Female Labor Supply, Human Capital, and Welfare Reform

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Motivating questions:

1. How should we account for interactions between human capital and female labour supply decisions?
   - especially in the design of transfers to low wage families in the form of ‘in-work benefits’ or ‘earned income tax credits’.

2. To what extent do dynamic issues change our view of the impact of these policies on female labour supply and earnings?

3. Can human capital investments explain the ‘gender gap’ in the earnings distribution?

4. What is the role of work experience and training?
   - work experience can enhance human capital and earnings throughout the life-cycle,
   - training investments could be used to offset human capital depreciation,
   - incentives for training, implicit in tax-credits, can be quite different from incentives to work, see Heckman, Lochner and Cossa (2003).
A life-cycle framework

Develop a life-cycle framework to examine how tax and welfare policies impact on human capital investment and female labour supply, and how labour supply and human capital impact on earnings over the life-cycle.

A life-cycle framework

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Human capital investments:

1. **Education choices** before work.
2. ‘Learning *by doing*’ at work - *work experience*.
3. **Training in work** - ‘learning *or* doing’.

Focus here on:

- the *complementarity* of work experience and training with education,
- the value of *part-time* work experience,
- and a role for training to offset human capital depreciation.
Motivate our analysis through the Earned Income Tax Credit and Welfare reforms in the UK:

- Focus on a specific reform - Working Families Tax Credit (WFTC) and Income Support (IS) in 1999/2000.
- Use this reform for reduced form comparisons with the structural model predictions.
- The reform involved an increase in the generosity of the welfare and earned income tax credit system for families with children.
- As in other countries, the motivation for these policies is that incentivising women into work, even when they have young children, will preserve labour market attachment, reduces skill depreciation and reduce the gender gap.
- An additional peculiarity of the UK tax-credit system is the minimum hours eligibility rules that focus incentives on part-time work.
Figure 1: Income Support and Tax credit award for lone parent with 1 child
Impact on married women in couples

Figure 2: The budget constraint for second-earner parents

Notes: See background paper.
Do the hours rules impact on observed behaviour?
The key question we ask is:

- How do the features of this broad kind of tax, tax-credit and welfare benefit system affect human capital accumulation, female labour supply and female earnings over the life-cycle?

The approach we take:

- **A structural dynamic approach**: using the time series of tax, tax credit, welfare benefit, and tuition cost reforms for new cohorts of women to identify parameters of preferences and wages,
  - conditioning on life-history family background variables,
  - using local/industry variation over time, in addition to tax and welfare reforms, to help identify returns to training.
- **Comparing with quasi-experimental contrasts where possible**:  
  - e.g. diff-in-diff contrasts for employment effects.
The Household Panel Data

British Household Panel Survey (BHPS), much like an enhanced PSID

Unbalanced panel of 4,200 females aged <50 over 18 waves, 1991-2008

- Measures of education, labour market outcomes, detailed measures of training and training intensity, childcare, detailed demographics, and assets.

IFS taxben budget constraint simulation model working on every wave:
- Taxes: income tax, NI, council tax, tax credits
- Benefits: child benefit, maternity grant, income support, housing benefit, council tax benefit, free school meals.

Linked life histories capture choices at age 16: educational qualifications; and detailed background measures, including
- parental education, number of siblings, sibling order, whether lived with parents when aged 16, books at home as a child, etc.
- detailed geocoded data mapping into local industrial composition.
Male and Female Wage Age Profiles: University Graduates

![Graph showing wage age profiles for men and women. The graph illustrates the wage progression from age 20 to 50 for both genders, with men's wages consistently higher than women's, especially after age 40.]
Employment over the life-cycle

All employment

Part-time employment

secondary  further  higher
Employment of mothers

All employment

Part-time employment

years to childbirth

secondary

further

higher
Appears to be strong complementarity with education.
Mincer/Ben-Porath assumption: investments drop with age.
Offset human capital depreciation in part-time work and non-employment?
READ OUT
I would like to ask some details about all of the training schemes or courses you have been on since September 1st 1999, (other than those you have already told me about), starting with the most recent course or period of training even if that is not finished yet.

