ECON-C4100 - Econometrics I

Lecture 11B: Aghion, Akcigit, Hyytinen & Toivanen - Parental Education and Invention: The Finnish Enigma. International Economic Review, forthcoming

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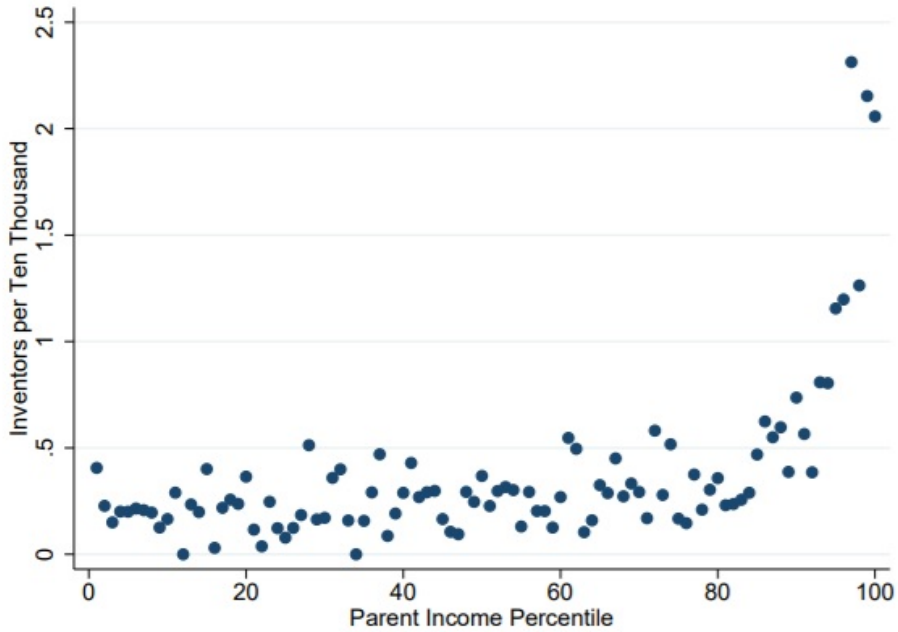
Parental education and invention

Figure: Parental income and Prob(invent)

1A. 1930s U.S.



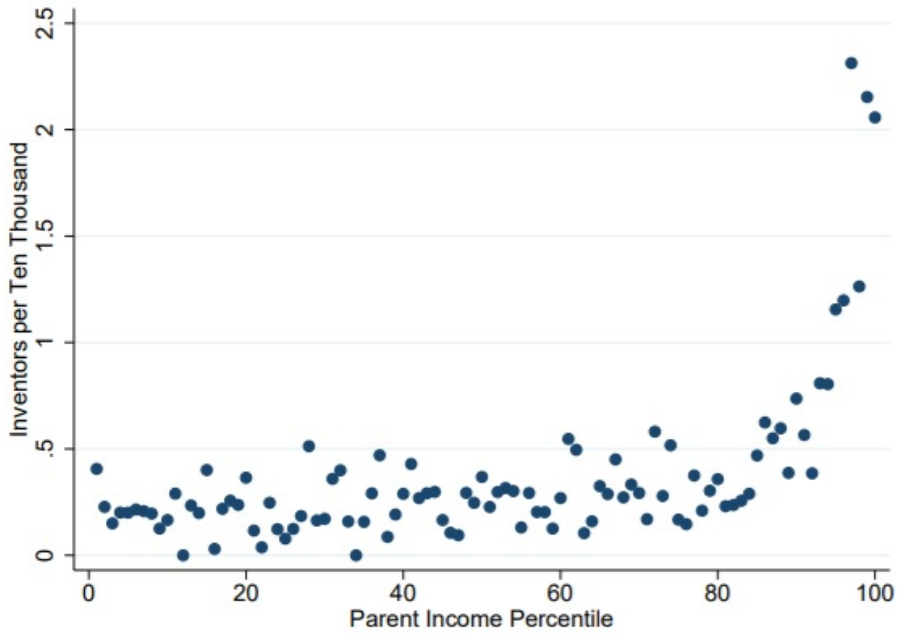
Note: Akcigit, U., Grigsby, J. & Nicholas, T. (2017). The rise of american ingenuity: Innovation and inventors of the golden age [National Bureau of Economic Research WP 23047].

