How does the tax system redistribute income? A lifecycle approach

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Overview (1)

- Based on “Lifetime inequality and redistribution” IFS WP12/23 by Mike Brewer, Monica Costa Dias and Jonathan Shaw
  - See also
    - Brewer, Costa Dias and Shaw: “How taxes and welfare distort work incentives: static lifecycle and dynamic perspectives” IFS WP13/01
    - Blundell, Costa Dias, Meghir and Shaw: “Female labour supply, human capital and welfare reform” NBER Working Paper No. 19007

- Our interest is in assessing the degree of income inequality, and the amount of redistribution achieved by the tax and benefit system, with a lifetime perspective

- Recurring themes:
  - dynamics
    - choices now affect opportunities tomorrow
    - opportunities tomorrow affect choices now
  - lifecycle effects
    - opportunities change as people age, and family circumstances change
  - a lifetime perspective
    - not all poor (rich) individuals will be poor (rich) in future

Overview (2)

- We estimate a structural, dynamic model of women's education and labour supply that replicates behaviour of real women in Great Britain
  - Women make choices over education, labour supply and savings
  - Experience gained through working affects future wages
  - Evolving, but exogenous, family circumstances
  - Lots of heterogeneity and uncertainty

- After estimation, use simulations of lifecycles to measure/estimate:
  - amount of annual and lifetime inequality, and how affected by tax/benefit system
  - what causes lifetime inequality
  - how does the current UK tax and benefit system reduce lifetime inequality

- We use simulated data to:
  - overcome lack of long panels
  - purge data of cohort, time and policy effects
  - allow explicit simulation under alternative policy regimes

- We focus on:
  - Women and their families
  - in working life (ages 19-59)

Overview (3)

- Inequality often viewed from annual perspective. This confounds:
  - true permanent individual differences
  - predictable lifecycle changes
  - decisions motivated by dynamic considerations
  - transitory shocks
- All means inequality usually greater when viewed from annual snapshot

- Taxes based on annual income & current circumstances. This confounds:
  - redistribution across individuals
  - individual transfers across periods of the lifecycle
- May therefore shift attention from those most in need

- Most assessments of taxes take static view
  - Redistribution assessed on the basis of snapshots
  - [NB see also Brewer, Costa Dias and Shaw: "How taxes and welfare distort work incentives: static lifecycle and dynamic perspectives" IFS WP13/01. Distortionary effects of taxes may be realised in future (if choices have future payoffs e.g. labour supply or education) or past (if individuals can anticipate) (Imai and Keane, 2004; Blundell et al, NBER w19007)]

Literature (1)

- Annual inequality is larger than lifetime inequality
  - e.g. Lillard, 1977; Blomquist, 1981; Bjorkland, 1993; Jenkins, 2010; Kopczuk et al, 2010

- The impact of tax-benefits on income distribution
  - Annual progressivity of tax system higher than lifetime progressivity (Petterson and Petterson, 2003; Piketty and Saez, 2007; Bengtsson et al., 2011)
  - Modern tax systems do reduce lifetime inequality but by less than they do annual inequality (Liebman, 2002)
  - A large proportion of net taxes redistribute income across life-cycle (Bjorklund and Palme, 1997; O'Donoghue, 2001; Bovenberg et al., 2008)
    - if exclude retirement transfers, some conclude that most redistribution is interpersonal (van de Ven, 2005)
  - Efficiency gains in making the taxes dependent on age or past choices (Fennel and Stark, 2006; Weinzier, 2010; Bovenberg et al., 2008; Laroque, 2009)

Literature (2)

- Dynamic (female) labour supply, with education choices, taxes and benefits, and family formation
  - e.g. Eckstein and Wolpin (1989), Keane and Wolpin (1997, 2010), Imai and Keane (2004), Mazzocco et al (2007), Eckstein and Lifshitz (2011), Adda et al (2011a,b), Fernandez and Cheng Wong (2014), Greenwood et al (2012)

- Transmission of inequality across working-life (Blundell 2014)

The model: utility, constraints and uncertainty

- Women choose education, labour supply and consumption (savings) to maximise lifetime utility
  - Early years: investments in education
  - Working life: choose from not work; PT, FT
    - Human capital accumulates while working
    - family formation exogenous but stochastic
  - Retirement
- Features
  - interaction between education, labour supply and experience accumulation
  - unobserved heterogeneity in tastes for working (correlated with women's initial productivity)
  - detailed representation of UK personal tax and benefit system
  - uncertainty (over employment, wages and family composition), credit constraints and retirement generate need for savings

The model: early life

- Women “born” with (random) set of preferences for work/leisure & education, and initial assets
- Choose 1 of 3 levels of education to maximise expected lifetime utility (given distaste for education and work, assets, and costs, and all parameters in model)
  - Women can borrow to fund education
- Women finish education as single with no children, and enter labour market with productivity draw (correlated with tastes for work)

The model: family composition

- Men arrive and leave exogenously (given women's education) and stochastically
  - rate depends on women's age, education & children
  - men's characteristics depend on women's education
- Male labour supply is stochastic; male wages depend on woman's age & education and persistent shock
- Children arrive exogenously (given women's education) and stochastically (stork theory of childbirth…?), and leave home after 18 years
  - Children
    - affect utility from consumption (equivalence scale)
    - increase disutility of working
    - may require money to be spent on childcare
    - affect rate of family transitions
    - affect tax and benefit entitlement

The model: female labour supply

$$\max_{\{c_\alpha, l_\alpha\}} \; E_\alpha \left\{ \sum_{\alpha=a}^{A} \beta^{\alpha-a} U\left(c_\alpha, l_\alpha; s, m_\alpha, l_\alpha^m, k_\alpha, a_\alpha^k, \theta_{PT}, \theta_{FT}\right) \mid X_a \right\}$$

- Women choose no work, part-time (20 hours/wk), full-time (40 hours/wk) given own wage and male labour supply

$$\ln y_a = \ln W_s + \gamma_s \ln\left(e_a + 1\right) + \upsilon_a$$

$$\upsilon_a = \rho_s \upsilon_{a-1} + \mu_a$$

$$e_a = e_{a-1}\left(1 - \delta_s\right) + g_s\left(l_a\right)$$

- Female wages depend on price of skill (education), accumulated experience and persistent individual shock
  - Accumulated experience depreciates if do not work, and PT work worth less than FT work
- Women need to provide childcare to cover working time
- Utility depends on equivalised family consumption

The model: data

- BHPS, the main UK household panel dataset
- Started in 1991 with around 5,500 households
- We use unbalanced panel of c5,300 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, income, demographics
  - remove cohort effects and real wage growth

- Calibrate interest rate, discount rate, intertemporal preferences parameter
- Estimate exogenous parameters outside structural model (family transitions, childcare costs, model for men's employment)
- For other 55 parameters, use indirect inference (method of simulated moments) (Smith, 1990, Gourieroux, Monfort and Renault, 1993, De Nardi, French and Jones, 2008, Guneven and Smith, 2008)
  - Calculate moments of real data
    - 207 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 of distribution of earnings by working hours; change in earnings by past employment status; moments of distribution of initial earnings; distribution of education; proportion paying for childcare
  - Given set of parameters, solve model and calculate same moments of simulated data
    - draw exogenous shocks (e.g. for productivity, family composition, ability) and use model to determine choices made at each age
  - Minimise distance between real and simulated moments
- Having estimated model, then simulate lifetimes of c20,000 women under 2006/7 tax system
- All analysis that follows done on these simulated lifetimes

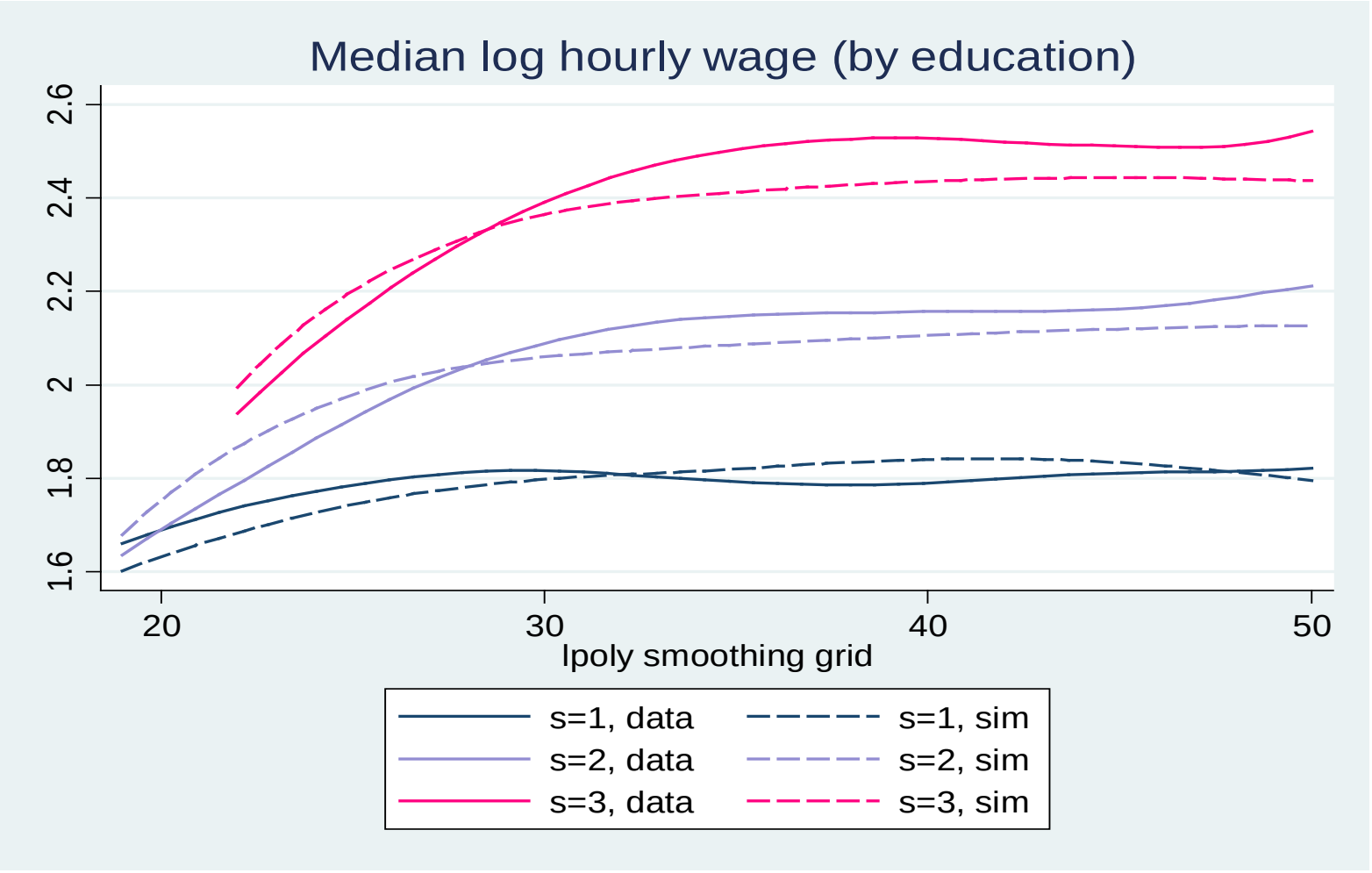
Coefficients: wages

Table 2: Estimates of the female wage equation and experience accumulation parameters