<table>
<thead>
<tr>
<th>Event no.</th>
<th>SHOWCARD D13 Where was the main place that this course or training took place?</th>
<th>SHOWCARD D14 Which statement or statements on this card describe how any fees were paid, either for the course or for examinations? CODE ALL THAT APPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WRITE IN MAIN PLACE AND ENTER CODE FROM SHOWCARD CODE ONE ONLY ENTER CODE FROM SHOWCARD</td>
<td>No fees..................01 JTRFEEA1</td>
</tr>
<tr>
<td></td>
<td>WRITE IN PLACE</td>
<td>Self/family.............02 JTRFEEB1</td>
</tr>
<tr>
<td></td>
<td>__________________________</td>
<td>Employer/ future emp.....03 JTRFEEC1</td>
</tr>
<tr>
<td></td>
<td>__________________________</td>
<td>New Deal scheme..........05 JTRFEED1</td>
</tr>
<tr>
<td></td>
<td>ENTER CODE FROM SHOWCARD</td>
<td>Training for work, Youth/ Emp training/ TEC ..................06 JTRFEEF1</td>
</tr>
<tr>
<td></td>
<td>JTRPLCE1</td>
<td>Other arrangement (SPECIFY)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>_________________ 07 JTRFEEG1</td>
</tr>
</tbody>
</table>

D69. Was this course or training...

**READ OUT AND CODE FOR EACH**

D70. Since September 1st 1999 how much time have you spent on this course or training in total?

D71. ENTER NUMBER

D72. CODE UNIT

- Hours..................1
- Days....................2
- Weeks...................3
- Months..................4
- Other (SPECIFY) 
  __________________________ 5

- To help you get started
- To increase your skills
- To improve your skills
- To prepare you for a job or jobs you might do in the future
- To develop your skills generally

- JTRWHYA1
- JTRWHYB1
- JTRWHYC1
- JTRWHYD1
- JTRWHYE1
- JTRPLCE1
- JTRQ1
- JTRR1
A Note on Our Measure of Training

- Respondents may report training spell lengths in any unit (hours, days, weeks, or months).
- We convert these measures into hours, assuming 8 hours in a day for full-time workers and 4 hours in a day for part-time workers and sum across multiple training spells.
- The training variable is an indicator for whether the respondent received more than 50 hours of training in the previous year.
  - Results are shown to be robust to using continuous measure.
- Here we focus on work-related training, i.e. training which helps get started or increase or improve skills.
  - In robustness checks, we use non-induction-only work-related training and all training. Results are robust.
- In addition to the tax and benefit variation, use variation by location/industry and time as ‘instruments’ for training....
Training Intensity by Industry: High school women

women, secondary

Agriculture, fishing, Mining, quarrying, Manufacturing, Manufacturing, Electricity, gas, water, Construction, Wholesale, retail, Hotels, restaurants, Transport, communication, Financial services
Summary of main findings:

- Experience effects display strong dynamic complementarity with education.

- *Lower returns to experience for low educated* and those in part-time work.

- Women with lower education and children have more elastic labour supply and larger income effects.

- There is a significant but small effect of tax credit/welfare reform on education choice, attenuating some of the employment gains.

- Work experience and the part-time penalty explain a large part (70%) of the gender gap in wages - *especially for college educated women*.

- Uncover a role for training to offset human capital depreciation from part-time work and non-employment, especially for middle education levels.
Baseline Model: female life-cycle

Life in three stages:

- **Education** ‘s=0,1,2’: three levels chosen sequentially up to age 18/21
  - secondary (GCSE-level at 16), further/high school (A-levels or vocational at 18), higher (university and college at 21)

- **Working life (the focus here):**
  - consumption ‘c’ and asset ‘a’ accumulation
  - labour supply ‘l’ (0, part-time and full-time)
  - experience accumulation
  - training
  - partnering
  - childbearing

- **Retirement:** pension incomes take effect exogenously at age 60 (see Fan/Sheshadri/Taber paper).

Focus mainly in this talk on labour supply, work experience and life-cycle earnings with some preliminary results on training.
Model: education decisions

- Sequential discrete choice model
  - risk averse preferences,
  - future earnings and family composition are uncertain.