Note #2: All tables and figures from Aghion, P., Akcigit, U., Hyytinen, A. & Toivanen, O. (2023). Parental income and invention: The finnish enigma. *International Economic Review* if not otherwise noted.

Parental income and invention

Figure: Parental income and Prob(invent)

1B. 1980s U.S

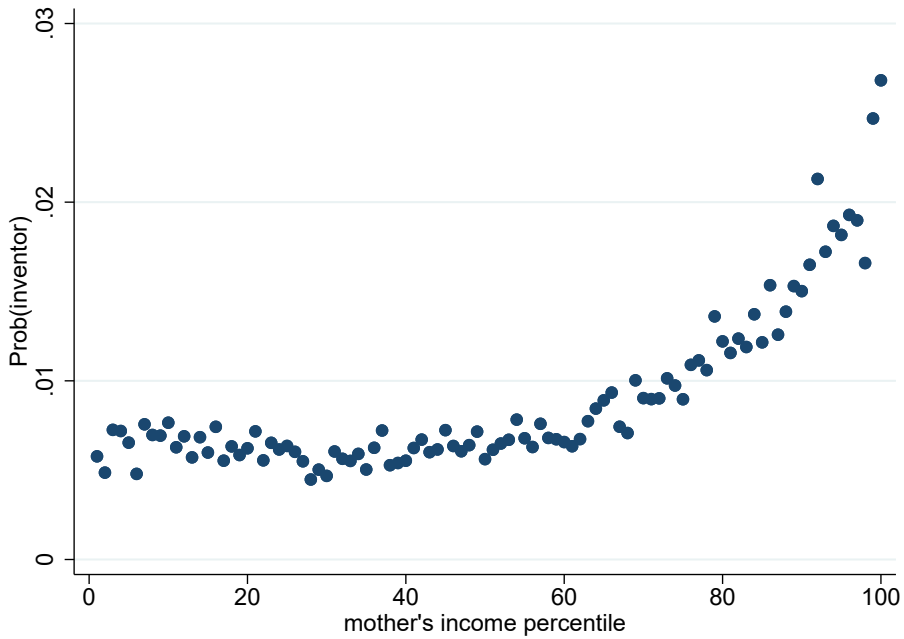


Note: Bell, A., Chetty, R., Jaravel, X., Petkova, N. & Van Reenen, J. (2019). Who becomes an inventor in america? the importance of exposure to innovation. *Quarterly Journal of Economics*, *134*(2), 647–713

Parental income and invention

Figure: Parental income and Prob(invent)

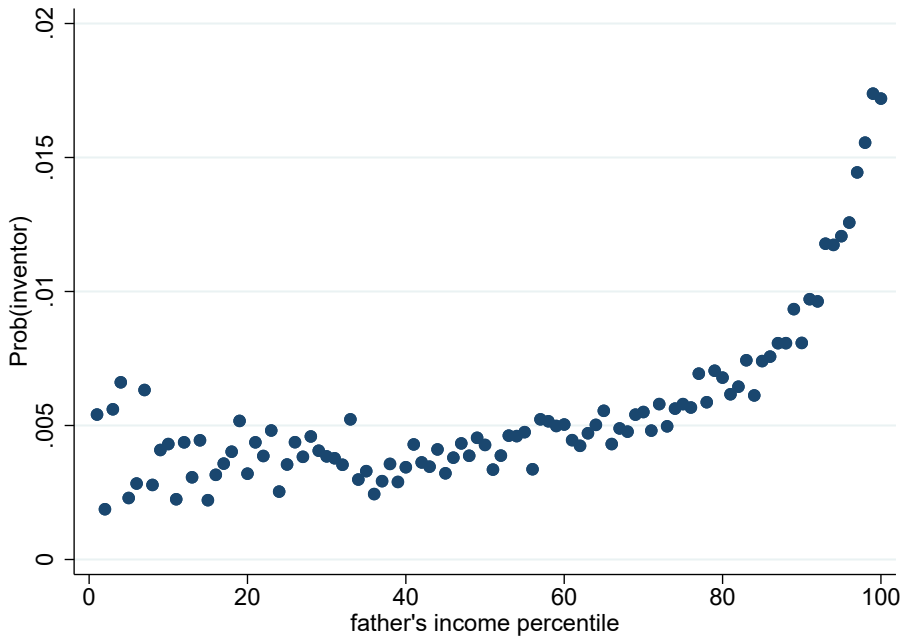
1C. Finland 1953-1981, maternal income



Parental income and invention

Figure: Parental income and Prob(invent)

