia}) = 1 \) for full-time, part-time estimated
- Persistence of shocks - so we distinguish heterogeneity from state dependence (experience effects)
- Correlation of initial shock with preferences
- Concave profile of experience effects
- Depreciation of human capital - cost of not working
Model: exogenous family dynamics

- Children
  - model youngest child, with exogenous arrival rate
  - arrival probability depends on female age, education, presence of partner and older children
  - departure with certainty when child reaches age 18
Partner

- random arrival depending on level of education and age
- characterised by education, employment status and earnings
- arrival probability for male with given education depends on female age and education
- departure probability depends on female age, presence of child and male education

In couples, female acts as second earner, partly insuring for shocks in other sources of income with labour supply
Model: other family income

- Male log-wage equation

\[
\ln w_{sma}^{m} = \ln W_{sm}^{m} + \gamma_{sm}^{m} \ln (a - 18) + \nu_{sma}^{m}
\]

\[
\nu_{sma}^{m} = \rho_{sm}^{m} \nu_{sma-1}^{m} + \mu_{sma}^{m}
\]

Conditional on education, male and female productivity processes are independent

- Detailed model of UK tax and benefit system (FORTAX)
  - Taxes: income tax, NI, council tax
  - Benefits: child benefit, maternity grant, tax credits, income support, housing benefit, council tax benefit, free school meals
Model: optimisation problem

Post-education

The female chooses \( \{c_{ia}, l_{ia}\}_{a=a,\ldots,\bar{a}} \) during her working life to maximise lifetime utility

\[
V_a (X_{ia}) = E_a \left[ \sum_{\alpha=a}^{\bar{a}} \frac{(c_{ia}/n_{ia})^\eta}{\eta} \exp \left( f \left( l_{i\alpha}, X_{i\alpha} \right) \right) \right] _{X_{ia}}
\]

subject to the budget constraint

\[
k_{ia+1} = (1 + r) k_{it} + l_{ia} w_{sia} + d_{ia} l_{ia} w_{smia} - T \left( X_{ia}, l_{ia}, l_{ia}^m \right) - CC_a \left( X_{ia} \right) - c_{ia}
\]

- non-separability
- uncertain environment: earnings (own and partner’s) and family composition
- \( f \left( l_{i\alpha}, X_{i\alpha} \right) \) is a function of family composition, education and male, unobserved heterogeneity by female employment
- liquidity constraints: \( k > 0 \) but allow \( k > -\£15,000 \) for university students
- One-off decision in knowledge of utility and monetary costs of education
- Costs correlated with initial level of productivity
BHPS

- Unbalanced panel of around 6,600 females over 16 waves
- 10% observed in all 16 periods 60% in 6 or fewer periods 25% observed leaving education and entering working life
- Labour market outcomes during working life, income information, detailed demographics, limited assets information
Set IES, interest rate and discount rate (Blundell, Browning and Meghir, 1993))

Estimate exogenous parameters outside model: male earnings and employment, family dynamics, childcare costs

Method of Simulated Moments for the rest: simulate individuals under different tax regimes; Compute overall moment to match with those in the data.

207 moments, including employment rates by family type, transition rates, means, variances and percentiles of earnings distribution, earnings at entrance in working life, change in earnings by past hours, education achievement,…

55 parameters to estimate
Estimates: female wage equation

<table>
<thead>
<tr>
<th></th>
<th>second.-GCSE</th>
<th>HS A-Level</th>
<th>university</th>
</tr>
</thead>
<tbody>
<tr>
<td>wage rate (0 experience)</td>
<td>4.5</td>
<td>4.9</td>
<td>6.3</td>
</tr>
<tr>
<td>returns to experience</td>
<td>0.15</td>
<td>0.23</td>
<td>0.28</td>
</tr>
<tr>
<td>autocorrelation coef</td>
<td>0.92</td>
<td>0.95</td>
<td>0.88</td>
</tr>
<tr>
<td>se innovation</td>
<td>0.13</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>initial prod: mean high pref for work</td>
<td>0.11</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>initial productivity: se</td>
<td>0.30</td>
<td>0.26</td>
<td>0.26</td>
</tr>
<tr>
<td>depreciation rate</td>
<td>0.12</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td>accumulation of HC in PTE</td>
<td>0.15</td>
<td>0.12</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Estimates: preferences

