Structural Econometrics in Labour and IO
Dynamic Discrete Choice in Labour

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10 June, 2021

Next session

1. June 23th
2. Discuss PS with Boryana Ilieva).

Plan for today: Blundell, Costa-Dias, Meghir and Shaw (2016)

1. Motivation and model
   - Structure of Model
   - Identification
   - Reduced form and structural model
2. Solution and Estimation
   - compare to KW
3. Policy Simulations
   - Long term effects of In-work tax credits
4. Problem set (Boryana)

- What is the research question?
- What are the main contributions?
- What is the value added to the literature?

Main aims/ contributions of paper

1. Explain **long run or career effects** of in work credits
2. Understand in detail returns to experience (Part time/ full time)
3. Estimate and solve a model with discrete and continuous choices
4. Use reduced form evidence for identification of structural model

Main aims of paper

Explain **long run or career effects** of in work credits

- What is an in-work tax credit?
- What are short run effects of in-work tax credit?
- Why can in work tax credit have long run effects?
- Which dimension of household behavior might be affected by in work credits?

In Work tax credit

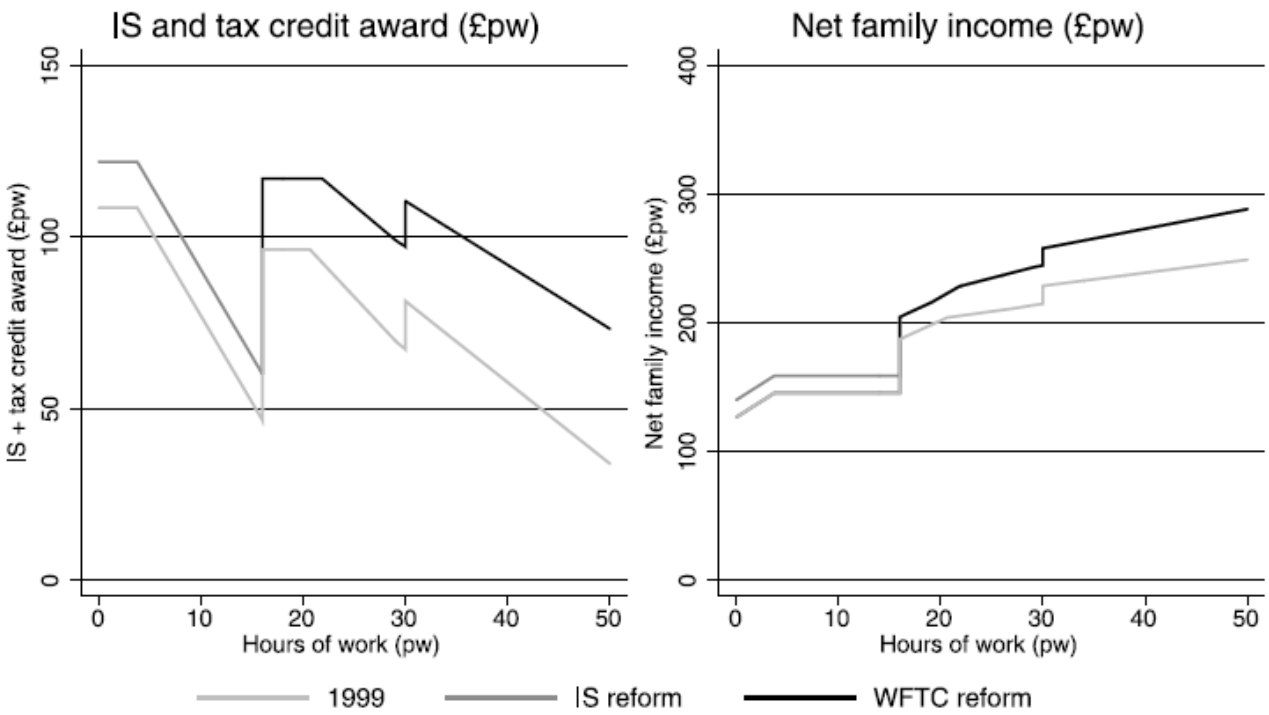

FIGURE 1.—IS/tax credit award and budget constraint for low-wage lone parent. Notes: Lone parent earns the minimum wage (April 2004) and has one child aged 4 and no expenditure on childcare or rent. All monetary values in 2008 prices.