1D. Finland 1953-1981, paternal income



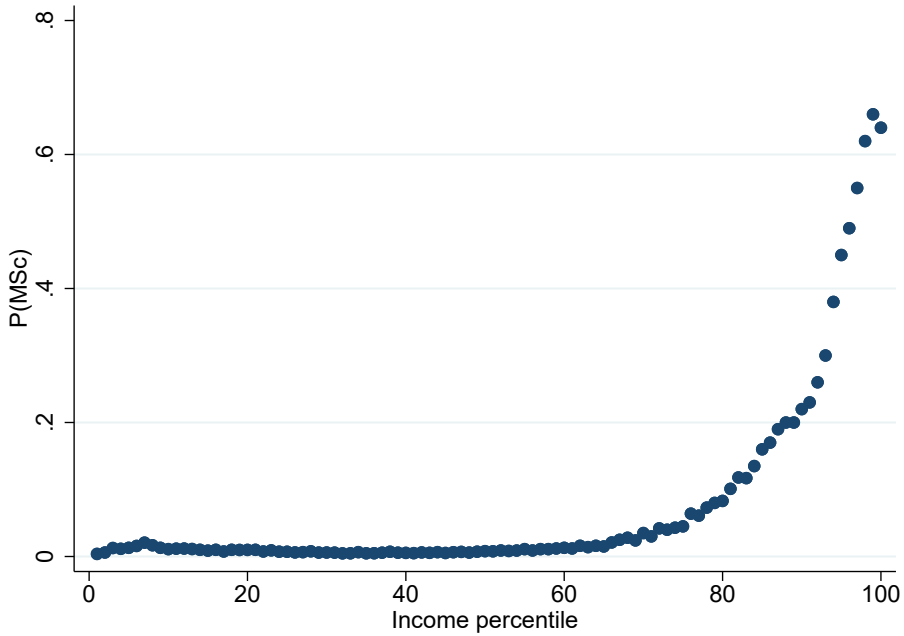
Finnish enigma

- How come in Finland the relationship between parental income and probability of offspring becoming an inventor is so similar to the US?

Parental income and education

Figure: Parental income and parental education

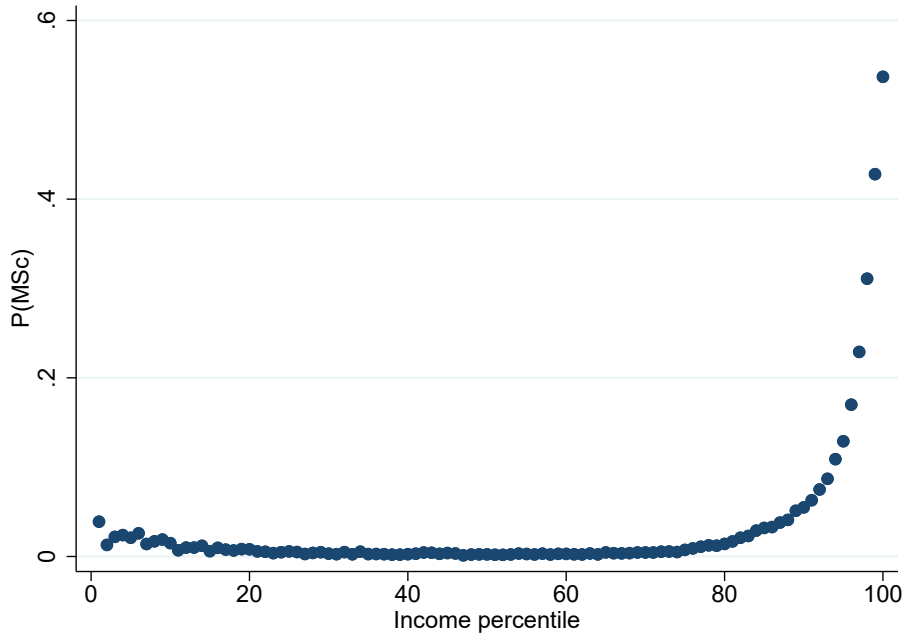
2A. Finland 1953-1981, maternal income & education



Parental income and education

Figure: Parental income and parental education

2B. Finland 1953-1981, paternal income & education



What do AAHT do?

