Philipps Universität Marburg

The cohort size-wage relationship in Europe

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Motivation

- Changes in Europe's demographic and educational composition:
  - Share of young individuals declining
  - Tendency towards more education

- Age-education structures modelled by relative cohort size

- Identification of causal effect of cohort size on wages:
  - Use of instrumental variable estimation
  - Use of large and recent European data set
  - Identification of effect on individual rather than average wages

Research questions

- Does cohort size have a negative effect on individual wages?
- Are any negative effects permanent of temporary?
- Does cohort size affect the wages of education-gender groups differently?
- How do the estimated cohort size effects compare to the results of related research?

Literature review

- Large cohorts start entering US labour market from 1960s onwards:
  - Effects on wages, unemployment, education, etc.

- Results of empirical studies (mainly from the US):
  - Members of larger cohorts receive reduced earnings
  - Depressing effects larger for highly educated individuals
  - Uncertainty regarding persistence of negative effects
  - Evidence for Europe limited

- Theoretical framework:
  - Identically educated individuals of different age only imperfectly substitutable
  - Highly educated individuals less substitutable across age

Theoretical model (based on Brunello 2010)

- Education-specific production function:

$$Y_{te} = \varphi_{te} N_{te}$$

- Labour input is a weighted average of age-specific inputs:

$$N_{te} = \left[\sum_{j=1}^{K} \left(\nu_{jte} N_{jte}{}^{\eta^e}\right)\right]^{1/\eta^e}$$

- Firm's profits:

$$\pi\left(N_{jte}\right) = p_{te}\varphi_{te}\left[\sum_{j=1}^{K} \left(\nu_{jte} N_{jte}{}^{\eta^e}\right)\right]^{1/\eta^e} - \sum_{j=1}^{K} w_{jte} N_{jte}$$

- Inverse age-education specific labour demand functions:

$$\ln w_{jte} = \ln p_{te} + \ln \varphi_{te} + \ln \nu_{jte} + (\eta^e - 1) \ln \left[\frac{N_{jte}}{N_{te}}\right]$$

Theoretical model

- Key parameter:
  - Parameter η^e reflects the substitutability of identically educated workers of different age
  - By definition, $1>\eta^e>-\infty$ ($\eta=1$ represents perfect substitutability)
  - Theoretically, coefficient on relative cohort size expected to be negative if workers are not perfectly substitutable
  - Differences in coefficient estimates across educational groups represent differences in elasticity of substitution

Data source and data selection

- Data:
  - EU-SILC Longitudinal UDB 2010 (version 1)
  - Up to 24 countries for period 2007-2010 (20 countries finally used)
- Separate regressions by International Standard Classification of Education:
  - ISCED 2: Lower secondary education
  - ISCED 3: (Upper) secondary education
  - ISCED 5: Tertiary education (also includes ISCED 6)
- Separate regressions for males and females
- Restrictions:
  - Age 20-45 (ISCED 2 and 3)
  - Age 25-45 (ISCED 5)
  - Employed and unemployed individuals
- Regional classification:
  - First level of Nomenclature of Territorial Units for Statistics (NUTS 1)

Empirical model

- Regression model:

$$\ln w_{ijkte} = \alpha_1 \ln CS_{jkte} + \alpha_2 \ln\left[CS_{jkte}\right] Age_j + \alpha_3 \ln\left[CS_{jkte}\right] {Age_j}^2 + \boldsymbol{\beta X_{ijkte}} + \varepsilon_{ijkte}$$

- Marginal effects of cohort size:

$$\frac{\partial \ln w_{ijkte}}{\partial \ln CS_{jkte}} = \alpha_1 + \alpha_2 Age_j + \alpha_3 {Age_j}^2$$

- Key regressor:

$$CS_{jkte} = \frac{(1/9)N_{j-2kte} + (2/9)N_{j-1kte} + (3/9)N_{jkte} + (2/9)N_{j+1kte} + (1/9)N_{j+2kte}}{N_{kte}}$$

- Weighting:
  - Construction of cohort size variable
  - Estimation

Empirical model – Control variables

- Age and squared age (age-specific)
  - The age variable is rescaled to 0-25 (ISCED 2, 3) and 0-20 (ISCED 5)
- Time fixed effects (time-specific)
- Geographical area fixed effects (area-specific)
- Employed, occupation, married, part-time, health limitation (individual-by-time-specific)
- Interaction of age and time fixed effects (age-by-time-specific)
- Unemployment rate, degree of urbanisation, interaction of area effects and time fixed effects, interaction of unemployment rate and time fixed effects (area-by-time-specific)