<table>
<thead>
<tr>
<th></th>
<th>all employment</th>
<th></th>
<th>PT employment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>secondary</td>
<td>HS</td>
<td>university</td>
<td>secondary</td>
</tr>
<tr>
<td>intercept</td>
<td>0.41</td>
<td>0.41</td>
<td>0.47</td>
<td>-0.15</td>
</tr>
<tr>
<td>children</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>-0.06</td>
</tr>
<tr>
<td>child aged 0-2</td>
<td>0.15</td>
<td></td>
<td></td>
<td>-0.05</td>
</tr>
<tr>
<td>child aged 3-5</td>
<td>0.07</td>
<td></td>
<td></td>
<td>-0.06</td>
</tr>
<tr>
<td>child aged 6-10</td>
<td>-0.02</td>
<td></td>
<td></td>
<td>0.03</td>
</tr>
<tr>
<td>child aged 11-18</td>
<td>-0.07</td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>male</td>
<td>-0.06</td>
<td></td>
<td></td>
<td>-0.02</td>
</tr>
<tr>
<td>male working</td>
<td>-0.17</td>
<td></td>
<td></td>
<td>0.09</td>
</tr>
<tr>
<td>High pref work (p=0.51)</td>
<td>-0.16</td>
<td></td>
<td></td>
<td>-0.07</td>
</tr>
</tbody>
</table>
Reproduce life-cycle profiles of wage distribution, employment, transition rates, as well as same profiles by age of child, including before and after child is present.
Model fit

Female Wage Rate
Percentiles 10, 25, 50, 75 and 90

- Low education
- A-levels and equivalent
- University education

Inter-quartile ratio to median: log hourly wage (by education)

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Model fit
Employment of mothers

Female employment rate (by education)
Model fit

Female PT employment rate (by education)

-1
-0.5
0
0.5
1
1.5
2
2.5
3

l_poly smoothing grid

s=1, data
s=1, sim
s=2, data
s=2, sim
s=3, data
s=3, sim
Can reproduce empirical estimates of the impact of WFTC

Effect after three years of reforms for cross section of women

Table 1: The impact of WFTC reform on employment: simulated versus empirical literature results

<table>
<thead>
<tr>
<th></th>
<th>lone mothers</th>
<th></th>
<th>married mothers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Simulated results</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>own accommodation</td>
<td>+5.0%</td>
<td>-2.2%</td>
<td>-4.2%</td>
<td>+2.7%</td>
</tr>
<tr>
<td>rented accommodation</td>
<td>+2.4%</td>
<td>-1.2%</td>
<td>-2.3%</td>
<td>+1.4%</td>
</tr>
<tr>
<td>all population</td>
<td>+3.4%</td>
<td>-2.0%</td>
<td>-3.9%</td>
<td>+2.1%</td>
</tr>
<tr>
<td>Results in literature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBS, 2005</td>
<td>+3.6%</td>
<td></td>
<td>-0.1%</td>
<td>+2.6%</td>
</tr>
<tr>
<td>FRK, 2009</td>
<td></td>
<td>+0.7%*</td>
<td>+0.1-0.6%*</td>
<td>3.1%</td>
</tr>
<tr>
<td>BDSS, 2006</td>
<td>+5.0%</td>
<td></td>
<td>-0.5%</td>
<td></td>
</tr>
<tr>
<td>BDSS, 2006 (combined)</td>
<td>+3.7%</td>
<td>-0.4%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: BBS, 2005 stands for Blundell, Brewer and Shephard, 2005. BDSS, 2006 stands for Brewer, Duncan, Shephard and Suarez, 2006. FRK, 2009 stands for Francesconi, Rainer and Van Der Klaauw, 2009. Estimates in row (4) are for WFTC alone; estimates in row (5) are the combined effects of WFTC and other reforms occurring up to 2002. The latter are comparable with estimates in rows (2) and (3). Row (1) shows simulations based on the model discussed in this paper and effects are for first three years after unexpected change of tax regime amounting to the reforms occurring between April 1999 and April 2002.