- Allow for borrowing constraints, tuition costs and student loans.

- Condition on factors formed of many family background variables at age 16, including
  - parental education/occupation, financial circumstances, siblings, region of birth, books in the home, whether lived with parents at 16, etc.
  - financial shocks at 16 used to ‘instrument’ education.
Model: female wages

Wage equation: for woman ‘i’, age ‘t’, in each birth cohort; with school level ‘s’, experience ‘e’, labour supply ‘l’

\[
\ln w_{sit} = \ln W_{sit} + \gamma_{si} \ln (e_{sit} + 1) + \nu_{sit} + \zeta_{sit}
\]
\[
\nu_{sit} = \rho_s \nu_{sit-1} + \mu_{sit}
\]
\[
e_{sit} = e_{sit-1} (1 - \delta_s) + g_s (l_{sit})
\]

- \(\gamma_{si}\) varies with schooling level \(s\) and background factors \(x_i\).
- Persistence of shocks - distinguish heterogeneity from state experience effects.
- \(\zeta_{sit}\) is a transitory shock.
- Correlation of initial permanent shock with preferences.
- Concave profile of experience effects that differs by schooling level and background factors.
- \(g_s(l_{sit})\) set to unity for full-time \(g_s(FT) = 1\), the part-time experience value \(g_s(PT)\) is estimated.
- \(\delta_s\) depreciation of human capital - cost of not working.
In this initial exploratory work we add training to experience dynamics:

\begin{align*}
\ln w_{sit} &= \ln W_s + \gamma_s \ln (e_{sit} + 1) + \nu_{sit} \\
\ln \tilde{w}_{sit} &= \ln w_{sit} + \xi_{sit} \\

\nu_{sit} &= \rho_s \nu_{si,t-1} + \mu_{sit} \\
e_{sit} &= e_{si,t-1} (1 - \delta_s) + g_s (l_{si,t-1}) + h_{sl} (k_{si,t-1})
\end{align*}

where

- $k_{sit}$: proportion of working time dedicated to on-the-job training,
- $h_{sl} (k_{sit})$: additional experience accumulated through training.

Training investments takes time away from working time:

$$y_{sit} = w_{sit} l_{sit} (1 - k_{sit})^{\alpha_s}$$

- the worker pays for the training in lost earnings (and possibly fees).
Model: female wages, extension for training investments

In this initial exploratory work we add training to experience dynamics:

\[
\begin{align*}
\ln w_{sit} &= \ln W_s + \gamma_s \ln (e_{sit} + 1) + \nu_{sit} \\
\ln \tilde{w}_{sit} &= \ln w_{sit} + \zeta_{sit} \\
\nu_{sit} &= \rho_s \nu_{si,t-1} + \mu_{sit} \\
e_{sit} &= e_{si,t-1} (1 - \delta_s) + g_s (l_{si,t-1}) + h_{sl}(k_{si,t-1})
\end{align*}
\]

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- \(h_{sl}(k_{sit})\): additional experience accumulated through training.

Training investments takes time away from working time:

\[
y_{sit} = w_{sit} l_{sit} (1 - k_{sit})^{\alpha_s}
\]

- the worker pays for the training in lost earnings (and possibly fees).

Return to this later in talk. First, provide results and counterfactuals in the full dynamic life-cycle model with education and work experience alone.
Family formation dynamics

Children:

- Children are born with an (weakly) exogenous arrival rate, and depart with certainty when child reaches age 18

\[
\text{Prob} \left[ k^t = 0 \mid t, s, k_{t-1}, t^k_{t-1}, m_{t-1} \right]
\]

Partner:

- Arrival rate depending on level of education and age,
  - characterised by education, employment, prior marriage, children and earnings
  - arrival rate for male with given education depends on female age and education; the departure probability depends on female age, presence of child and male education

- Fertility and marriage behavior are ‘weakly exogenous’,
  - however, there is feedback: - individuals account for the implications of their choices on marriage and fertility.
Male employment depends on education and on whether he worked in the previous period or not.