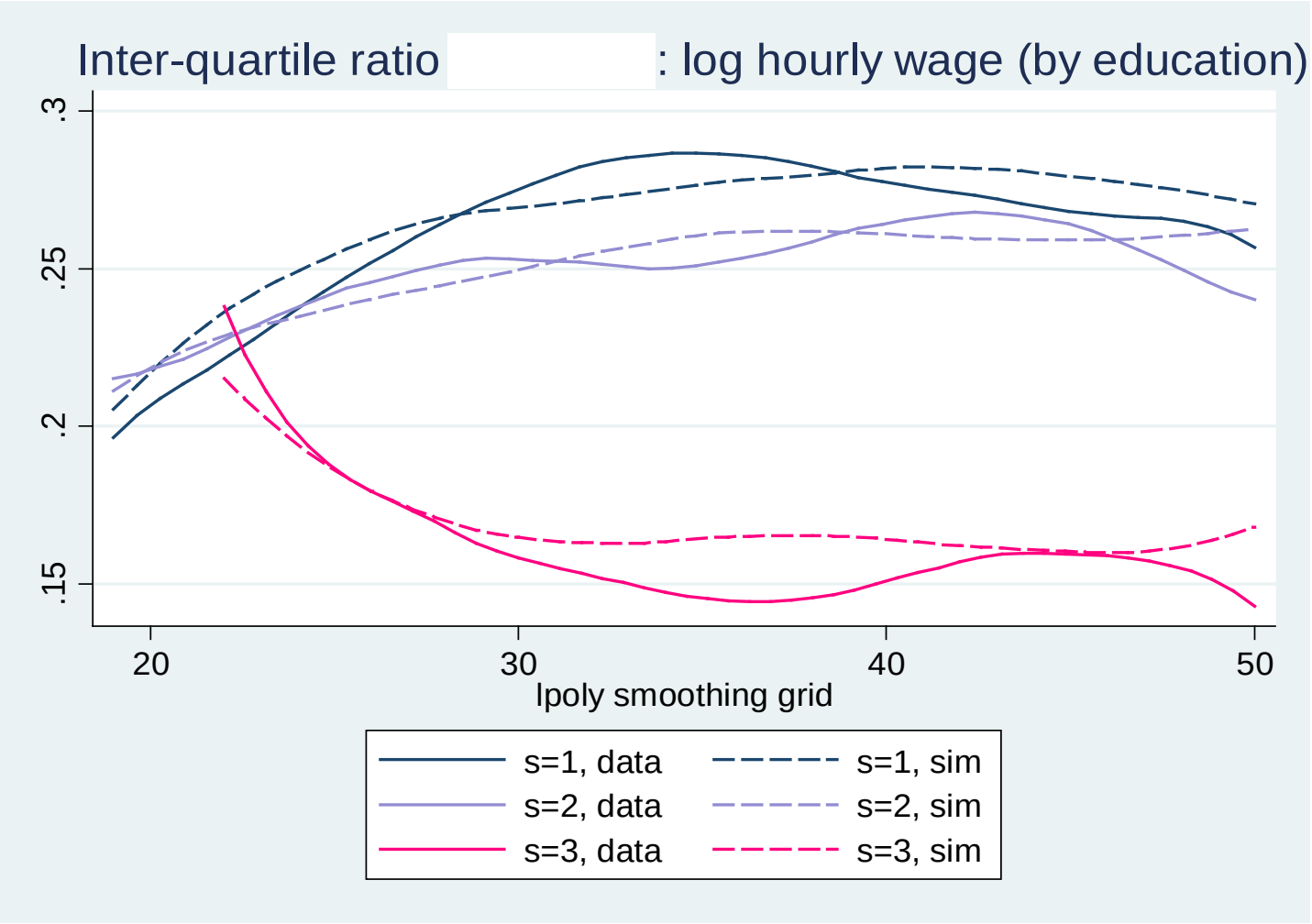
		Education attainment		
		secondary	further	higher
		(1)	(2)	(3)
(1)	hourly wage rate (0 experience): Y_s	4.49	4.88	6.29
		(0.018)	(0.022)	(0.034)
(2)	returns experience: γ_s	0.14	0.23	0.28
		(0.009)	(0.009)	(0.010)
(3)	autocorrelation coefficient: ρ_s	0.92	0.95	0.89
		(0.008)	(0.007)	(0.010)
(4)	st. error innovation in productivity: $\sqrt{\text{Var}(\zeta_s)}$	0.13	0.13	0.12
		(0.006)	(0.007)	(0.006)
(5)	mean initial productivity for type I: $\text{E}(\nu_{0s}\|\text{type I})$	0.10	0.10	0.20
		(0.013)	(0.016)	(0.015)
(6)	st. error initial productivity: $\sqrt{\text{Var}(\nu_{0s})}$	0.30	0.26	0.26
		(0.013)	(0.015)	(0.025)
(7)	human capital accumulation while in PT work: $g_s(l = PT)$	0.15	0.12	0.10
		(0.027)	(0.027)	(0.022)
(8)	human capital depreciation rate: δ_s	0.12	0.11	0.11
		(0.016)	(0.011)	(0.008)

Notes: Asymptotic standard errors in parenthesis under estimates. Type I women (row 5) are those with lower preferences for leisure. "PT" stands for part-time work.