Main aims of paper

Explain **returns to experience**

- Why important to differentiate between part an full time work?
- Why important to allow for different returns to experience by education?
- What is the difference between human capital depreciation and returns to experience?

Main aims of paper

Estimate a model with **discrete and continuous** choices

- What is a continuous choice in the model?
- Which choices are discrete?
- In this paper: Approximation of value functions to deal with kinks and jumps.
- What would be an alternative to deal with continuous choice variable?

Main aims of paper

Use reduced form models exploiting policy variation for identification - **causal moments**.

- Why are "causal moments" helpful?
- Would the model be identified without causal moments?

Reduced form evidence

- How do in-work tax credits affect behavior?
- Which groups are affected?
  - Employment
  - Education
  - Savings
- Reduced form identification in the paper?

In Work tax credit - effects on employment

TABLE V

DIFFERENCE-IN-DIFFERENCES EMPLOYMENT REGRESSIONS FOR LONE MOTHERS VERSUS SINGLE WOMEN[a]

	(1) Secondary	(2) High School	(3) University
1999 compared to 2002—Before and after all WFTC reforms			
Impact on employment	0.040***	0.055***	−0.005
Standard error	(0.012)	(0.015)	(0.016)
Pooled sample 1995–2004			
Impact on employment	0.0411**	0.0474*	−0.0095
	(0.0178)	(0.0266)	(0.0341)
Lone-mothers × pre-reform linear trend	0.0015	−0.0086	−0.0105
	(0.0040)	(0.0067)	(0.0087)
N	24,648	8,113	5,088

[a]Data from the Labour Force Survey. Standard errors in parentheses. Top panel: two period differences in differences comparing pre-reform employment (1999) to post-reform (2002) for treatment (lone mothers) and comparison group (single women with no children). Lower panel: pooled regression for 1995–2004, including pre-reform differential trend between lone mothers and single childless women. All regressions include a full set of dummies for time, age, and age of youngest child and an indicator for being a single mother. Impact on employment is coefficient on lone-mother × post-reform. ***, **, * indicates statistical significance at 1%, 5%, and 10%, respectively.

In Work tax credit - effects on education

	Treatment effect			
Average effect	−0.012**	−0.012**	−0.012**	−0.012**
St. error	(0.0052)	(0.0052)	(0.0053)	(0.0054)
Changes in expected income by education group comparing 1999 to 2002 $\Delta \ln(\overline{EY_C}) = 0.014, \Delta \ln(\overline{EY_{HS}}) = 0.010, \Delta \ln(\overline{EY_U}) = 0.004$				
N	1,033			

[a]Linear probability model on BHPS data. Cohorts 1970–1985. The dependent variable is 1 for those with post-compulsory education and zero otherwise. post-ref is a dummy for post-reform (cohorts 1982+); t is a linear time trend; f_1 and f_2 are the first two principal components extracted from the family background variables (the education of both parents (five levels each), number of siblings and sibling order (dummies for no siblings, three or more siblings, and whether respondent is the first child), books in childhood home (three levels), and whether lived with both parents when aged 16). The means of the factors (f_1, f_2) are (0.9, −0.033), the lowest quartile, the median and the top quartile are (−0.067, −1.02), (1.217, −0.086) and (2.08, 0.92), respectively.

Model

- Which choices in the model?
- Which risks are in the model?
- How is the budget constraint modeled?
- How is the household context modeled?
- How does the model differ from KW?

Preferences

$$(1) \qquad u(c_t, l_t; \theta, Z_t) = \frac{(c_t/n_t)^{\mu}}{\mu} \exp\{U(l_t, \theta, Z_t)\},$$

$$U(l_t, \theta, Z_t) = \begin{cases} 0, & \text{if } l_t = \text{O (Out of work)}, \\ \theta_l + Z_t'\alpha(l_t), & \text{if } l_t = \text{P or F (Part time or full time)}, \end{cases}$$

$$\text{where} \quad \alpha(l_t) = \alpha_{\text{F}} + \alpha_{\text{P}} \times \mathbf{1}(l_t = \text{P}),$$

$$V_t(X_t) = \max_{\{c_\tau, l_\tau\}_{\tau=t,\ldots,\bar{t}}} \text{E}\left\{ \sum_{\tau=t}^{\bar{t}} \beta^{\tau-t} u(c_\tau, l_\tau; \theta, Z_\tau) \middle| X_t \right\}$$

Preferences

- Why is there no error term ?
- How is observed and unobserved heterogeneity modelled?
- What is in the state space X?
- How are family circumstances captured (f)?
- What are the assumptions about discount factor and interest rate - what is the implication of this assumption?