His wages are uncertain:

\[
\ln w_{smit} = \ln W_{smit} + \gamma_{sm} \ln (t - 18) + \nu_{smit} + \zeta_{it}
\]

\[
\nu_{smit} = \rho_{sm} \nu_{smit-1} + \mu_{smit}
\]

Linked administrative, national insurance, earnings data will be key here.
Taxes and Assets

Detailed model of tax and benefit system - FORTAX (Shephard, 2011)

- Taxes: income tax, NI, council tax
- Benefits: child benefit, maternity grant, in-work tax credits, income support, housing benefit, council tax benefit, free school meals.

Assets:

- Initial period assets from the survey.
- Deal with the initial conditions problem by simulating from the start of life.
- Transfers implicit through funding of education.
Model for post-education choices:

\[ \{c_{it}, l_{it}\}_{t=t,\ldots,\bar{t}} \] are chosen over the life-cycle with preferences

\[
V_t(X_{it}) = E \left[ \sum_{t=t}^{\bar{t}} \beta^{t-t} \left( \frac{c_{it}}{n_{it}} \right)^{\mu} \exp \left( U(l_{it}, l_{it}^m, X_{it}) + \theta_i l_{it} \right) \right] | X_{it}
\]

subject to the budget constraint (including taxes and childcare costs):

\[
a_{it+1} = (1 + r)a_{it} + l_{it}w_{sit} + d_{it}^m l_{it}^m w_{it}^m - T(X_{it}, l_{it}, l_{it}^m) - Q(t_{it}^k, l_{it}, l_{it}^m, X_{it}) - c_{it}
\]

- net worth liquidity constraint: \( a > a_s \).
- uncertainty: earnings (own and partner’s) and family composition.
- \( U(l_{it}, l_{it}^m, X_{it}) \) is a function of family composition, education, partner, partner labour supply, background factors, and unobserved heterogeneity.
- \( \theta_i \): unobserved types.
- childcare costs (\( Q \)) and housing benefits (in \( T \)) vary by location and time.
Childcare Costs

$Q$ are childcare costs:

$$Q \left( t^k, h_t, \tilde{h}_t, m_t \right) = \begin{cases} 
  h_t \times CC_h & \text{if } d_{cc} = 1 \\
  & \text{and } t^k \leq 5 \text{ and } \left( \tilde{h}_t = 40 \text{ or } m_t = 0 \right) \\
  18 \times CC_h & \text{if } d_{cc} = 1 \text{ and } 5 < t^k \leq 10 \\
  & \text{and } h_t = 38 \text{ and } \left( \tilde{h}_t = 40 \text{ or } m_t = 0 \right) \\
  0 & \text{all other cases}
\end{cases}$$

where $CC_h$ is the per-hour rate, which is estimated externally from the data.

- Preschool children need childcare whenever no adult is staying at home, and school-age children only need childcare outside the school day as education is publicly provided.

- Childcare costs are zero for those with access to informal care ($d_{cc} = 0$), the probability of which is estimated from the data, and only depend on the age of the youngest child.
Estimate processes for male earnings and employment, family dynamics and childcare costs, recursively ‘outside’ the model.

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

\[
\hat{\Theta} = \arg\min_\Theta \left\{ \sum_{k=1}^{K} \left[ (M_{kN}^d - M_{ks}^m(\Theta))^2 / \text{Var}(M_{kN}^d) \right] \right\} 
\]

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

A key feature of our model is that it models the joint consumption and labor supply decisions over the working years of women, where the former is a continuous choice while the latter is discrete - the value function is piecewise concave with kinks, see BCMS.
### Table: Preference parameters

<table>
<thead>
<tr>
<th></th>
<th>all employment</th>
<th>part-time employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>secondary</td>
<td>further</td>
</tr>
<tr>
<td>intercept</td>
<td>0.41 (.00)</td>
<td>0.41 (.00)</td>
</tr>
<tr>
<td>children</td>
<td></td>
<td>0.05 (.01)</td>
</tr>
<tr>
<td>child aged 0-2</td>
<td></td>
<td>0.15 (.01)</td>
</tr>
<tr>
<td>child aged 3-5</td>
<td></td>
<td>0.07 (.01)</td>
</tr>
<tr>
<td>child aged 6-10</td>
<td>-0.02 (.01)</td>
<td></td>
</tr>
<tr>
<td>child aged 11-18</td>
<td>-0.07 (.01)</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>-0.06 (.01)</td>
<td></td>
</tr>
<tr>
<td>male working</td>
<td>-0.17 (.01)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Full interactions in Table 9 of BCMS.
### Summary: Female wage equation estimates