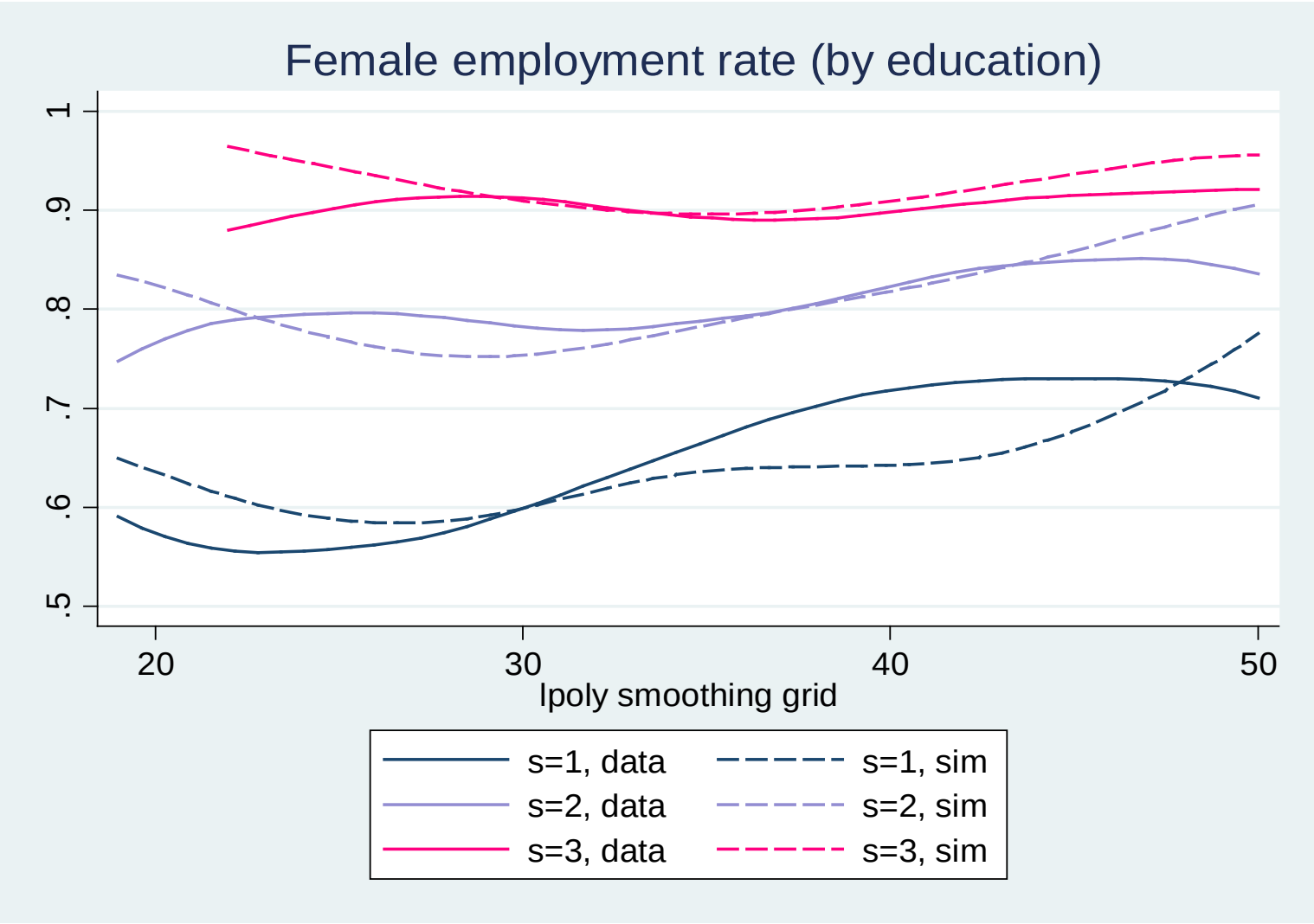
Model fit: hourly wages



Model fit: wage dispersion



Model fit: employment



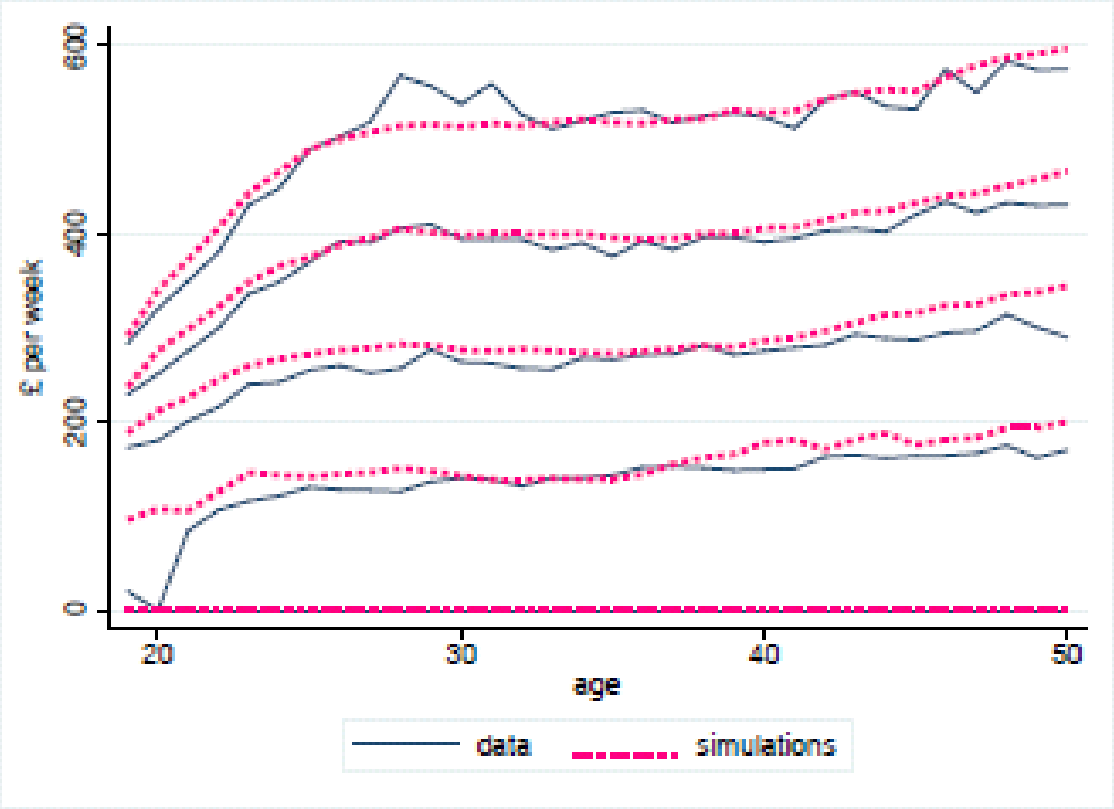
Model fit: earnings inequality

Table 1: Gini coefficient for earned equivalised family income; data versus simulations

	data	simulations	difference
1 year	0.406	0.356	0.053
3 years average	0.372	0.343	0.030
5 years average	0.354	0.335	0.021
9 years average	0.319	0.322	-0.001

Model fit: income inequality

Figure 2: Distribution of earned equivalised family income over the life-cycle of women; data versus simulations



Notes: Lines in the graph correspond to the 10th, 25th, 50th, 75th and 90th percentiles of the distribution of equivalised earned familiy income in the real (solid blue) and simulated (dotted pink) datasets

Model fit: earnings dynamics (1)

Table 3: Transition probabilities in equivalised earned family income; data versus simulations

	Same quintile		Same or neighbouring quintile	
	data	simulations	data	simulations
year-to-year, annual income	66.3%	73.2%	91.8%	95.6%
3-year transitions, 3-year mean income	57.3%	59.0%	90.6%	92.2%
5-year transitions, 5-year mean income	52.6%	52.0%	89.5%	89.3%

Model fit: earnings dynamics (2)

Table 2: Rank correlation between equivalised earned income at different ages; data versus simulations

	1-year income 1 year interval	3-year income 3-year interval	5-year income 5-year interval
All women			
BHPS data	0.836	0.828	0.805
simulated data	0.870	0.843	0.794
Women 35 or younger			
BHPS data	0.838	0.816	0.788
simulated data	0.848	0.827	0.776

Model: conclusion

- Key features
  - Human capital (though education and returns to experience) and savings are the main dynamic processes
  - Uncertainty, credit constraints and retirement generate need for savings
    - Uncertainty over employment, wages and family composition
  - Heterogeneity and heterogeneous preferences
  - Detailed policy environment
  - Model appropriate for all but top 5-10%

Story in 1 slide

- Lifetime vs annual measures
  - Lifetime inequality in UK lower than annual inequality
  - UK tax and benefit system is less progressive on lifetime basis than annual basis
  - Periods of zero earnings contribute a lot to inequality, but are well compensated-for by UK tax and benefit system
- Inequality and redistribution over the lifecycle
  - UK tax and benefits particularly good at reducing inequalities at bottom during main child-rearing ages
  - But circumstances at this time of life are good predictor of lifetime income, so redistribution to parents with low earnings is well targeted at reducing lifetime inequalities
  - Encouraging low-wage lone mothers to work is effective in reducing lifetime inequalities

Annual vs lifetime inequality
and
Within- vs between- redistribution

The tax and benefits system reduces annual inequality...

	Annual inequality		Lifetime inequality	
	Gross earnings	Net income	Gross earnings	Net income
All women	0.37	0.28	0.24	0.18
By education				
Basic	0.42	0.24	0.27	0.15
Intermediate	0.32	0.25	0.21	0.16
High	0.28	0.26	0.15	0.13

Gini coefficients for gross and net annual and lifetime income (remember: working age individuals only).

Other ineq measures show same pattern

...and it reduces lifetime inequality...

	Annual inequality		Lifetime inequality	
	Gross earnings	Net income	Gross earnings	Net income
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Gini coefficients for gross and net annual and lifetime income.

...particularly where disparities are large

	Annual inequality		Lifetime inequality	
	Gross earnings	Net income	Gross earnings	Net income
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By education				
Basic	0.42	0.24	0.27	0.15
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Gini coefficients for gross and net annual and lifetime income.

The tax system is more progressive on annual basis (especially at bottom)…

Table 5: Income shares, tax shares and aggregate tax rate by income quintile under the 2006 tax system

	Pooled annual				Life-cycle			
	earned income (1)	disposable income (2)	tax liability (3)	aggregate tax rate (4)	earned income (5)	disposable income (6)	tax liability (7)	aggregate tax rate (8)
Poorest	4.3%	8.5%	-10.7%	-55.3%	9.8%	12.5%	-0.2%	-0.6%
2nd	14.5%	14.9%	13.3%	20.2%	15.6%	16.5%	13.2%	18.1%
3rd	20.3%	19.5%	22.8%	24.8%	19.8%	19.5%	20.6%	22.5%
4th	24.7%	23.7%	28.5%	25.4%	23.5%	22.6%	26.9%	24.8%
Richest	36.2%	33.4%	46.1%	28.1%	31.2%	28.8%	39.6%	27.5%

Notes: The Aggregate ATR in columns 4 and 8 is the income quintile tax liability as a proportion of total pre-tax income.

...and is extremely good at offsetting zero earnings

Table 6: Within group (intra-personal) share of log income variation

	earned income (1)	disposable income (2)	change in total variance (3)
(1) Including zeros	63%	53%	-90%
(2) Excluding zeros	50%	53%	-17%

Notes: To include periods of no earned income, we have used the variance of log(income+1). This makes no difference to the variance decomposition excluding zeros in row (2).