Identification

- Endogeneity of cohort size variable:
  - Self-selection into specific educational groups
  - Self-selection into specific geographic areas
  - Cohort size variables potentially correlated with the error term
  - ➔ Least Squares estimation produces inconsistent cohort size coefficients (i.e. no convergence in probability on the “true” population value)

- Use of instrumental variables (IV) estimation necessary to identify causal effect of cohort size on wages:
  - Birth rate at year of birth of a specific age cohort
  - Interaction of age (squared age) and lagged birth rate

Identification

- Wages are modelled as the sum of the conditional mean and the error term:
  $w_{ijkte} = E[w_{ijkte}|CS, \boldsymbol{X}] + \varepsilon_{ijkte} = E[w_{ijkte}|CS, \boldsymbol{X}] + \eta_i + u_{ijkte}$
- If individual do self-select themselves into economically attractive areas and educational groups, then cohort size is itself dependant on the wage rate:
  $w_{ijkte} = E[w_{ijkte}|CS(w_{ijkte}), \boldsymbol{X}] + \eta_i + u_{ijkte}$
- This relationship makes cohort size indirectly depend on the control variables as well as the time-invariant and the idiosyncratic error terms:
  $w_{ijkte} = E[w_{ijkte}|CS(X, \eta_i, u_{ijkte}), \boldsymbol{X}] + \eta_i + u_{ijkte}$

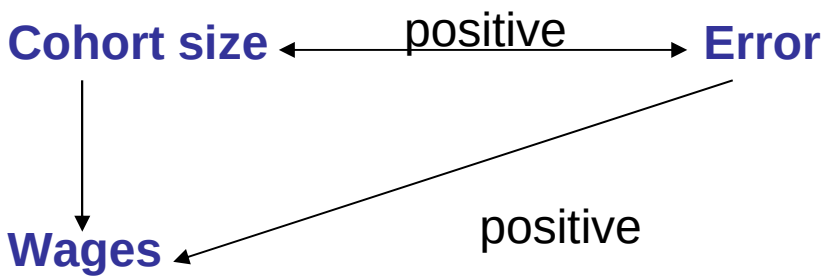
Assumption 1: Cohort size and the (idiosyncratic) error term are positively correlated

- The larger the error term, the larger the actual wage rate
- The higher the wage rate, the more individuals will be attracted into the corresponding area/ educational group and thus the larger will the cohort size variable be

Identification

- (Positive) Correlation between cohort size variable and error term
  - OLS estimation will produce an inconsistent cohort size coefficient
  - Cohort size coefficient will confound the direct effect on wages from a change in cohort size and the indirect effect stemming from the corresponding change in the error term

Assumption 2: OLS estimation overstates the direct effect of cohort size on wages due to confounding



Model selection

- Availability of panel data allows the choice between two different types of models for the data generating process (dgp):
  - Population-averaged (pooled) model: No individual-specific effects
  - Fixed effects (FE) model: Individual-specific effects that may be correlated with regressors
  - Random effects (RE) model: Individual-specific effects that must not be correlated with regressors

- Choice of model for dgp:
  - Estimation based on FE model attractive as it purges endogeneity that is due to correlation with time-invariant error component
  - However, problem of potential correlation with idiosyncratic error component not solved by use of FE model
  - ➔ Possibility of correlation between cohort size regressor and idiosyncratic error term components implies that each model has to be estimated through use of an IV estimator

Model selection

- Choice of model for dgp [continued]:
  - The chosen instrument is time-invariant which rules out the possibility of IV-estimation using the FE model
  - The instrument can be assumed to be uncorrelated with the time-invariant and the idiosyncratic components of the error term

    ➔the FE model is not required to identify the causal effect of cohort size on wages (even if time-invariant individual-specific effects are present)
  - IV-estimation is performed for the pooled model

- Limitations of the instrument:
  - The instrument does not vary across all of the dimensions of the endogenous regressor (no variation across education)
  - No regional birth rates available ➔ Loss of efficiency at regional level
  - Limited correlation with cohort size if migration in current period is large

Results I – Relevance of cohort size in wage determination

- Vast majority of cohort size-related variables highly significant for males and ISCED 3 females