<table>
<thead>
<tr>
<th></th>
<th>Secondary</th>
<th>Further</th>
<th>Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>baseline at age 25</td>
<td>7.19 (.050)</td>
<td>8.64 (.067)</td>
<td>10.55 (.31)</td>
</tr>
<tr>
<td>returns to experience</td>
<td>.15 (.01)</td>
<td>.23 (.01)</td>
<td>.31 (.02)</td>
</tr>
<tr>
<td>autocorrelation coef</td>
<td>.92 (.01)</td>
<td>.92 (.01)</td>
<td>.88 (.02)</td>
</tr>
<tr>
<td>se innovation</td>
<td>.12 (.01)</td>
<td>.15 (.01)</td>
<td>.14 (.01)</td>
</tr>
<tr>
<td>initial prod</td>
<td>.14 (.01)</td>
<td>.13 (.01)</td>
<td>.31 (.03)</td>
</tr>
<tr>
<td>initial productivity: se</td>
<td>.14 (.02)</td>
<td>.20 (.02)</td>
<td>.23 (.03)</td>
</tr>
<tr>
<td>depreciation rate</td>
<td>.08 (.01)</td>
<td>.06 (.01)</td>
<td>.07 (.01)</td>
</tr>
<tr>
<td>accumulation of HC in PTE</td>
<td>.15 (.02)</td>
<td>.10 (.02)</td>
<td>.12 (.02)</td>
</tr>
</tbody>
</table>

Notes: Full results with interactions of background factors etc at end of slides.
Model fit

Life-cycle profiles of wages

![Graph showing life-cycle profiles of wages for different educational levels: Sec, HS, Univ.](image-url)
Implication for Part-time Experience Penalty

![Graph showing wage gap (logs) vs. age for different levels of education: secondary, high school, and university degrees. The wage gap decreases with age for all education levels, with university degrees having the smallest wage gap at higher ages.]
Model fit: distribution of wages

Distribution of female wage rates by age

Wage distribution: perc 10, 25, 50, 75, 90

- Sec
- HS
- Univ
Model fit

Employment over life-cycle

![Graph showing employment rates over age for all employment and part-time employment. The graph includes data from secondary sources, further simulations, and data from higher sources.](image)
Employment of mothers

All employment

Part-time employment

-3 0 3 6 9 12 15 18 21

-3 0 3 6 9 12 15 18 21

years to childbirth

years to childbirth

- data, secondary
- simulations, secondary
- data, further
- simulations, further
- data, higher
- simulations, higher
### Table: Elasticities of labor supply

<table>
<thead>
<tr>
<th></th>
<th>Frisch</th>
<th></th>
<th>Marshall</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>extensive</td>
<td>intensive</td>
<td>extensive</td>
<td>intensive</td>
</tr>
<tr>
<td></td>
<td>elasticity</td>
<td>deriv</td>
<td>elasticity</td>
<td>deriv</td>
</tr>
<tr>
<td>All women</td>
<td>0.627</td>
<td>0.510</td>
<td>0.240</td>
<td>0.475</td>
</tr>
<tr>
<td>By education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>0.914</td>
<td>0.675</td>
<td>0.327</td>
<td>0.689</td>
</tr>
<tr>
<td>High school</td>
<td>0.567</td>
<td>0.469</td>
<td>0.223</td>
<td>0.428</td>
</tr>
<tr>
<td>University</td>
<td>0.427</td>
<td>0.375</td>
<td>0.180</td>
<td>0.331</td>
</tr>
<tr>
<td>By family composition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single no kid</td>
<td>0.532</td>
<td>0.486</td>
<td>0.159</td>
<td>0.419</td>
</tr>
<tr>
<td>Lone mother</td>
<td>2.240</td>
<td>1.275</td>
<td>0.452</td>
<td>1.362</td>
</tr>
<tr>
<td>Couples no kid</td>
<td>0.264</td>
<td>0.242</td>
<td>0.163</td>
<td>0.220</td>
</tr>
<tr>
<td>Couples w kid</td>
<td>0.688</td>
<td>0.522</td>
<td>0.316</td>
<td>0.553</td>
</tr>
</tbody>
</table>