Inequality and redistribution over the lifecycle

Figure 4: Family composition over the life-cycle: all and by women's education

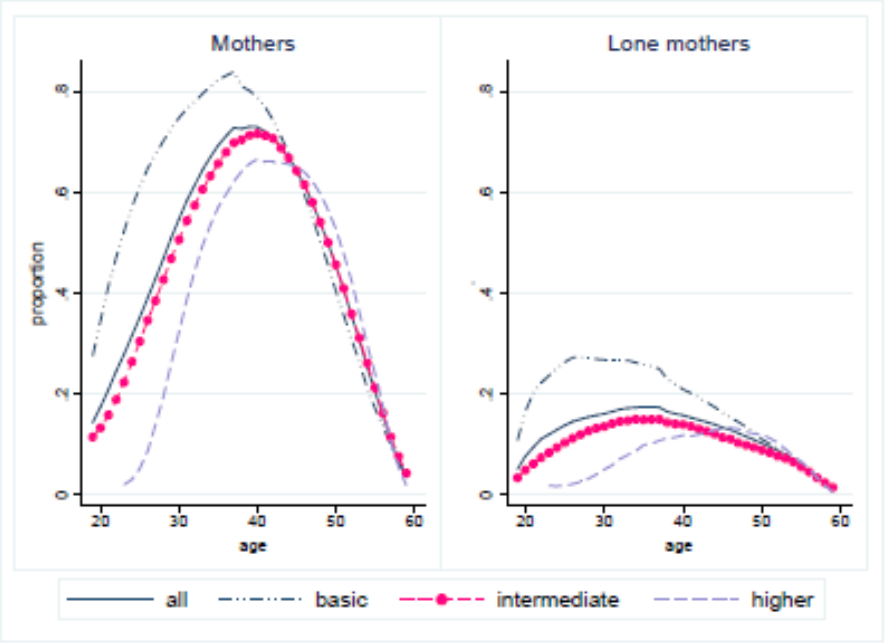
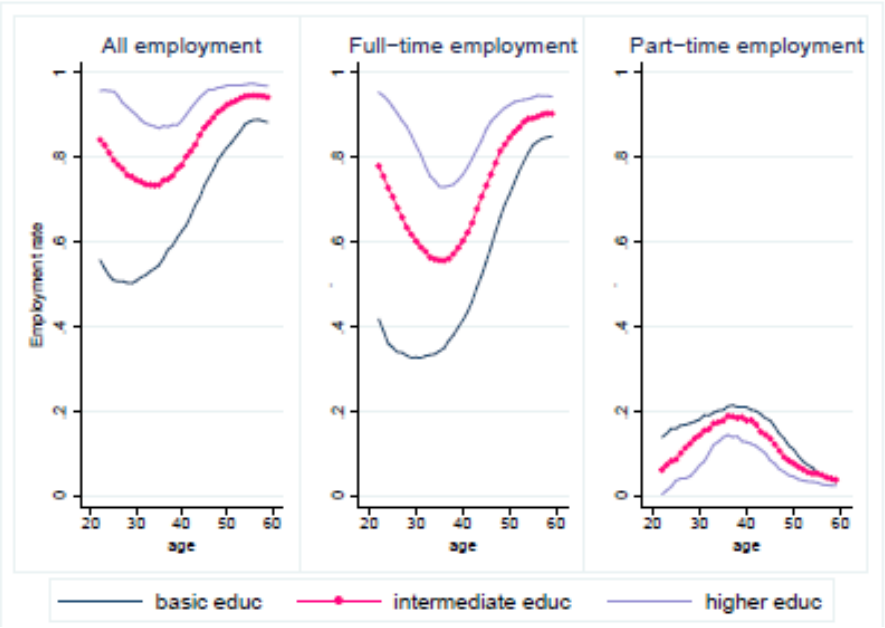
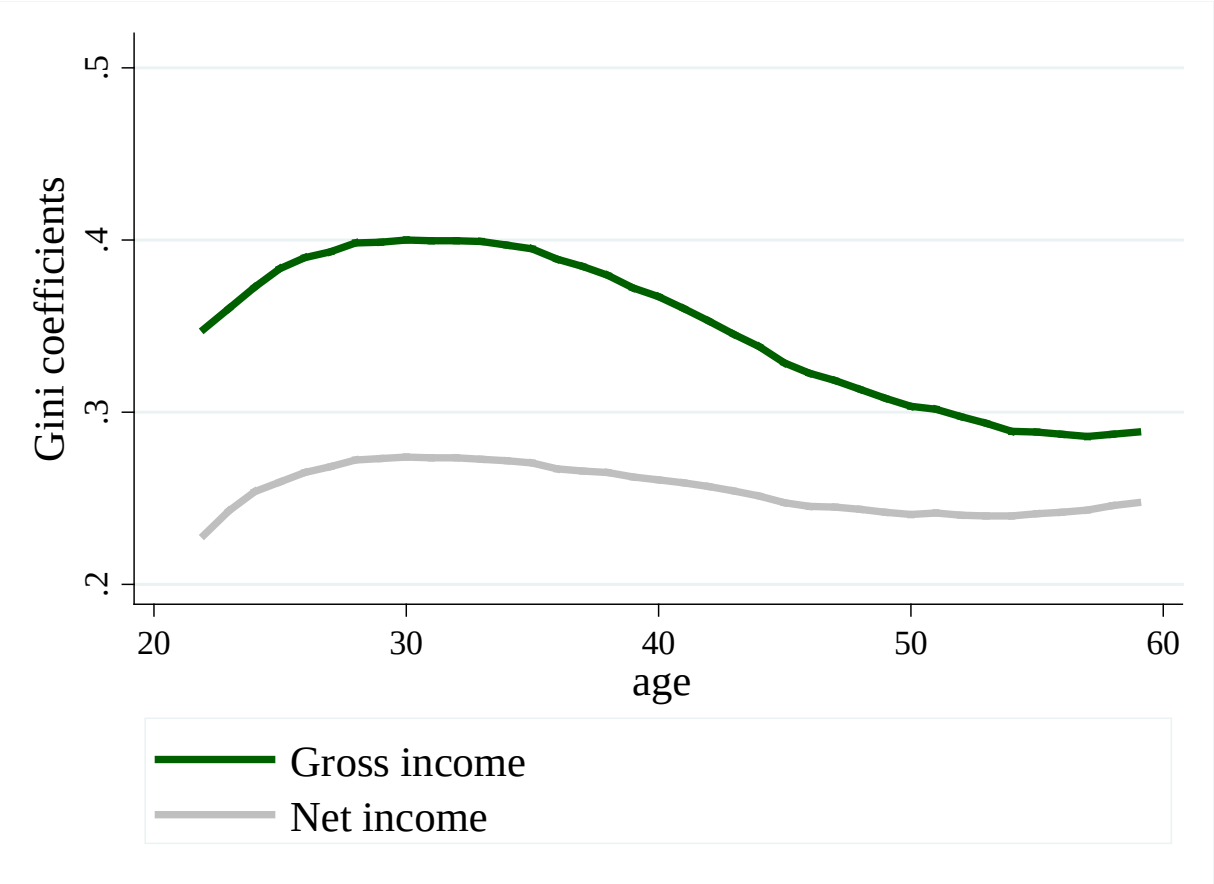


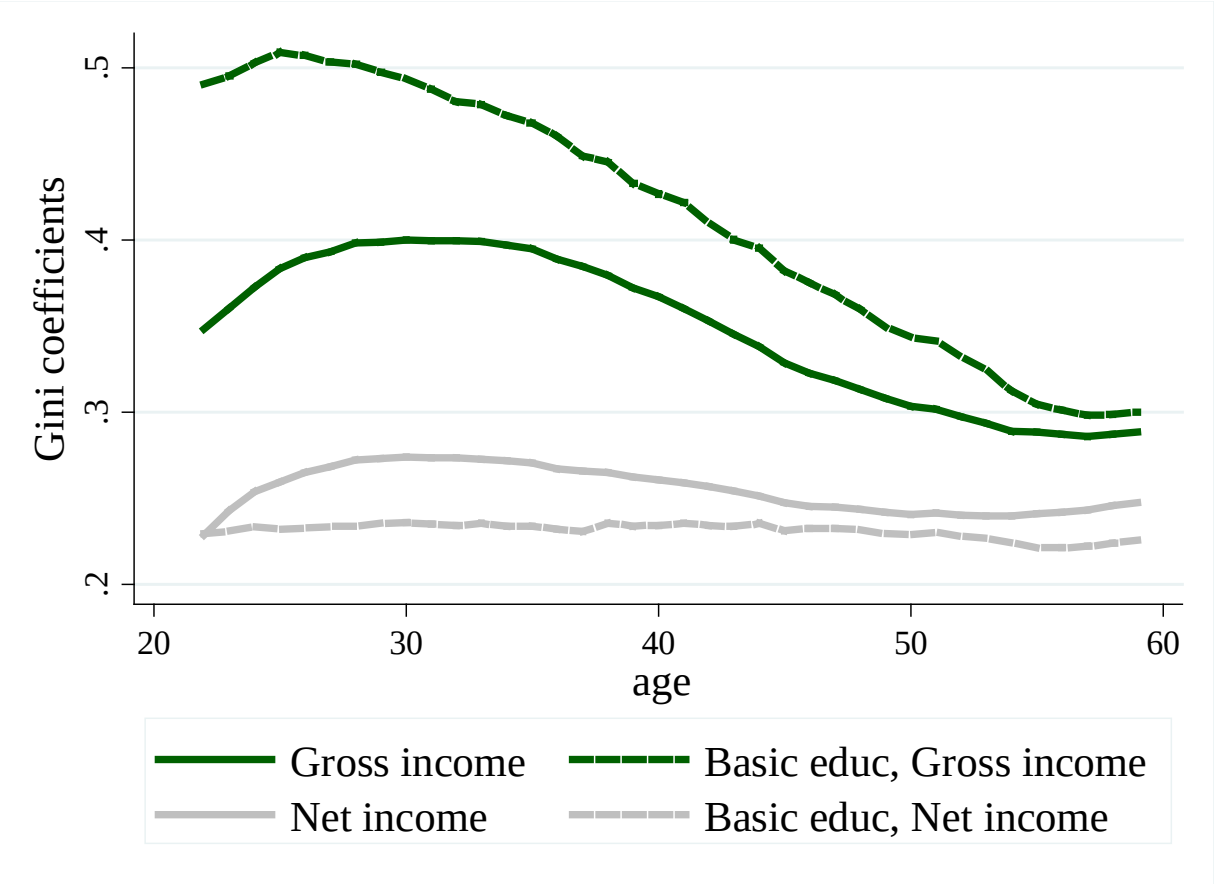
Figure 5: Women's employment rates over the life-cycle by education



Over the life-cycle, taxes and benefits are more redistributive when differences are more marked...