Education

$$s = \underset{s\in\{1,2,3\}}{\operatorname{argmax}}\{W_s(X_{17}) - B_s(X_{17})\},$$

where B_s measures the utility costs of the investment, defined as

$$B_s(X_{17}) = \pi_{1s} f_1 + \pi_{2s} f_2 + \pi_{5s} y_p + \varpi_s.$$

$$W_s(X_{17}) = \begin{cases} \mathrm{E}[V_{19}(X_{19})|X_{17}, s], & \text{if } s = 1, 2, \\ \mathrm{E}\left[\max\limits_{c_{19}, c20, c_{21}} \left\{\sum\limits_{t=19}^{21} \beta^{t-19} u(c_t, \mathrm{F}; \theta, Z_{17}) \right.\right. & \\ \left.\left. \quad + \beta^{22-19} V_{22}(X_{22})\right\} \middle| X_{17}, s\right], & \text{if } s = 3, \end{cases}$$

Education specific wages process

$$\ln w_t^m = b_{s,0} + b_{s,1}x_1 + b_{s,1}x_2 + (\gamma_{s,0} + \gamma_{s,1}x_1 + \gamma_{s,2}x_2)\ln(e_t + 1) + v_t + \xi_t, \tag{3}$$

$$\ln w_t = \ln w_t^m - \xi_t, \tag{4}$$

$$e_t = e_{t-1}(1 - \delta_s) + g_s(l_{t-1}), \tag{5}$$

$$v_t = \rho_s v_{t-1} + \zeta_t, \tag{6}$$

Budget

$$
(2) \qquad \begin{cases} a_{t+1} = (1+r)a_t + h_t w_t + m_t \tilde{h}_t \tilde{w}_t - T(l_t, X_t) \\ \qquad\qquad - Q\left(t^k, h_t, \tilde{h}_t, m_t\right) - c_t, \\ a_{t+1} \geq \underline{a}_s, \\ \quad \text{with initial and terminal conditions: } a_0 = 0 \text{ and } a_{\bar{t}+1} = 0, \end{cases}
$$

Model

- Marriage market?
- Fertility?
- Employment and Wages of husband?
  - How can restrict the state space?
- Labor market frictions?

Estimation and Approximation of value function

- Estimation method?
- Why 2 Step procedure - what is the advantage /disadvantage?
- Why is the approximation of the value function complicated?

- Identification: How does this differ to KW?

MSM vs ML

- What is the advantage of MSM?
- What is the disadvantage of MSM?
  - What is the problem with discrete choices in MSM - how is this solved?
- How are policy changes implemented in the MSM?

Approximating Value function

- Problem: Continuous and Discrete Decisions - neither smooth nor concave.
- Intuition of solution
- Alternative?

Identification

- Which moments are used.
- Is the identification more convincing than in KW?

Estimation results

Wages

FEMALE WAGE EQUATION AND EXPERIENCE ACCUMULATION[a]

		Education		
		Secondary (1)	High School (2)	University (3)
(1)	Intercept ($b_{s,0}$)	5.406 (0.030)	5.547 (0.038)	6.949 (0.071)
(2)	Increment: high factor 1 ($b_{s,1}$)	0.005 (0.040)	0.018 (0.038)	0.061 (0.066)
(3)	Increment: high factor 2 ($b_{s,2}$)	0.014 (0.036)	−0.186 (0.031)	0.045 (0.048)
(4)	Mean hourly wage rate at 25	7.19 (0.050)	8.64 (0.067)	10.55 (0.317)
	Returns to experience			
(5)	Baseline ($\gamma_{s,0}$)	0.152 (0.006)	0.229 (0.009)	0.306 (0.011)
(6)	Increment: high factor 1 ($\gamma_{s,1}$)	0.054 (0.009)	0.014 (0.009)	−0.002 (0.010)
(7)	Increment: high factor 2 ($\gamma_{s,2}$)	−0.002 (0.008)	0.029 (0.008)	−0.006 (0.008)
(8)	Mean value of the coefficient on experience	0.16 (0.008)	0.25 (0.012)	0.30 (0.014)
	Distribution of unobserved productivity			
(9)	Autocorrelation coefficient: ρ_s	0.925 (0.006)	0.916 (0.006)	0.880 (0.008)
(10)	St. deviation of innovation in productivity: $\sqrt{\text{Var}(\zeta_s)}$	0.125 (0.005)	0.154 (0.005)	0.139 (0.005)
(11)	Mean of initial productivity for type I: E(v_{0s}|type I)	0.140 (0.011)	0.111 (0.028)	0.306 (0.015)
(12)	St. deviation initial productivity: $\sqrt{\text{Var}(v_{0s})}$	0.145 (0.012)	0.202 (0.015)	0.223 (0.016)
	Human capital dynamics			
(13)	While in part-time work: g_s(P)	0.150 (0.015)	0.096 (0.022)	0.116 (0.013)
(14)	Depreciation rate: δ_s	0.081 (0.008)	0.057 (0.008)	0.073 (0.009)