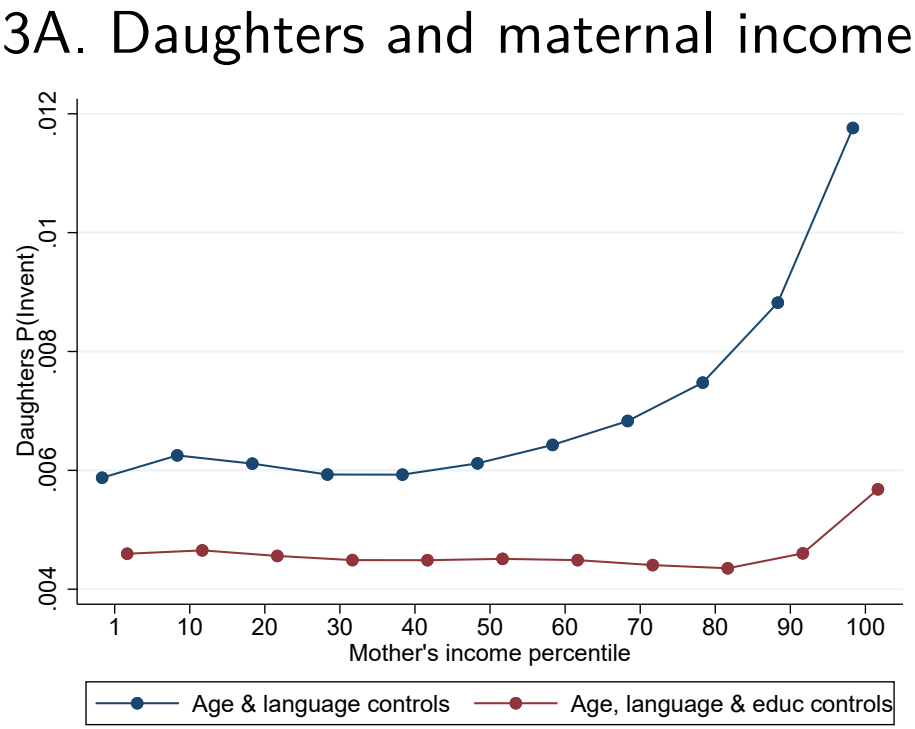
- How does the relationship between parental income and probability of becoming inventor change when parental education is controlled for?
- IV regression of probability of becoming inventor on parental education.

OLS regression

$$y_i = \boldsymbol{X_i'}\beta + f(income_{p,i}, \boldsymbol{\theta}) + g(Educ_{p,i}, \gamma) + \epsilon_i \quad (1)$$

- y_i is a dummy for being an inventor,
- $\boldsymbol{X_i'}\beta$ are control variables and the associated vector of parameters to be estimated,
- $f(income_{p,i}, \boldsymbol{\theta})$ is a fifth order polynomial of income of the parent of type p ($p = mother,\ father$), with $\boldsymbol{\theta}$ being the associated vector of parameters to be estimated,
- $g(\boldsymbol{Educ_{p,i}}, \gamma)$ includes a vector of field (STEM, non-STEM) and level (secondary, college, masters, PhD level, with base-level being omitted) of education dummies $Educ_{p,i}$ of parent of type p, with γ being the associated vector of parameters to be estimated and
- ϵ_i is the error term.

Parental income and education



IV

- Instrument: Parental distance to nearest university from birth-municipality, measured in the year when the parent in question turns 19.
- Exclusion restriction: parental distance to university uncorrelated with unobservables affecting probability of offspring becoming an inventor.