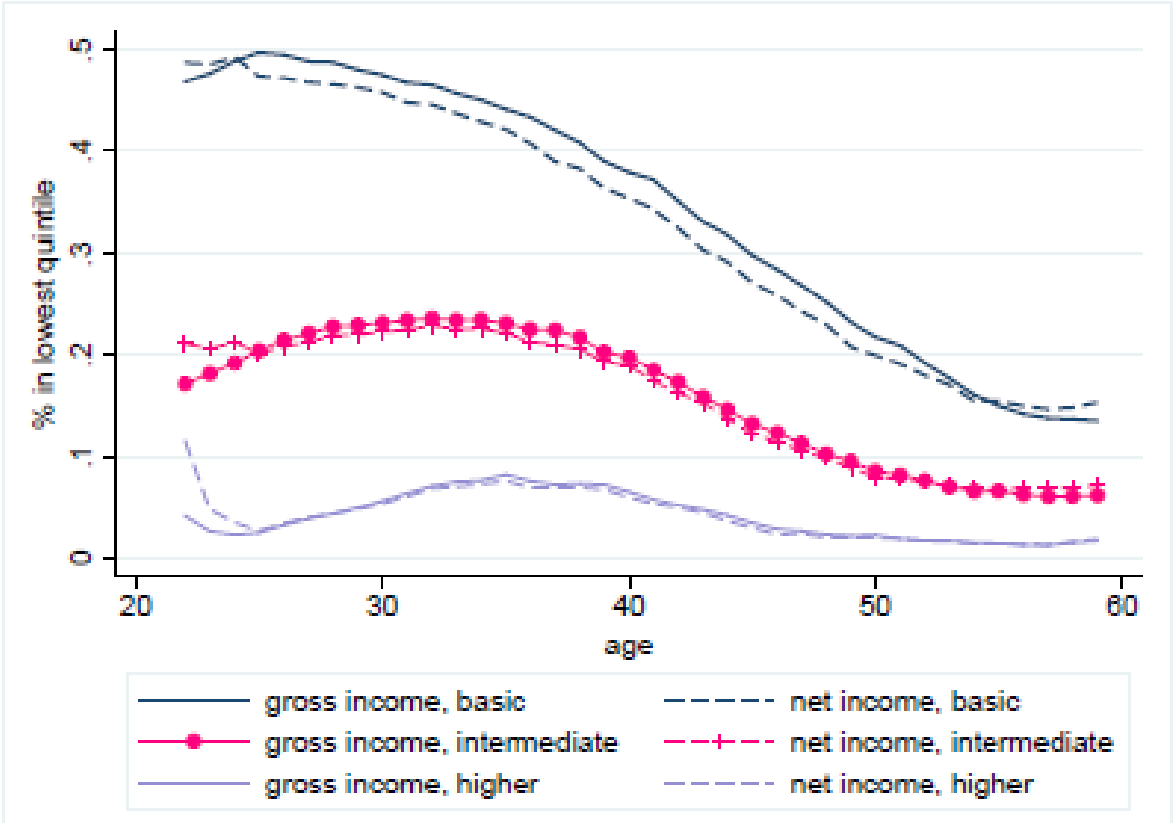


…particularly for those exposed to greater disparities…



…although between-group inequalities remain large

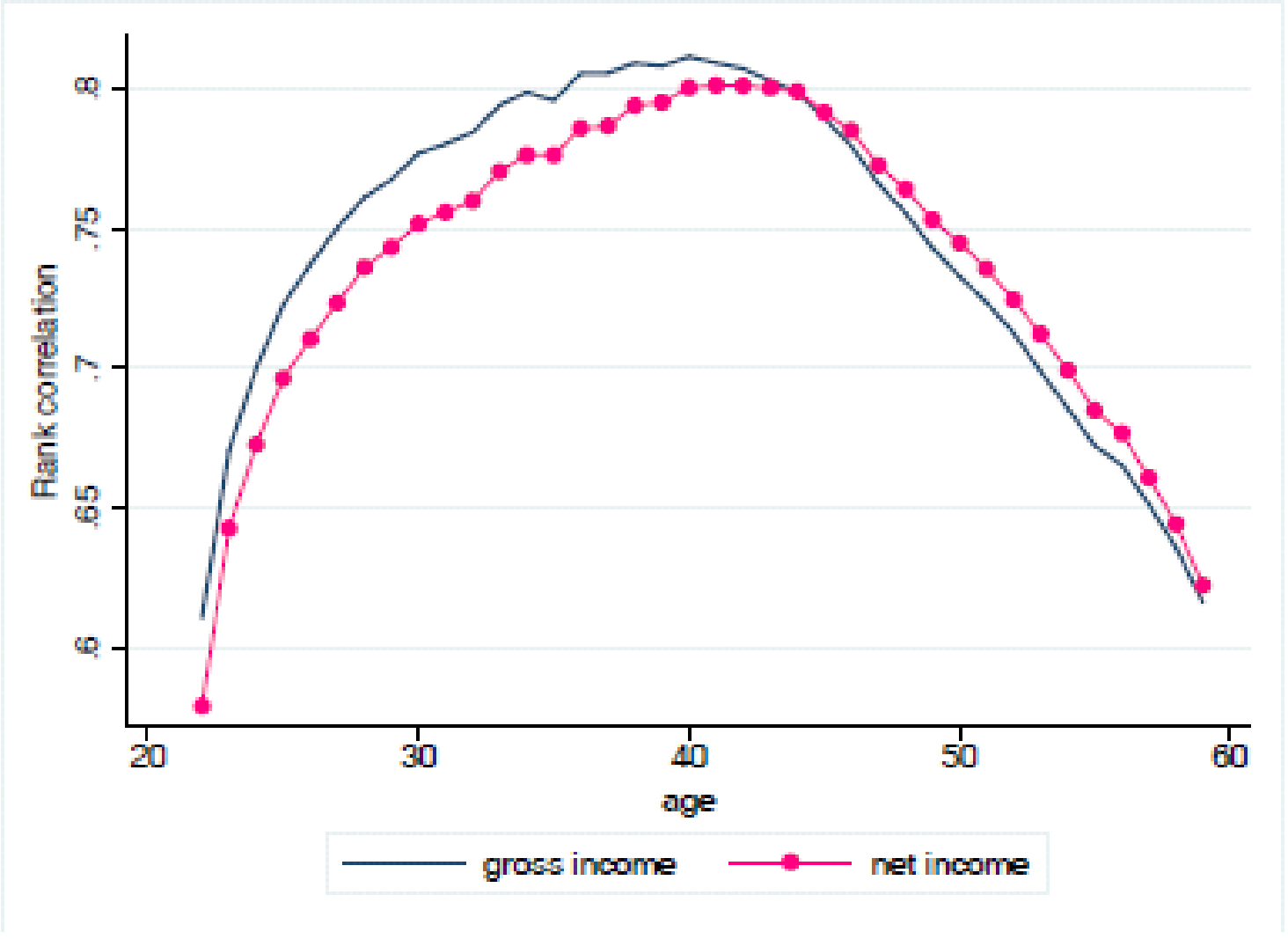
Figure 6: Proportion of families in bottom quintile of annual income over the life-cycle: by women's education



Sources of lifetime inequality

Relative income in child-bearing years correlates well with lifetime income

Figure 7: Rank correlation between annual and lifetime income



Decompose lifetime inequality in its main building blocks...

	Initial wealth and education	Family history			
		Partner	Children	Lone mother	Total
Gross income	34.1%	3.4%	6.0%	8.7%	18.1%
Net income	39.5%	3.1%	7.2%	1.1%	11.4%

Share of variation in lifetime income explained by each factor.

...largest share of lifetime inequality established early in adult life...

	Initial wealth and education	Family history			
		Partner	Children	Lone mother	Total
Gross income	34.1%	3.4%	6.0%	8.7%	18.1%
Net income	39.5%	3.1%	7.2%	1.1%	11.4%

Share of variation in lifetime income explained by each factor.

...but tax and benefits system ensures the impact of lone-motherhood does not persist

	Initial wealth and education	Family history			
		Partner	Children	Lone mother	Total
Gross income	34.1%	3.4%	6.0%	8.7%	18.1%
Net income	39.5%	3.1%	7.2%	1.1%	11.4%

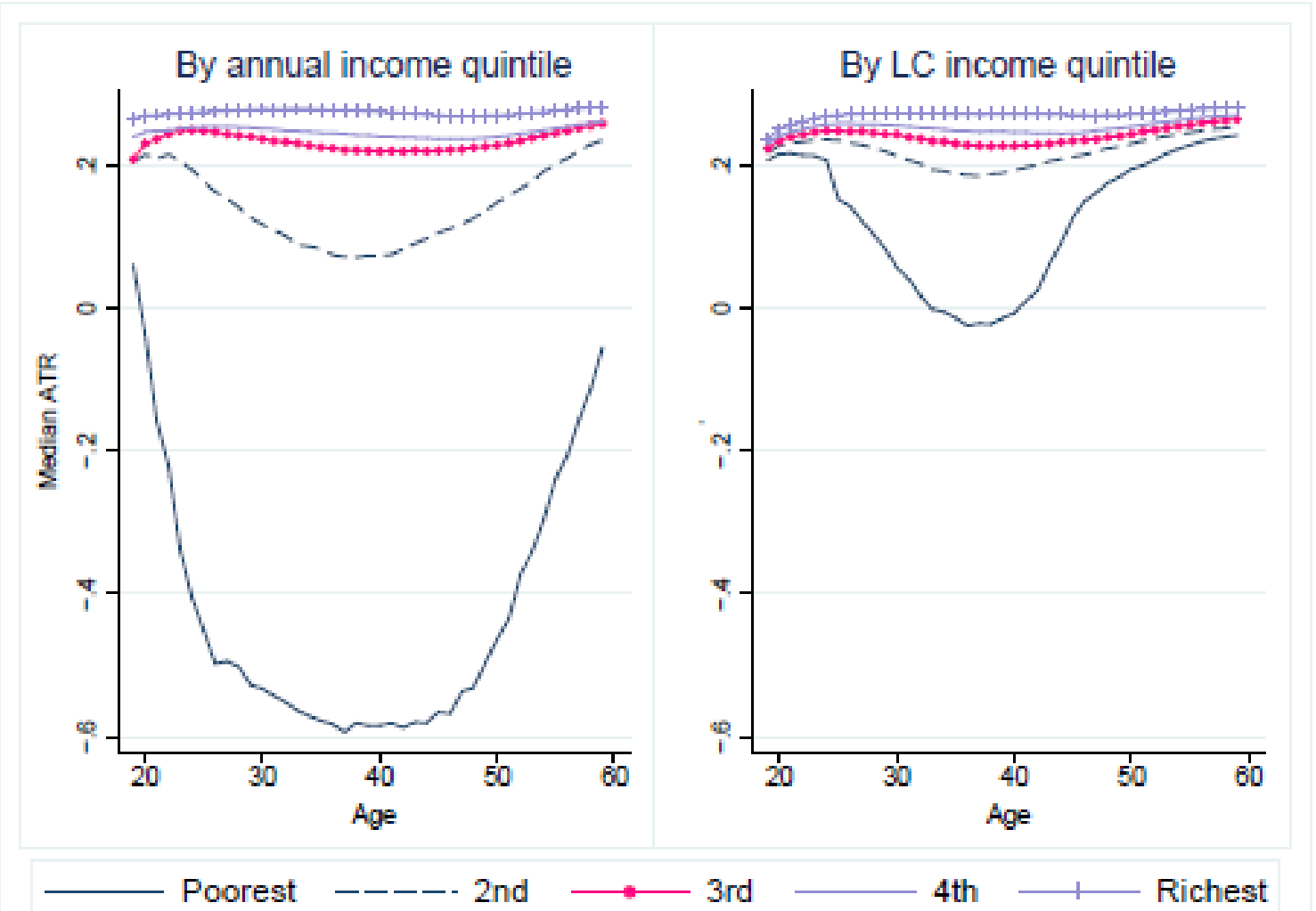
Share of variation in lifetime income explained by each factor.