Preferences

ESTIMATES OF PREFERENCE PARAMETERS—FUNCTION U IN EQUATION (1)[a]

		Coeff. (1)	St. Error (2)	Coeff. (3)	St. Error (4)
		Utility Parameters			
		All Employment α_F		Part-Time Employment α_P	
(1)	Singles, no children: Sec	0.344	(0.011)	−0.269	(0.009)
(2)	Singles, no children: HS	0.412	(0.013)	−0.315	(0.012)
(3)	Singles, no children: Univ	0.555	(0.014)	−0.382	(0.012)
(4)	Married, no children: Sec	0.226	(0.013)	−0.154	(0.009)
(5)	Married, no children: HS	0.222	(0.011)	−0.156	(0.008)
(6)	Married, no children: Univ	0.276	(0.013)	−0.180	(0.010)
(7)	Single mothers: Sec	0.375	(0.010)	−0.161	(0.006)
(8)	Single mothers: HS	0.330	(0.019)	−0.142	(0.015)
(9)	Single mothers: Univ	0.372	(0.016)	−0.184	(0.066)
(10)	Married mothers: Sec	0.226	(0.011)	−0.168	(0.009)
(11)	Married mothers: HS	0.233	(0.012)	−0.180	(0.009)
(12)	Married mothers: Univ	0.282	(0.015)	−0.212	(0.012)
(13)	Child aged 0–2	0.156	(0.010)	−0.095	(0.008)
(14)	Child aged 3–5	0.093	(0.010)	−0.067	(0.009)
(15)	Child aged 6–10	0.047	(0.008)	−0.027	(0.007)
(16)	Partner working	−0.077	(0.009)	0.066	(0.007)
(17)	High background factor 1	0.002	(0.007)	0.000	(0.005)
(18)	High background factor 2	0.006	(0.006)	0.001	(0.005)
		Unobserved Heterogeneity in Cost of Work			
		Full-Time Employment θ_F		Part-Time Employment θ_P	
(19)	Type I	−0.193	(0.006)	−0.093	(0.005)
(20)	Type I: probability	0.361 (0.005)			

[a]Standard errors in parentheses. The utility costs of working full-time and part-time for preference type II are

Education

ESTIMATES OF PREFERENCES FOR EDUCATION AND PROBABILITY OF POSITIVE CHILDCARE COSTS IF WORKING[a]

	High School		University	
	Coeff. (1)	St. Error (2)	Coeff. (3)	St. Error (4)
(1) Intercept	−0.053	(0.025)	0.682	(0.015)
(2) Background factor 1	0.227	(0.012)	0.363	(0.014)
(3) Background factor 2	0.009	(0.022)	0.299	(0.011)
(4) Parental liquidity shock when aged 16	0.305	(0.158)	0.695	(0.036)
(5) St. deviation unobserved utility cost of education ($\sqrt{V\varpi_s}$)	1.579	(0.093)	1.015	(0.183)
(6) Probability of positive childcare costs	0.576	(0.014)		

[a] Residual parental income constructed from regression of parental income on all long-term background characteristics when the woman is 16 years old.