IV

Our main estimation equation is of the form

$$y_i = \boldsymbol{X_i'}\beta + \delta D_i + \epsilon_i \tag{2}$$

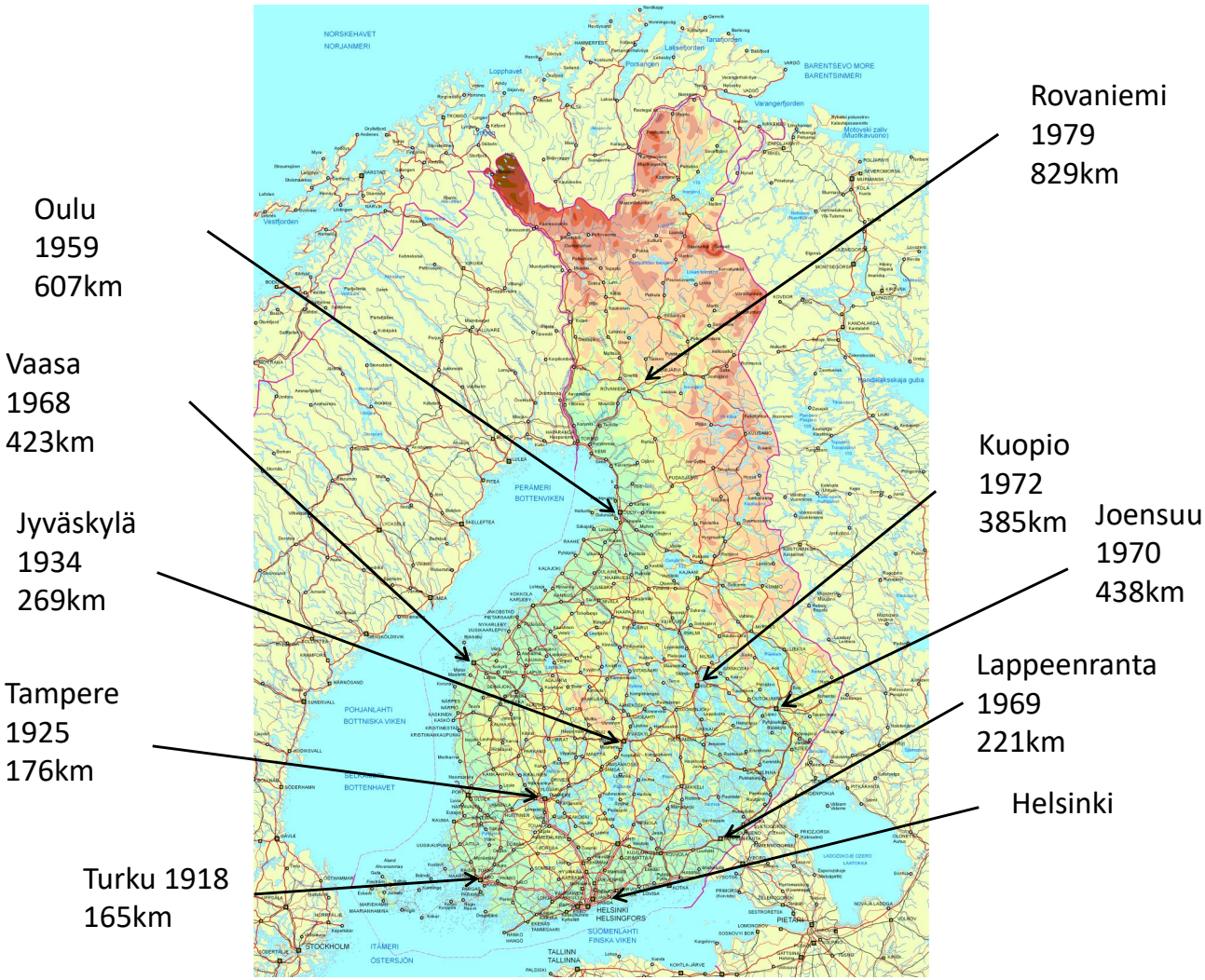
- y_i is the outcome dummy variable taking value 1 if individual i is an inventor of a patent, and 0 otherwise.
- $\boldsymbol{X_i}$ is a vector of controls (maternal and paternal year of birth dummies, a dummy for mother tongue not being Finnish, and the controls for the birth municipalities of both parents discussed above); β is the associated coefficient vector.
- D_i is the parental education dummy taking value 1 if individual i has at least one parent with at least an MSc and 0 otherwise.
- δ is the causal parameter of interest and
- ϵ_i is an error term capturing all those determinants of an individual becoming an inventor that are unobservable to us

Challenge with IV

- Parents growing up near a university are different from those growing up further away.
- Solution #1: utilize data around the establishment of new universities.
- Solution #2: bring in control variables that reduce/remove the potential problem.