- So UK tax and benefit system is quite effective at preventing lone motherhood from leading to permanent inequalities

- Can also see this when look at redistribution and inequality over the lifecycle (i.e., by age)

Redistribution over the lifecycle

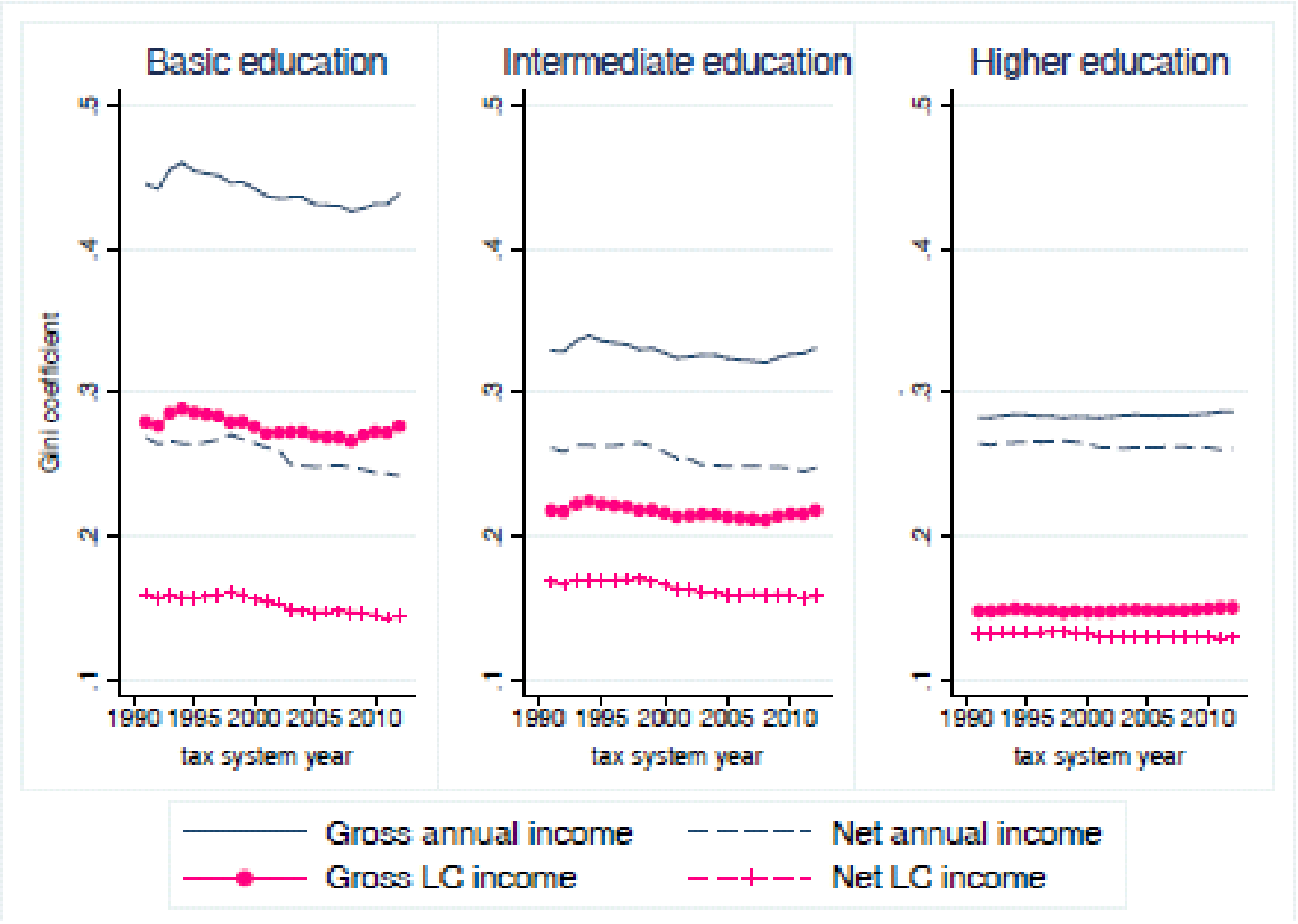
Figure 8: Median Average Tax Rate over the life-cycle by quintile of the distributions of earned annual and lifetime income



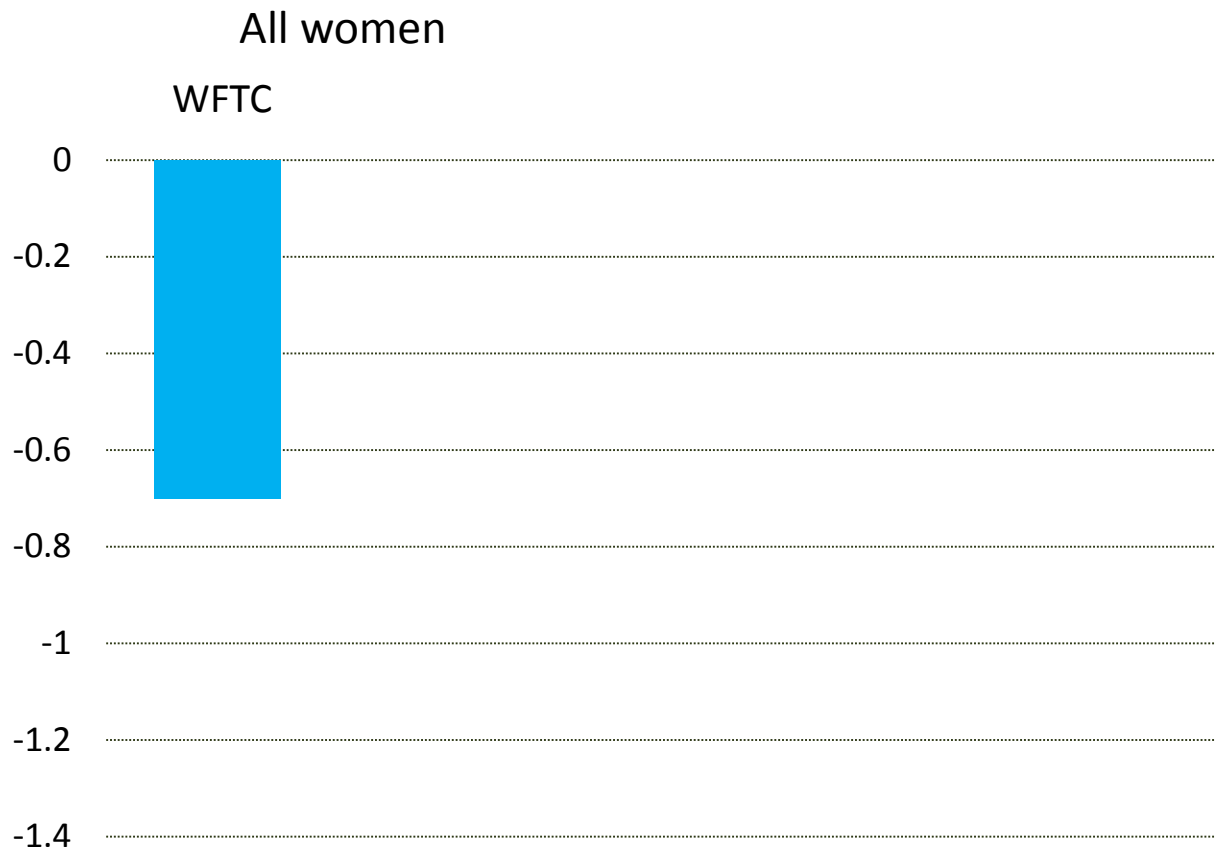
Alternative tax and benefit systems

Recent tax changes have made the UK more equal

Figure 10: Gini coefficients for annual and lifetime income by tax and benefits system and education

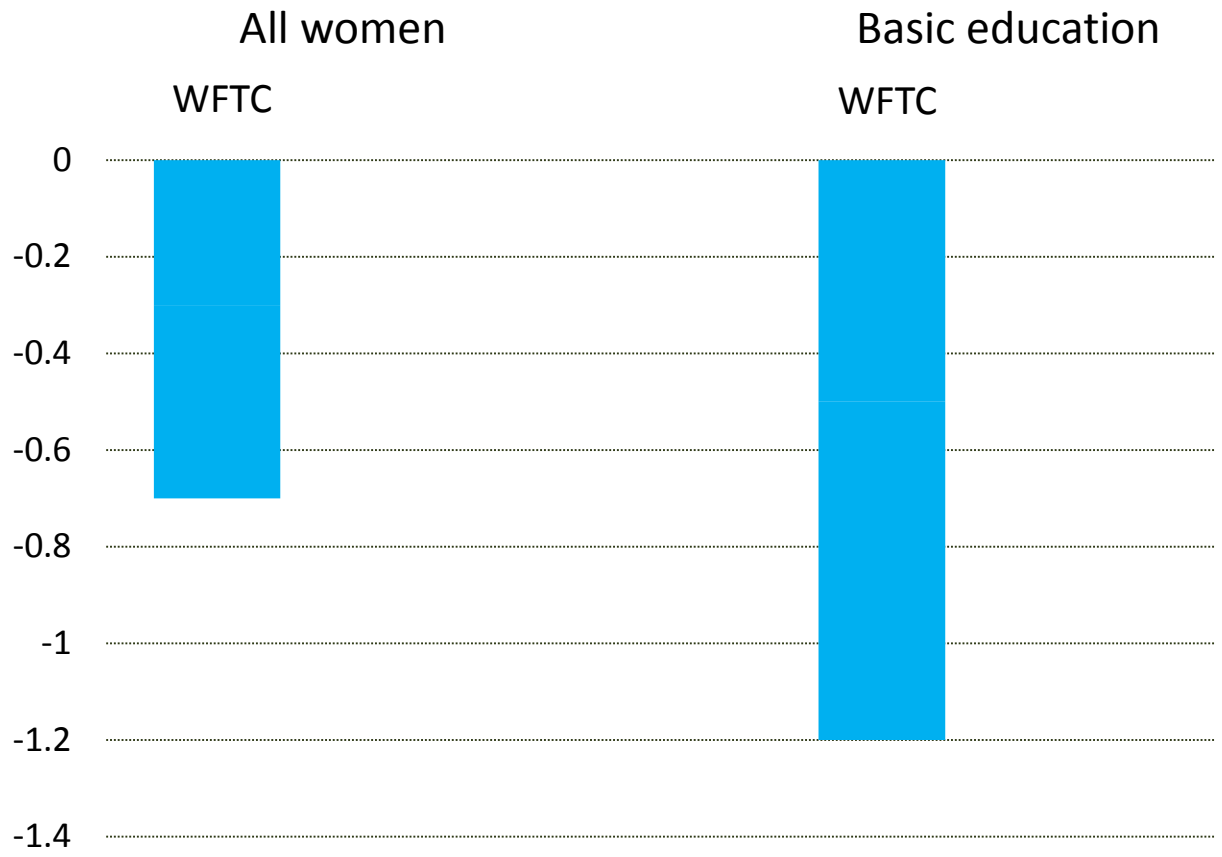


…mostly because in-work benefits for low income families with children reduce lifetime inequality