Model fit - Wage age profile

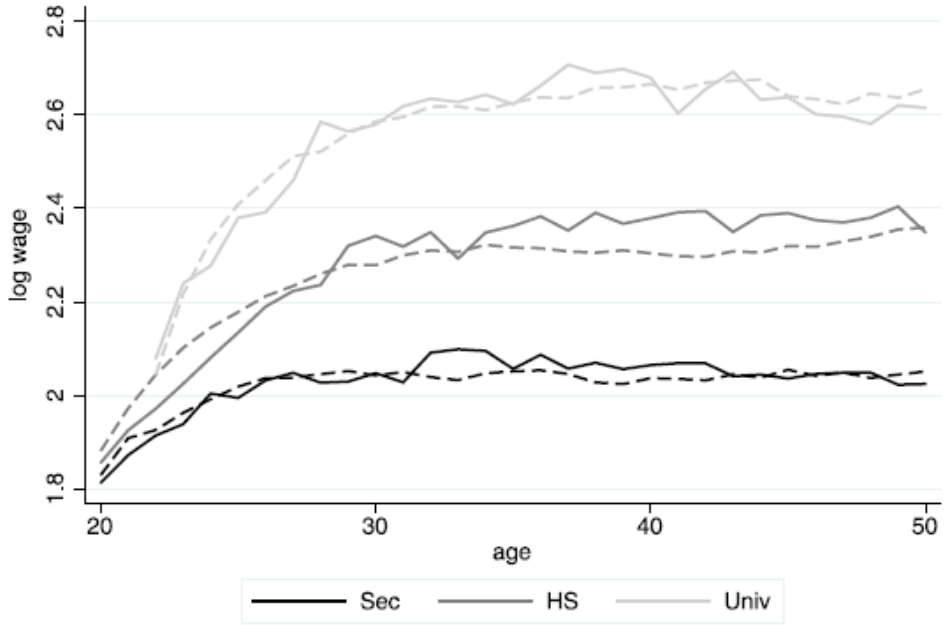

FIGURE 5.—Mean log wage rates for working women over the life-cycle by education: data versus model. Notes: BHPS versus simulated data, in solid and dashed lines, respectively. 2008 prices.

Model fit - Inequality of wages

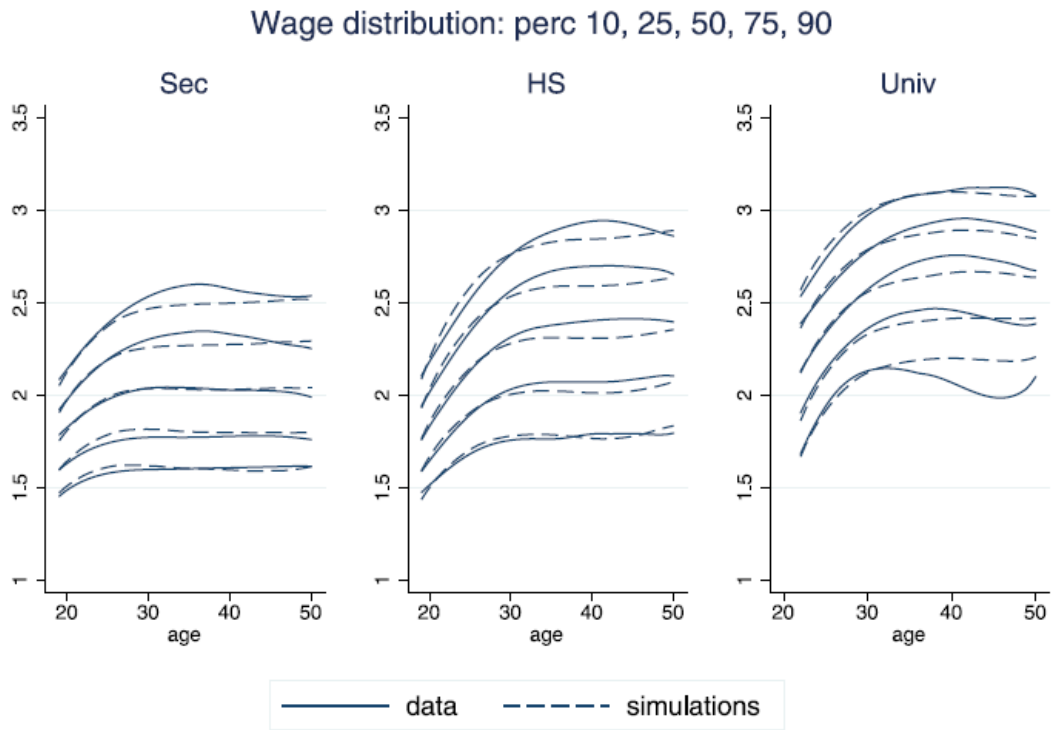

FIGURE 6.—Distribution of log wage rates for working women over the life-cycle by education: data versus model. Notes: BHPS versus simulated data. 2008 prices. All curves smoothed using kernel weights and a bandwidth of 2 years.