Notes: See Table 14, BCMS.
Table: Gender Gap: The effect of work experience on female wages at age 50

<table>
<thead>
<tr>
<th></th>
<th>No part-time penalty</th>
<th>No penalty for not working and no part-time penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary (%)</td>
<td>5.3</td>
<td>10.5</td>
</tr>
<tr>
<td>High School (%)</td>
<td>7.0</td>
<td>13.5</td>
</tr>
<tr>
<td>University (%)</td>
<td>8.7</td>
<td>16.3</td>
</tr>
</tbody>
</table>

Notes: The first column shows the effect on wages at 50 if the amount of experience gained from part-time work is the same as that of full time work. The second column shows the effect on wages at 50 if the amount of experience gained was the same as that for men.
Table: The impact of the WFTC and Income Support reforms on Employment of Lone Mothers

<table>
<thead>
<tr>
<th></th>
<th>1999 - 2002</th>
<th>Average Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulations</td>
<td>+4.4 (0.09)</td>
<td></td>
</tr>
<tr>
<td>Matched Diff-in-diff</td>
<td>+4.2 (0.11)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: % point employment impact and matched diff-in-diff for low educated lone parents.

- Placebo effects on pre-reform data in Table 6 of background paper (BCMS).
Table: The impact of the WFTC and Income Support reforms on education attainment – model simulations versus ‘reduced form’ data estimates.

<table>
<thead>
<tr>
<th></th>
<th>High school</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Estimates based on BHPS data</td>
<td>-.012</td>
<td>-.005</td>
</tr>
<tr>
<td>St. Error</td>
<td>(.005)</td>
<td>(.005)</td>
</tr>
<tr>
<td>(2) Model simulation</td>
<td>-.008</td>
<td>-.005</td>
</tr>
</tbody>
</table>
Table: Counterfactual Effects of Tax Credit on Employment

<table>
<thead>
<tr>
<th>Pre-reform education</th>
<th>Secondary</th>
<th>High School</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single</td>
<td>Married</td>
<td>Single</td>
</tr>
<tr>
<td>(1) All (pp)</td>
<td>20.4</td>
<td>-6.6</td>
<td>14.9</td>
</tr>
<tr>
<td>(2) Full-time(pp)</td>
<td>9.3</td>
<td>-3.6</td>
<td>6.5</td>
</tr>
<tr>
<td>(3) Part-time(pp)</td>
<td>11.1</td>
<td>-3.0</td>
<td>8.4</td>
</tr>
</tbody>
</table>

Impact on Employment: Mothers of Adult Children (19+)

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Married</th>
<th>Single</th>
<th>Married</th>
<th>Single</th>
<th>Married</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4) All (pp)</td>
<td>0.4</td>
<td></td>
<td>0.3</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>(5) Full-time(pp)</td>
<td>0.4</td>
<td>-0.0</td>
<td>-0.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Part-time(pp)</td>
<td>-0.0</td>
<td></td>
<td>0.3</td>
<td></td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Reform is revenue neutral by adjusting the income tax rate. See Table 15 in background paper.
<table>
<thead>
<tr>
<th>Pre-reform education choice</th>
<th>Impact on Education</th>
<th>Impact on Lifetime Disp. Income and Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary</td>
<td>0.54</td>
<td>-1.09</td>
</tr>
<tr>
<td>High School</td>
<td>-0.19</td>
<td>-0.25</td>
</tr>
<tr>
<td>University</td>
<td>-0.16</td>
<td>-0.87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(7) Education (pp)</th>
<th>(12) Disp. Income (%)</th>
<th>(13) Cons. equiv. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.54</td>
<td>-1.09</td>
<td>2.49</td>
</tr>
<tr>
<td></td>
<td>-0.19</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>-0.16</td>
<td>-0.27</td>
</tr>
</tbody>
</table>

(14) Adjustment in the basic rate of Income Tax to fund reform: +0.9pp

Reform is revenue neutral by adjusting the income tax rate. Education is allowed to adjust.
Model: Estimate an extended wage equation with training.