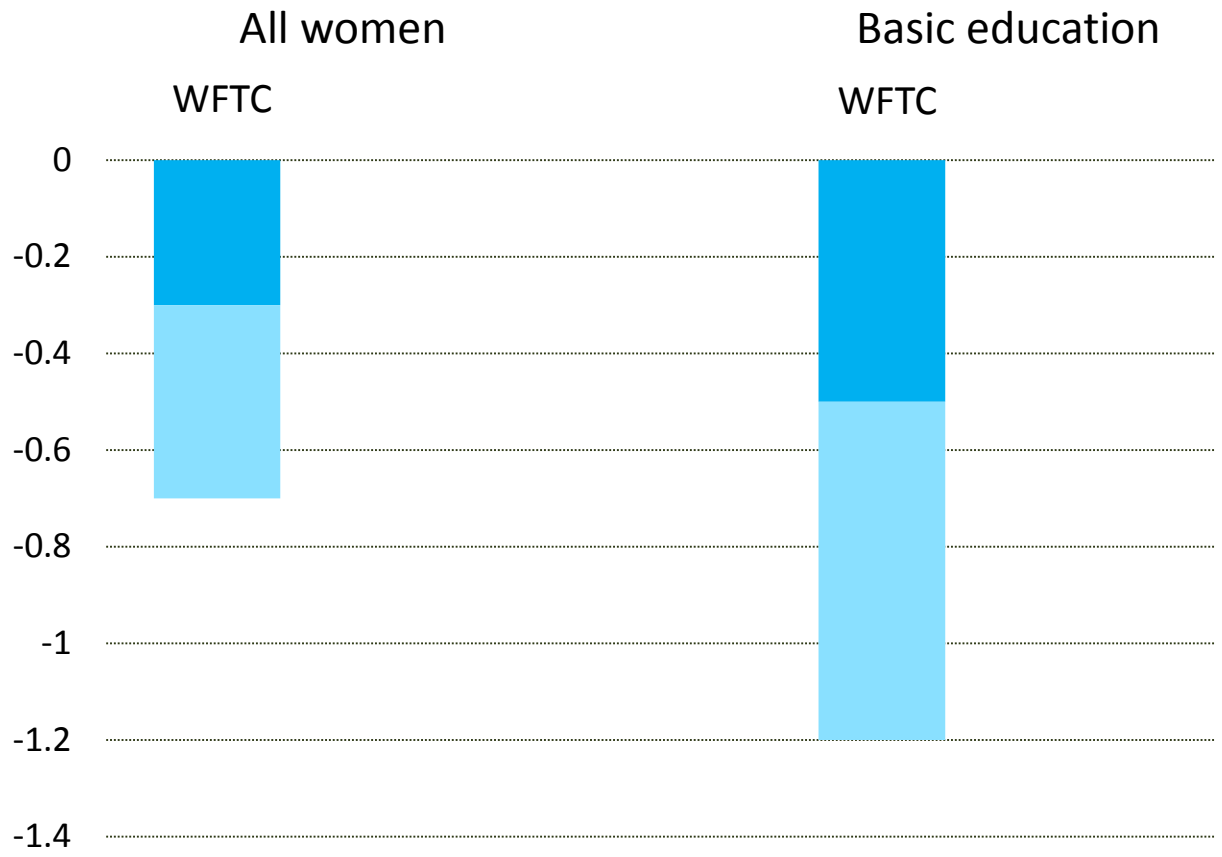
Effects on Gini coefficient: 2002 version of WFTC and IS versus pre-WFTC 1999 tax and benefits system

…particularly for women with basic education…



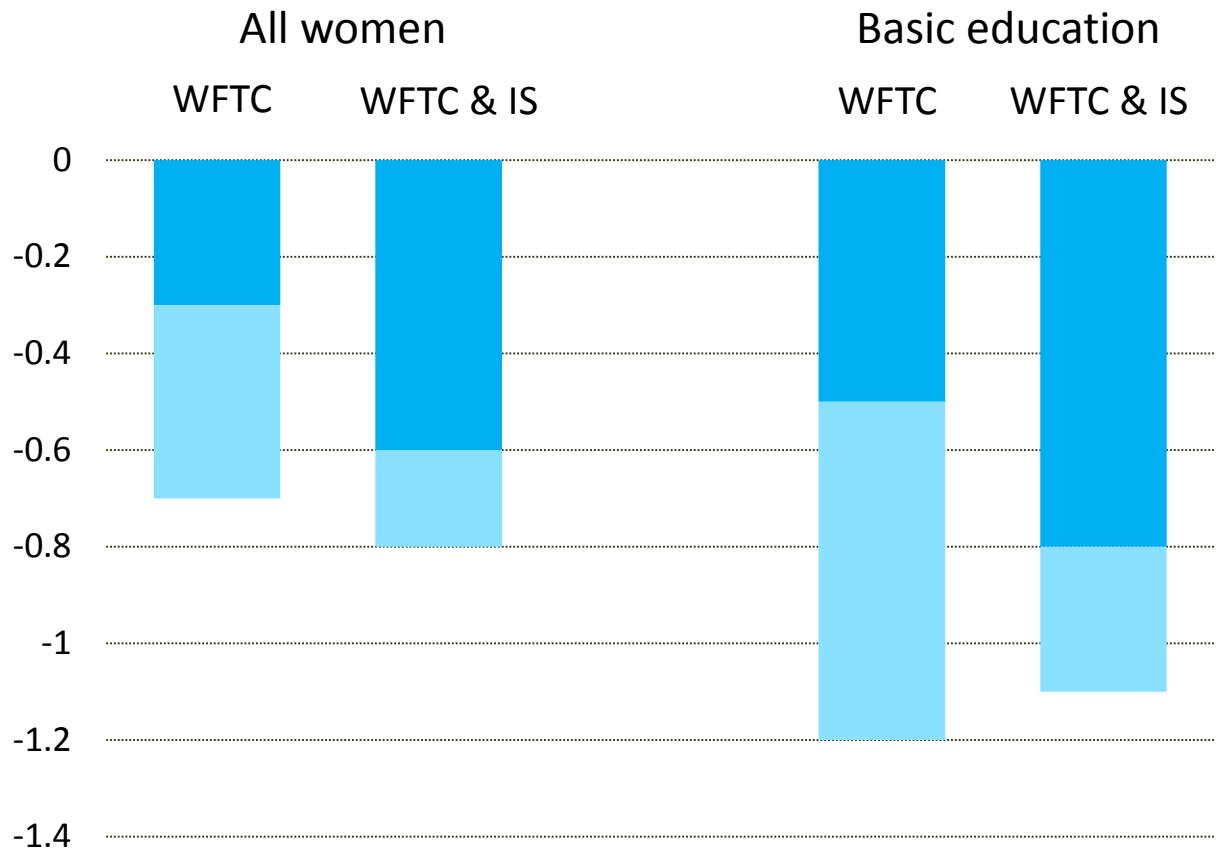
Effects on Gini coefficient: 2002 version of WFTC and IS versus pre-WFTC 1999 tax and benefits system

…and this largely driven by its impact on moving women into work…



Effects on Gini coefficient: 2002 version of WFTC and IS versus pre-WFTC 1999 tax and benefits system