Model fit - Part time wage penalty

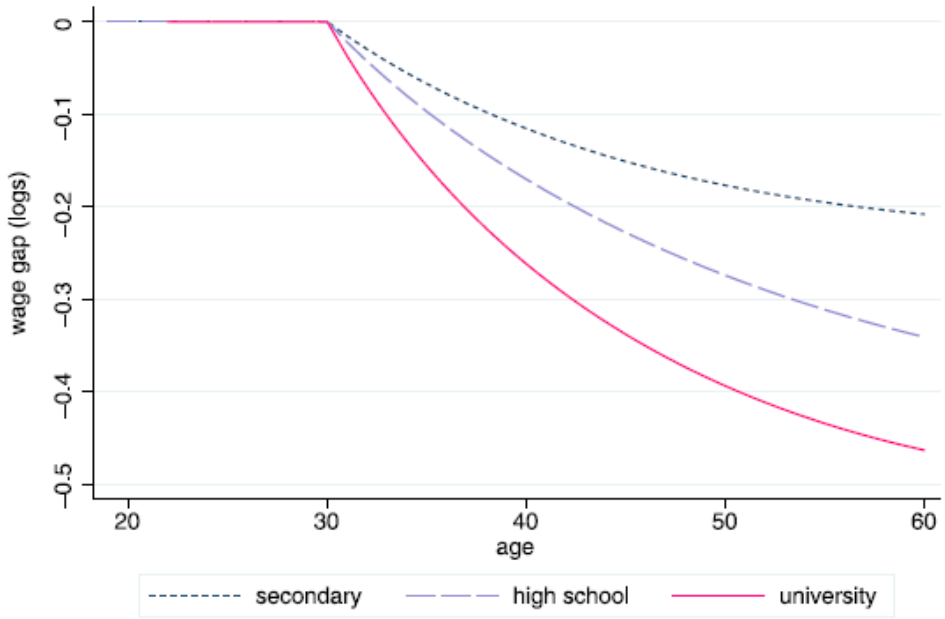

FIGURE 7.—Experience gap for women in part-time work from the age of 30; by education. Notes: All values in log wage units. Curves represent difference in accumulated experience between women taking part-time work from the age of 31 onwards as compared to taking full-time work over the same period, all conditional on full-time employment up to the age of 30.

Validation?

TABLE XII

THE IMPACT OF THE REFORMS ON THE EMPLOYMENT RATES OF LONE MOTHERS—MODEL SIMULATIONS VERSUS DID DATA ESTIMATES[a]

		Secondary	High School	University
(1)	Estimates based on LFS data	4.0	5.5	−0.5
	St. error	(1.2)	(1.5)	(1.6)
(2)	Model simulation	5.6	5.0	1.2

[a] Row 1 displays the result from the difference-in-differences as in the top panel of Table V. Row 2 shows the results of similar calculations on simulated data from the model.

Implications: Labor supply elasticities

TABLE XIV

ELASTICITIES OF LABOR SUPPLY[a]

	Frisch			Marshall		
	Extensive		Intensive	Extensive		Intensive
	Elasticity	Derivative	Elasticity	Elasticity	Derivative	Elasticity
All women	0.627	0.510	0.240	0.475	0.386	0.210
By education						
Secondary	0.914	0.675	0.327	0.689	0.509	0.280
High school	0.567	0.469	0.223	0.428	0.354	0.198
University	0.427	0.375	0.180	0.331	0.291	0.158
By family composition						
Single women with no children	0.532	0.486	0.159	0.419	0.383	0.055
Lone mothers	2.240	1.275	0.452	1.362	0.775	0.378
Women in couples, no children	0.264	0.242	0.163	0.220	0.203	0.167
Women in couples with children	0.688	0.522	0.316	0.553	0.419	0.304

[a]Calculations based on simulated data under the 1999 tax and benefit system. The derivatives in columns 2 and 5 measure the *percentage point change* in labor supply, in response to a 1% increase in net earnings. All effects are measured in the year the change in earnings occurs.

Policy Simulations

- Based on the model policy reforms can be simulated - how?
- Based on the model welfare effects can be simulated - how?