- Estimate using tax instruments for part time and full time simulated incomes, also use interactions of time x local area.
- Instead of adding directly to the stock of human capital we enter the recent history of training:

\[
\ln w_{sit} = \ln W_s + \gamma_s \ln (e_{sit} + 1) + \phi_s K_{sit} + \phi_{s1} K_{si,t-1} + \ldots + \nu_{sit}
\]

\[
\ln \tilde{w}_{sit} = \ln w_{sit} + \zeta_{sit}
\]

\[
\nu_{sit} = \rho_s \nu_{si,t-1} + \mu_{sit}
\]

\[
e_{sit} = e_{si,t-1} (1 - \delta_s) + g_s (l_{si,t-1})
\]

- The aim to explore the impact of allowing for training in this ‘semi-structural’ wage equation.

In the initial results we present here we assume training $K_{sit}$ is carried out at the beginning of the period. The wage and hours of work are measured later in the period.
Table: Female log wages, training and work experience

<table>
<thead>
<tr>
<th></th>
<th>(a) Endogenous experience and selection</th>
<th>(b) Adding twa*time instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Secondary</td>
<td>High school</td>
</tr>
<tr>
<td>(1) training ($\phi_{s0}$)</td>
<td>0.0396</td>
<td>0.0288</td>
</tr>
<tr>
<td></td>
<td>(.0182)</td>
<td>(.0131)</td>
</tr>
<tr>
<td>(2) training ($\phi_{s1}$)</td>
<td>0.103</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>(.0175)</td>
<td>(.0126)</td>
</tr>
<tr>
<td>(3) work experience ($\gamma_s$)</td>
<td>0.157</td>
<td>0.197</td>
</tr>
<tr>
<td></td>
<td>(.0073)</td>
<td>(.0078)</td>
</tr>
<tr>
<td>family background</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>region and time dummies</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>N</td>
<td>8478</td>
<td>8986</td>
</tr>
</tbody>
</table>

Notes: Experience is entered as the log(1 + linearly as the sum of full time experience). Results in differences and with further lags of training available on request.
Summary of main results:

- Experience effects display strong dynamic complementarity with education.
- Lower returns to experience for low educated and those in part-time work.
- Lower education women with children have more elastic labour supply and larger income effects.
- There is a significant but small effect of tax credit/welfare reform on education choice, attenuating some of the employment gains.
- Work experience and the part-time penalty explain a large part (70%) of the gender gap in wages - especially for college educated women.
- Find potential role for training to offset human capital depreciation from part-time work and non-employment, primarily for middle educated.
Summary of main findings:

- Experience effects display strong dynamic complementarity with education.

- Lower returns to experience for low educated and those in part-time work.

- Women with lower education and children have more elastic labour supply and larger income effects.

- There is a significant but small effect of tax credit/welfare reform on education choice, attenuating some of the employment gains.

- Work experience and the part-time penalty explain a large part (70%) of the gender gap in wages - especially for college educated women.

- A role for training to offset human capital depreciation from part-time work and non-employment, especially for middle education levels, -> still incomplete, develop the empirical training model to allow cost of training to be shared...
Future Work: On-the-job investments and incidence

- Classical competitive labor market: workers pay for general training, wages fully reflect returns to investment (Becker 1964)

- Not the case with frictional competition (Acemoglu, Pischke 1999; Flinn, Genmici, Laufer 2016; Lentz, Roys 2015)
  - Search frictions create lock-in effect, resulting in workers being paid below their marginal product
  - Cost of training is shared between workers and firms, and firms retain part of the return to the investment
  - Rents from training only gradually reflected in wages, in response to competing offers
  - Nuanced distinction between general and specific HC: wages increase within and between jobs in response to both investments
Future work: model

- Search model with learning-by-doing and training to understand wage incidence, HC accumulation and investment choices

- Extend Bagger, Fontaine, Postel-Vinay and Robin (2014)
  