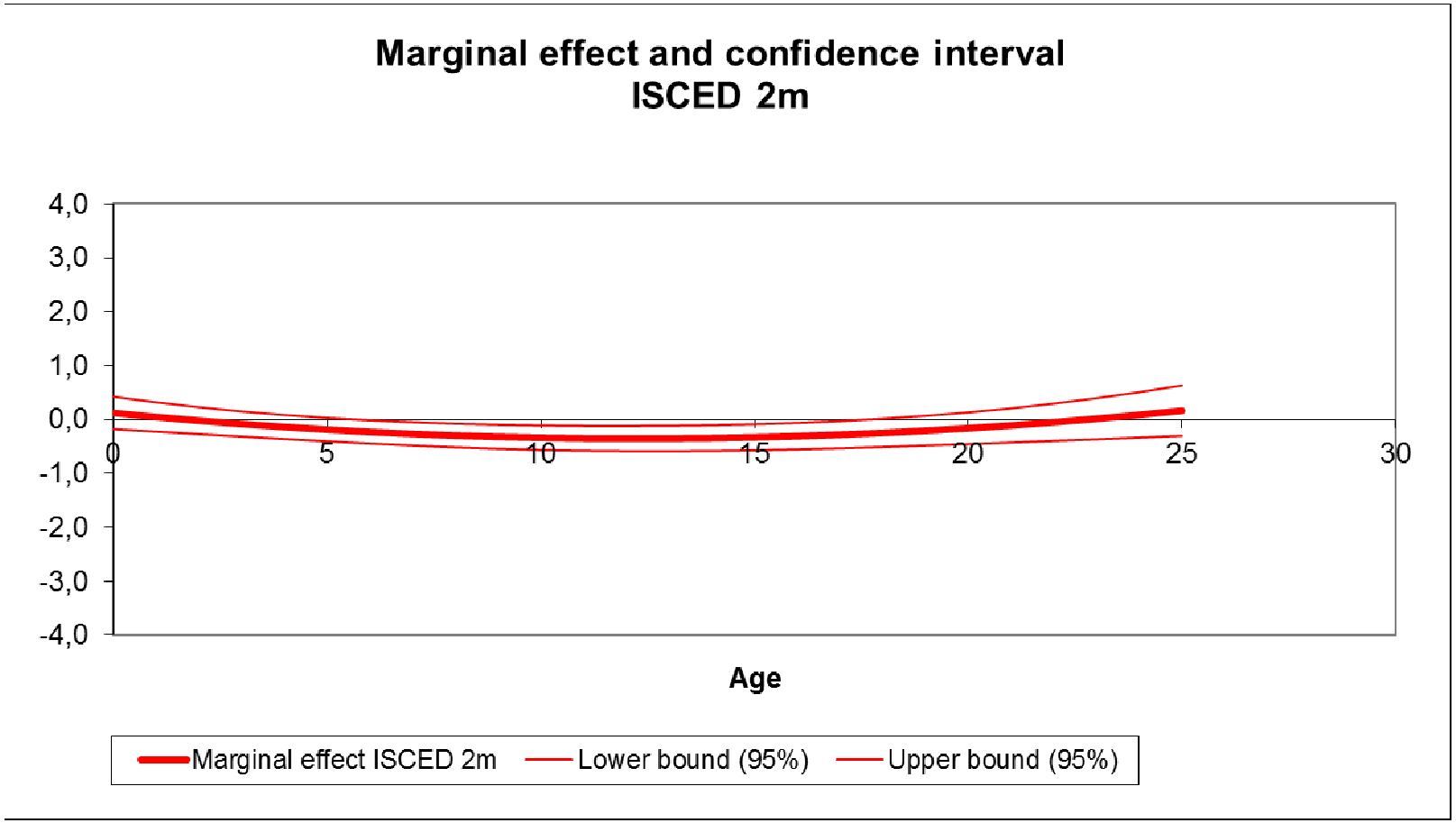
- Cohort size variables are less significant (individually and jointly) in the determination of female wages at ISCED 2 and ISCED 5 level

	ISCED 2f lwage	ISCED 2m lwage	ISCED 3f lwage	ISCED 3m lwage	ISCED 5f lwage	ISCED 5m lwage
ICS	0.6822**	0.1218	0.6591***	0.2279	0.8587	1.4368***
	(0.2662)	(0.1538)	(0.2288)	(0.2168)	(0.5894)	(0.4688)
ICS*Age_20	-0.0797*	-0.0778***	-0.0914***	-0.1241***		
	(0.0446)	(0.0259)	(0.0242)	(0.0203)		
ICS*Age_20_sq	0.0022	0.0032***	0.0035***	0.0064***		
	(0.0018)	(0.0011)	(0.0011)	(0.0009)		
ICS*Age_25					-0.6649*	-0.7344***
					(0.4016)	(0.2555)
ICS*Age_25_sq					0.0385*	0.0394***
					(0.0232)	(0.0141)
N	8,420	13,080	36,638	48,624	31,066	24,346
R2	0.5984	0.6616	0.7492	0.7838	0.6185	0.6205