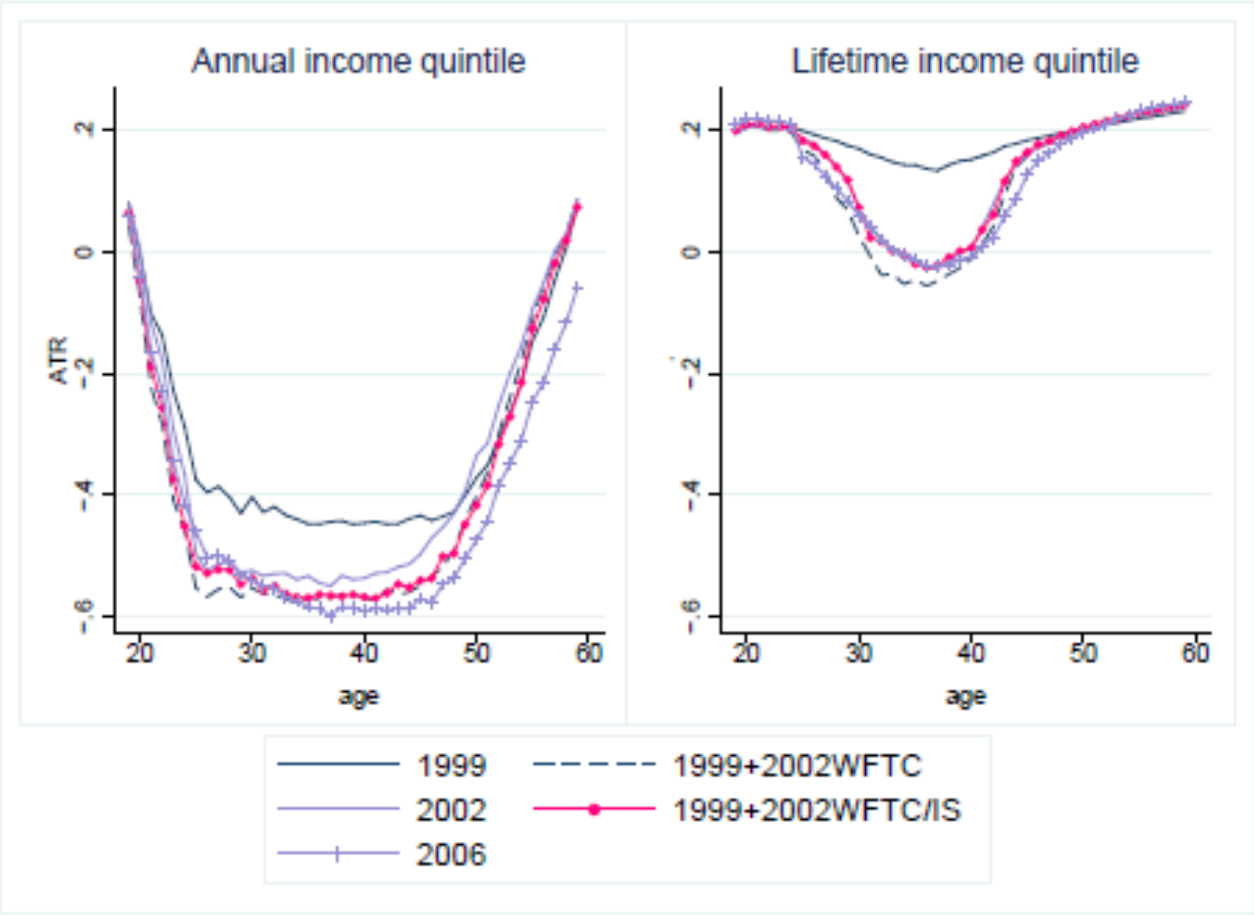
…but welfare increases ("IS") for families with kids dulled employment responses



Effects on Gini coefficient: 2002 version of WFTC and IS versus pre-WFTC 1999 tax and benefits system

Post-1999 reforms have made UK t-b system much more progressive at bottom

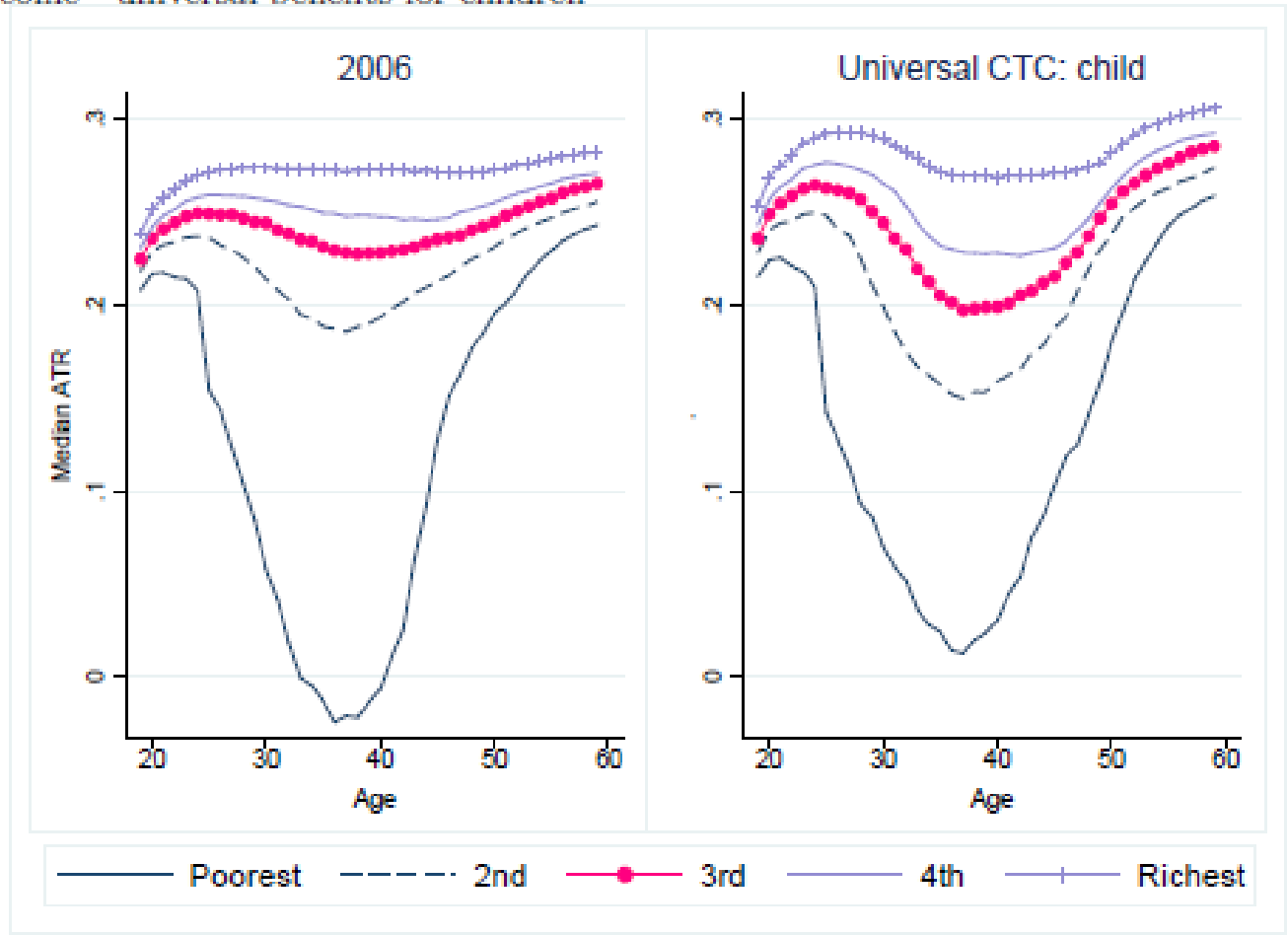
Figure 14: Median Average Tax Rate over the life-cycle at the bottom quintile of the distribution of annual and lifetime earned income by tax and benefits system



Notes: All reforms revenue neutral by adjusting the basic tax rate to reproduce the 1999 public budget position.

Impact of universal benefits for children (don't means-test CTC; increase income tax to pay)

Figure 15: Median Average Tax Rate over the life-cycle by quintile of the distribution of lifetime earned income - universal benefits for children



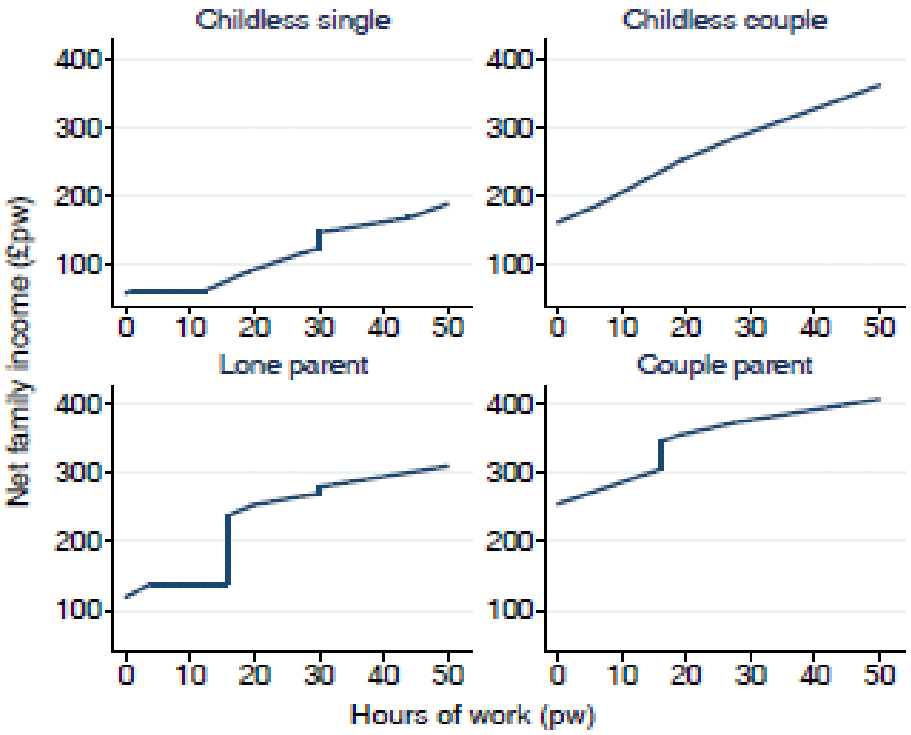
Notes: All reforms revenue neutral by adjusting the basic tax rate to reproduce the 2006 public budget position.

Overall summary

- We used a dynamic, structural model, that replicates behaviour of real women, to analyse impact of UK tax and benefit system on inequality and work incentives over the lifetime and across the lifecycle
- Lifetime vs annual measures
  - Lifetime inequality is lower than annual inequality
  - UK tax and benefit system is less progressive on lifetime basis than annual basis
  - Variation in family circumstances and employment patterns when a mother key to lifetime inequalities
  - Periods of zero earnings contribute a lot to inequality, but are well compensated-for by UK tax and benefit system
- Inequality and redistribution over the lifecycle
  - UK tax and benefits particularly good at reducing inequalities at bottom during main child-rearing ages, especially its support for lone mothers
  - Redistribution to parents with low earnings is well targeted at reducing lifetime inequalities
  - Encouraging low-earning lone mothers to work is especially effective at reducing lifetime inequalities

Budget constraints for low wage women

Figure 1: Budget constraints by family type and female working hours: UK 2006 tax and benefits system



Notes: The plotted lines represent family income by female working hours under the 2006 tax and benefits system. All adults are assumed to earn the 2006 minimum wage (5.05 per hour), and males in couples are assumed to be working full time (40 hours per week). Families with children are assumed to have one child aged 4 and spend 50 on childcare. All families assumed to pay no rents for housing.