Welfare

[51] The value of consumption compensation is the solution to the equation

$$\mathrm{EV}_0 = E\sum_t \beta^{a-\underline{A}} \frac{\left((1-r)c_{1a}/n_{1a}\right)^{\mu}}{\mu} \exp\left\{U(l_{1a}, X_{1a}) + \theta(l_{1a})\right\},$$

where the index 0/1 stands for the pre/post-reform solutions and the value function is evaluated at different stages in life for different rows. The equation can be solved for r, yielding

$$r = 1 - \left(\frac{\mathrm{EV}_0}{\mathrm{EV}_1}\right)^{1/\mu}.$$

Policy Simulation I

TABLE XV

EFFECTS OF TAX CREDITS[a]

		Pre-Reform Education Choice					
		Secondary		High School		University	
		Impact on Employment: Mothers of Dependent Children (0–18)					
		Single	Married	Single	Married	Single	Married
(1)	All (pp)	20.4	−6.6	19.9	−3.6	8.5	−1.0
(2)	Full-time (pp)	9.3	−3.6	7.5	−2.4	−2.1	−1.1
(3)	Part-time (pp)	11.1	−3.0	12.3	−1.2	10.6	0.1
		Impact on Employment: Mothers of Adult Children (19+)					
(4)	All (pp)	0.4		0.3		0.0	
(5)	Full-time (pp)	0.4		−0.0		−0.2	
(6)	Part-time (pp)	−0.0		0.3		0.2	
		Impact on Education and Wages					
(7)	Education (pp)	0.84		−0.19		−0.65	
(8)	Wages: mothers of child aged 19 (%)	−0.20		0.05		−0.29	
		Impact on Assets (%)					
(9)	No children	−3.3		−2.1		−1.5	
(10)	Dependent child (0–18)	−7.2		−5.3		−2.6	
(11)	Adult child (19+)	−2.3		−1.7		−1.3	
		Impact on Lifetime Disposable Income and Welfare					
(12)	Disposable income (%)	−1.09		−0.25		−0.87	
(13)	Consumption equivalent (%)	1.97		0.76		−0.27	
(14)	Adjustment in the basic rate of Income Tax to fund reform: +0.9 pp						

[a]Reform is revenue neutral by adjusting the income tax rate. Education is allowed to adjust. Educational classification fixed at the pre-reform (no tax credits) choice. All effects are percentage points change (pp) or percent changes (%) as marked.

Policy Simulation II

TABLE XVII

EFFECTS OF ASSESSING TAX CREDITS AT THE INDIVIDUAL LEVEL—INTEGRATED WITH THE 2002 TAX AND BENEFIT SYSTEM[a]

		Pre-Reform Education Choice					
		Secondary		High School		University	
		Impact on Employment: Mothers of Dependent Children (0–18)					
		Single	Married	Single	Married	Single	Married
(1)	All (pp)	−3.7	29.6	−4.3	21.6	−4.6	15.0
(2)	Full-time (pp)	−6.3	−16.2	−7.3	−19.2	−9.8	−18.0
(3)	Part-time (pp)	2.6	45.8	3.0	40.7	5.2	33.1
		Impact on Employment: Mothers of Adult Children (19+)					
(4)	All (pp)	−2.8		−2.8		−3.7	
(5)	Full-time (pp)	−8.7		−6.6		−7.3	
(6)	Part-time (pp)	5.1		3.7		3.6	
		Impact on Education and Wages					
(7)	Education (pp)	1.97		−0.82		1.15	
(8)	Wages: mothers of child aged 19+ (%)	−3.7		−5.7		−5.9	
		Impact on Assets (%)					
(9)	No children	−12.4		−11.5		−11.4	
(10)	Dependent child (0–18)	21.3		8.3		−2.8	
(11)	Adult child (19+)	6.8		0.0		−6.4	
		Impact on Lifetime Disposable Income and Welfare					
(12)	Disposable income (%)	0.22		−3.51		−6.74	
(13)	Consumption equivalent (%)	1.70		−2.14		−3.20	
(14)	Adjustment in the basic rate of Income Tax to fund reform: +8.5 pp						

[a]Reform is revenue neutral by adjusting the income tax rate. Education is allowed to adjust. Educational classification fixed at the pre-reform choice. All effects are percentage points change (pp) or percent changes (%) as marked.

10 minutes break -home work