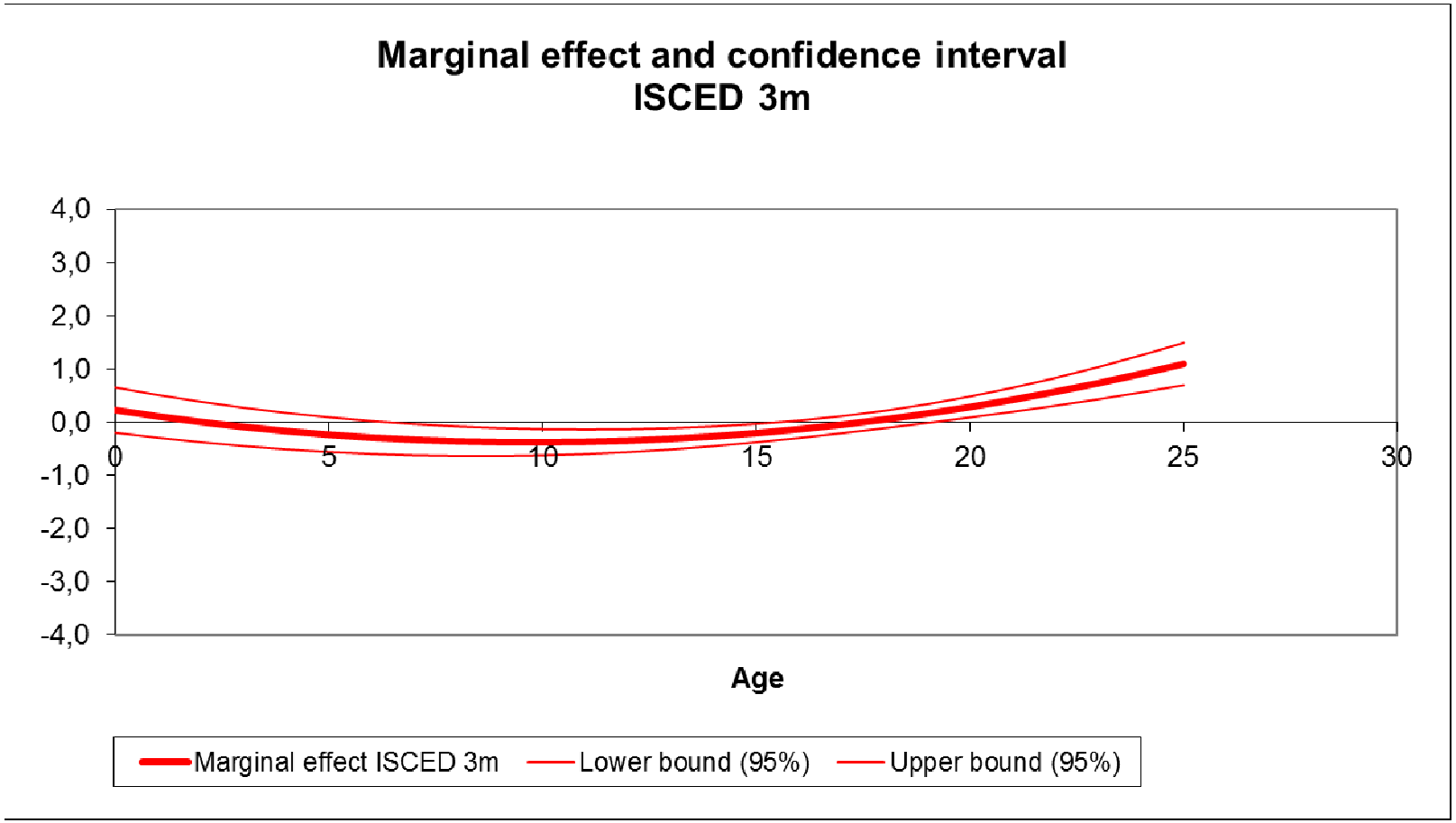
Results II – Marginal effects

- Cohort size reduces male wages
- Results less conclusive for female wages
- Future research:
  - Relevance of cohort size for female labour market participation