  - Bargaining model: wages depend on the worker’s outside options
  - Productive HC accumulates with working experience and training
  - Depreciation results in HC losses during non-working periods
  - Returns to HC gradually included in wages as workers receive competing offers and move up the job ladder
  - Transferable utility: training choices maximise match surplus
  - Women’s three stages of life: varying participation costs drive career breaks
  - Resulting HC losses induce investments in training later in life

- we are currently in the process of implementing this model.....
Table: Detailed female wage equation and experience accumulation

<table>
<thead>
<tr>
<th></th>
<th>Secondary (1)</th>
<th>High school (2)</th>
<th>University (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept ((b_{s,0}))</td>
<td>5.406</td>
<td>5.547</td>
<td>6.949</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.038)</td>
<td>(0.071)</td>
</tr>
<tr>
<td>High factor 1 ((b_{s,1}))</td>
<td>0.005</td>
<td>0.018</td>
<td>0.061</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.038)</td>
<td>(0.066)</td>
</tr>
<tr>
<td>High factor 2 ((b_{s,2}))</td>
<td>0.014</td>
<td>-0.186</td>
<td>0.045</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.031)</td>
<td>(0.048)</td>
</tr>
<tr>
<td>Mean wage at 25</td>
<td>7.19</td>
<td>8.64</td>
<td>10.55</td>
</tr>
<tr>
<td></td>
<td>(.050)</td>
<td>(.067)</td>
<td>(.317)</td>
</tr>
</tbody>
</table>

Returns to experience:

<table>
<thead>
<tr>
<th></th>
<th>Secondary (1)</th>
<th>High school (2)</th>
<th>University (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline ((\gamma_{s,0}))</td>
<td>0.152</td>
<td>0.229</td>
<td>0.306</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.009)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>High factor 1 ((\gamma_{s,1}))</td>
<td>0.054</td>
<td>0.014</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>High factor 2 ((\gamma_{s,2}))</td>
<td>-0.002</td>
<td>0.029</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Mean coeff experience</td>
<td>0.16</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>(.008)</td>
<td>(.012)</td>
<td>(.014)</td>
</tr>
</tbody>
</table>
Table: Female wage equation and experience accumulation (cont..)

<table>
<thead>
<tr>
<th></th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Secondary (1)</td>
</tr>
<tr>
<td>(9) autocorrelation coefficient: $\rho_s$</td>
<td>0.925</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
</tr>
<tr>
<td>(10) productivity $\sqrt{\text{Var}(\zeta_s)}$</td>
<td>0.125</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
</tr>
<tr>
<td>(13) while in Part-Time work: $g_s(P)$</td>
<td>0.150</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
</tr>
<tr>
<td>(14) depreciation rate: $\delta_s$</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
</tr>
</tbody>
</table>
Labour supply among parents: employment rates

The differences in labour supply widen with the first birth.

BHPS 1991-2008, 22 or older at first birth.
Part-time employment by age and sex

- GCSEs
- A-levels
- University

For each category, the diagrams show the proportion of part-time employment by age and sex. The x-axis represents age, and the y-axis represents the proportion. The lines represent men (solid) and women (dashed).
The key focus is on modelling the *life-cycle labor supply and human capital decisions of women*:

- Labour supply of women has been found to be more responsive to incentives, especially *low wage women with school age children*.

- Reduced labour supply, especially early in a career, points towards the potential importance of returns to experience.

- Could training offset human capital depreciation due to part-time work and non-employment?

- ... But what if *education, training and work experience investments are complementary* in the production of human capital?

- This research aims to unravel the way these aspects of *human capital interact with labour supply decisions and impact on female earnings over the life-cycle*. 
What role for training?

- Estimate an extended wage equation with training.

Q: Is there a role for training to offset human capital depreciation from part-time work and non-employment?

- Estimate using tax instruments for part time and full time simulated incomes.

- Also use interactions of time x local area and industry as additional (to tax and welfare reforms) excluded instruments for training.

- Overall results for impact of work experience are very similar.

- Impact of training seems to matter most for middle educated, even among lower educated,

- distinguish employer provided qualification training.