∗ Statistical insignificant estimate at standard levels.
Elasticities

- Frisch Elasticity: effect of small and anticipated transitory change in net employment earnings
  - adjust initial assets so that marginal utility at start of life-cycle remains constant
- Marshallian Elasticity: permanent and unexpected change in net employment earnings
  - more relevant for welfare analysis
Results: wage elasticities of labour supply (extensive)

- Large Frisch elasticities, smaller responses to (uncompensated) permanent unexpected changes in earnings
- Overall values not at odds with recent estimates for women (Blundell, Pistaferri and Eksten, 2012)
- Very heterogeneous responses to changes in earnings and income, both especially high among low educated and lone mothers

<table>
<thead>
<tr>
<th></th>
<th>Frisch</th>
<th>Marshalian</th>
<th>Income effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.90</td>
<td>0.50</td>
<td>-0.41</td>
</tr>
<tr>
<td>Secondary</td>
<td>1.97</td>
<td>0.93</td>
<td>-0.53</td>
</tr>
<tr>
<td>A-levels</td>
<td>0.68</td>
<td>0.46</td>
<td>-0.40</td>
</tr>
<tr>
<td>University</td>
<td>0.28</td>
<td>0.18</td>
<td>-0.26</td>
</tr>
<tr>
<td>Lone mother</td>
<td>4.23</td>
<td>1.93</td>
<td>-0.91</td>
</tr>
<tr>
<td>Mothers in couples</td>
<td>0.70</td>
<td>0.51</td>
<td>-0.29</td>
</tr>
<tr>
<td>Childless women</td>
<td>0.33</td>
<td>0.20</td>
<td>-0.35</td>
</tr>
</tbody>
</table>
Frisch Elasticities

Participation elasticities
Transitory expected change in female net earnings

by education

by family composition

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Participation elasticities
Permanent unexpected change in net earnings
by education

by family composition

Marshallian Elasticities

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Income Effects
Unearned income increased at each point in the lifecycle

Income effects
permanent unexpected change in non-labour income
by education
by family composition

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Education, Labour Supply and Welfare
Results: long-run effects of WFTC & IS (2002)

- Revenue neutral reforms
- No education choice

<table>
<thead>
<tr>
<th></th>
<th>(ppt)</th>
<th>Single Mother</th>
<th>Couple with Kids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>GCSE</td>
<td>HS</td>
</tr>
<tr>
<td>2002 WFTC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>employment</td>
<td></td>
<td>9.9</td>
<td>12.9</td>
</tr>
<tr>
<td>FTE</td>
<td></td>
<td>4.9</td>
<td>2.6</td>
</tr>
<tr>
<td>2002 WFTC + IS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>employment</td>
<td></td>
<td>4.8</td>
<td>5.2</td>
</tr>
<tr>
<td>FTE</td>
<td></td>
<td>3.1</td>
<td>0.6</td>
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</tbody>
</table>

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Impact relative to 1999 system, allowing for education choice, but by pre-reform (1999) education choice

<table>
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<tr>
<th>(ppt)</th>
<th>Single Mother</th>
<th>Couple with Kids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
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<td>employment</td>
<td>9.9</td>
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<tr>
<td>FTE</td>
<td>4.8</td>
<td>1.9</td>
</tr>
<tr>
<td>2002 WFTC + IS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>employment</td>
<td>4.8</td>
<td>4.4</td>
</tr>
<tr>
<td>FTE</td>
<td>2.9</td>
<td>-0.3</td>
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</tbody>
</table>
Impact on Education Shares

- Increase in unskilled labour

<table>
<thead>
<tr>
<th></th>
<th>GCSE</th>
<th>HS</th>
<th>Uni.</th>
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</thead>
<tbody>
<tr>
<td>Pre-reform</td>
<td>31.8</td>
<td>47.2</td>
<td>20.9</td>
</tr>
<tr>
<td>2002 WFTC</td>
<td>33.2</td>
<td>46.9</td>
<td>19.7</td>
</tr>
<tr>
<td>2002 WFTC + IS</td>
<td>33.8</td>
<td>46.7</td>
<td>19.4</td>
</tr>
</tbody>
</table>

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Education, Labour Supply and Welfare
And how much does it cost?

- Adjustment in basic tax rate to keep budget deficit at pre-reform level

<table>
<thead>
<tr>
<th></th>
<th>Education choice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pre-reform</td>
</tr>
<tr>
<td>2002 WFTC</td>
<td>+1.4</td>
</tr>
<tr>
<td>2002 WFTC + IS</td>
<td>+2.3</td>
</tr>
</tbody>
</table>

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Willingness to pay in consumption terms; compare to change in output (gross wealth).
Women with high labour market attachment respond less to the new incentives.

Women with low attachment have a very elastic LS and large income responses as well.

Tax credits have more or less equal and opposite responses for single and married women with children.

There is a small effect on education choice, pushing some women to obtain less education.

The insurance value of the welfare program is substantial, particularly for the lowest skill.