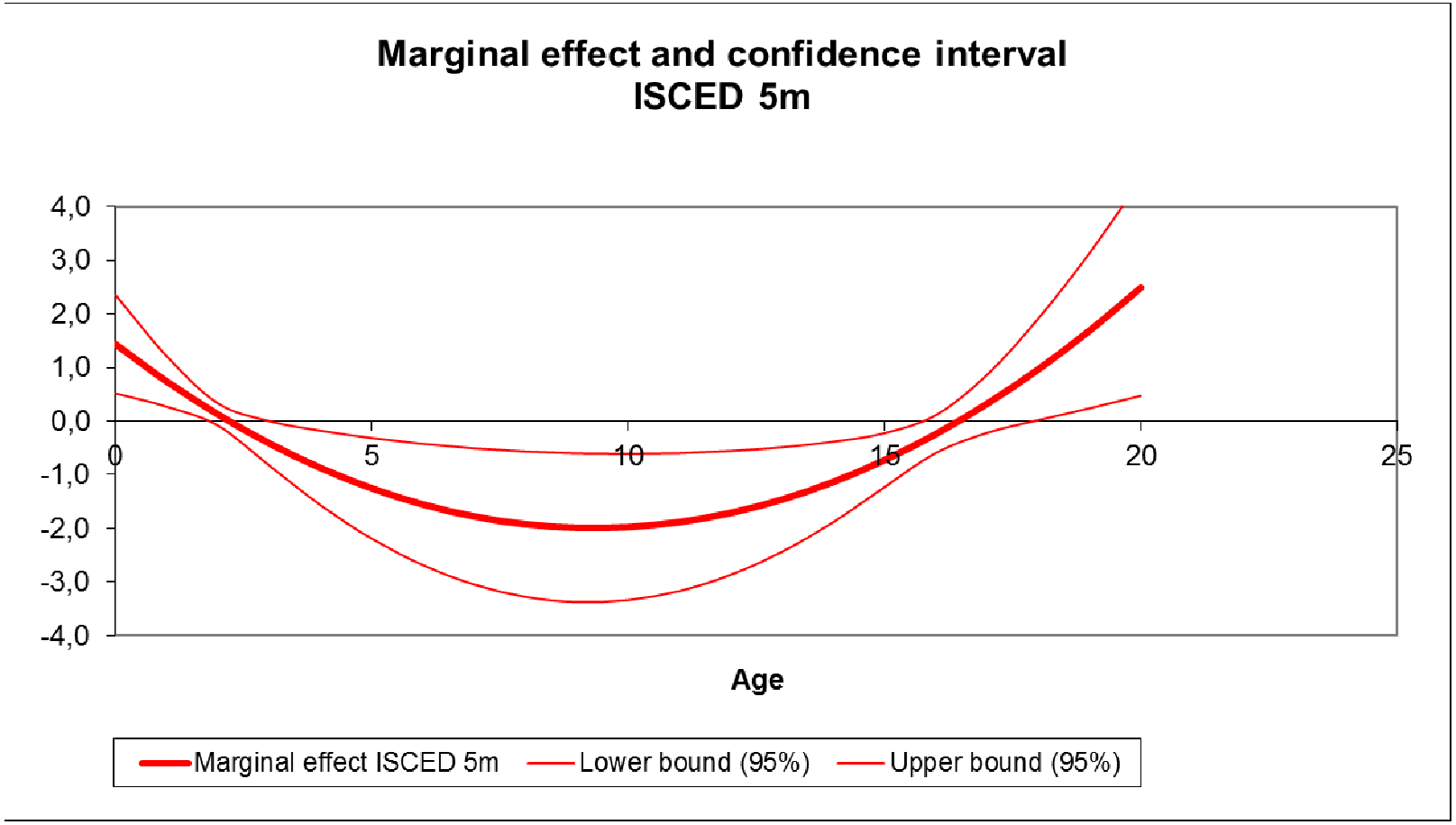
Results II – Marginal effects profiles ISCED 2m



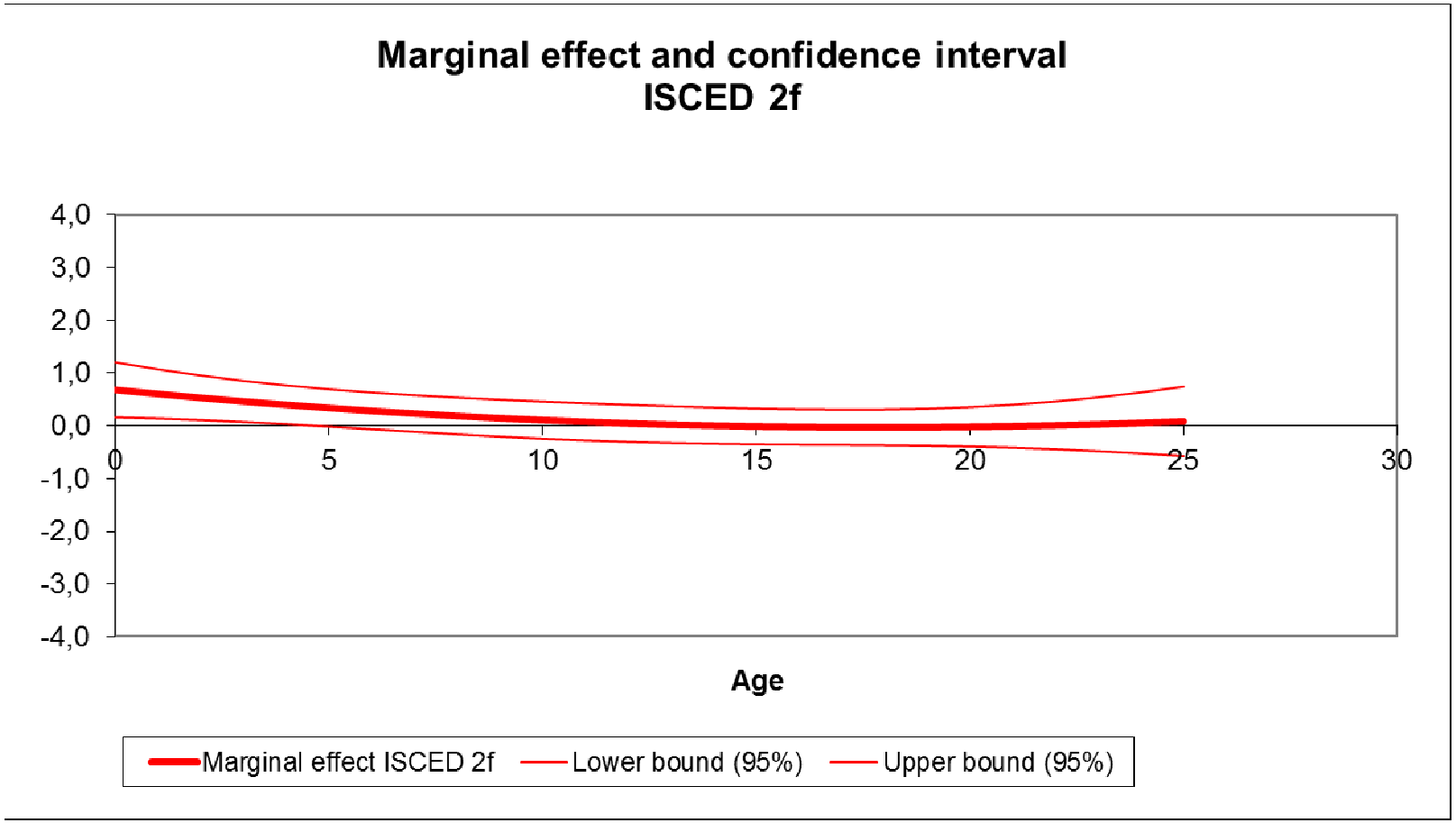
Results II – Marginal effects profiles ISCED 3m



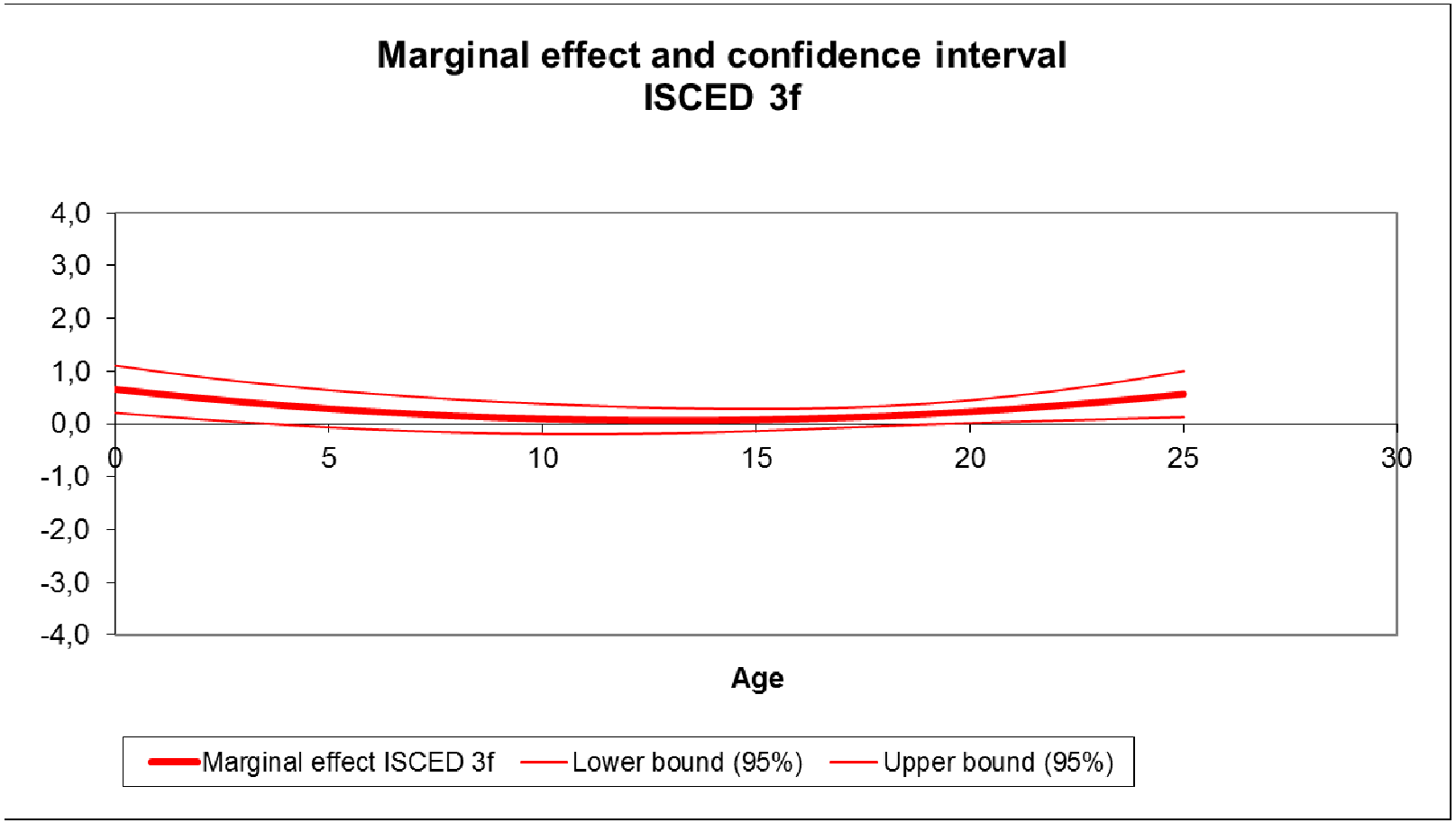
Results II – Marginal effects profiles ISCED 5m



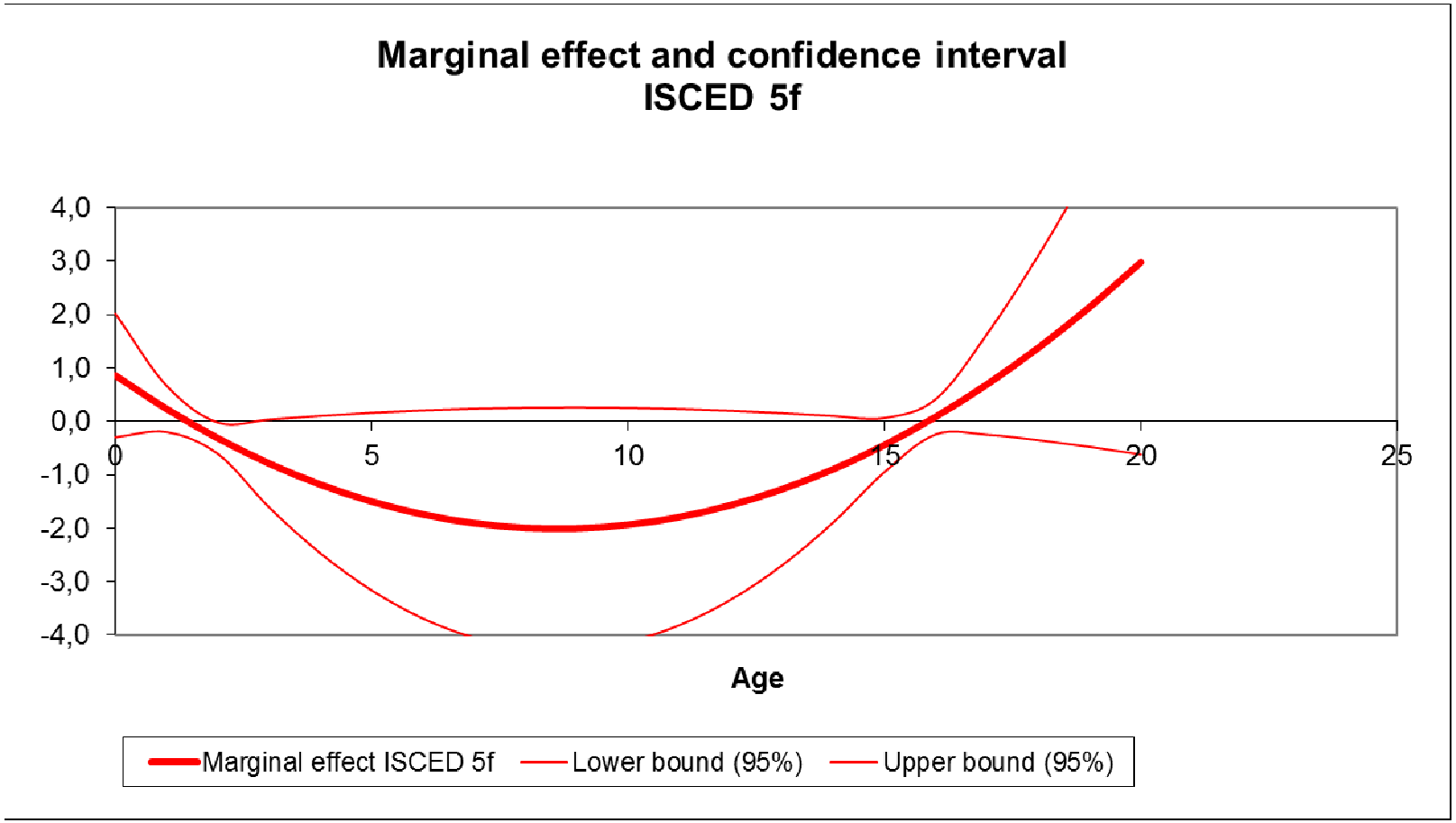
Results II – Marginal effects profiles ISCED 2f



Results II – Marginal effects profiles ISCED 3f



Results II – Marginal effects profiles ISCED 5f



Results III – Persistence of cohort size effects

- Any significant negative cohort size effects are only temporary
  - ISCED 2m: 12 years (age 26-37)
  - ISCED 3m: 9 years (age 27-35)
  - ISCED 5m: 13 years (age 28-40)
  - [ISCED 5f:14 years (age 27-40)]
- Future research:
  - Why do marginal effects turn positive?
    - Investment into skill acquisition during period of depressed wages leading to faster wage growth?
    - Move out of perfect competition framework?

Results IV – Comparison across education

- Relative to ISCED 3 the negative effects of cohort size are larger for more educated individuals (males and females):
  - Longer period of predicted negative marginal effects
  - Marginal effects are more negative (profiles are shifted down)

- Results compatible with theory that less educated individuals are better substitutable across age

Results V – Comparison with other studies

- Wright (1991):
  - ISCED 2:
    - Marginal effects: 0.175 (average), -0.153 (minimum); 6 years
  - ISCED 3+5:
    - Marginal effects: 0.004 (average), -0.351 (minimum); 13 years

- Brunello (2010):
  - ISCED 3:
    - Marginal effect : -0.07; constant over age
  - ISCED 5:
    - Marginal effect: -0.175; constant over age

- Own results:
  - ISCED 2:
    - Marginal effects: -0.175 (average), -0.351 (minimum); 12 years
  - ISCED 3:
    - Marginal effects: 0.027 (average), -0.374 (minimum); 9 years
  - ISCED 5:
    - Marginal effects: -0.530 (average); - 1.985 (minimum); 13 years

Summary

- Analysis of cohort size-effects on individual wages
- Identification of causal effect using instrumental variables estimation
- Evidence of negative marginal cohort size effects for male wages
- Impact on female wages less clear (labour force participation)
- Negative effects on wages only temporary
- Evidence that negative effects are larger for more educated individuals
- Estimated cohort size effects large in comparison with similar research results