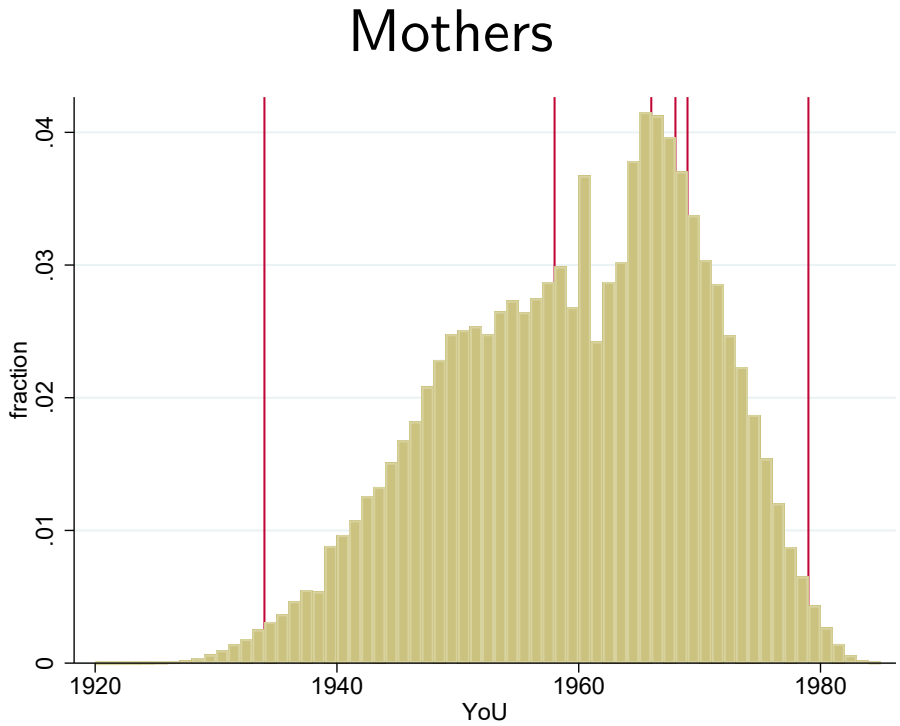
Finnish universities

Figure: Map of Finnish university establishments 1918 - 1979



Parental age distribution & new universities

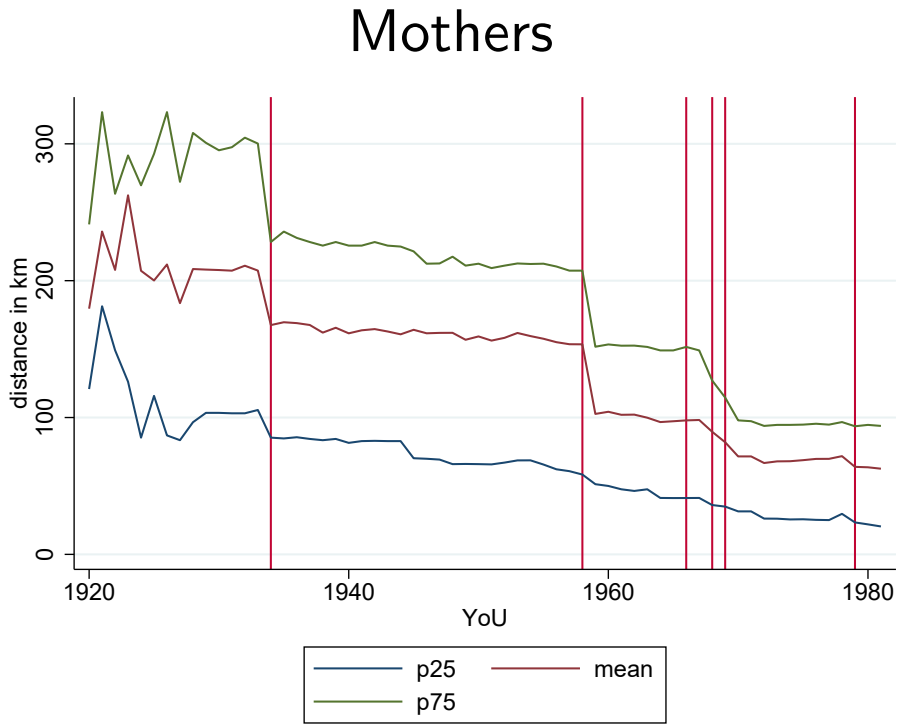
Figure: Distribution of parents by year at age 19



Note: *YoU* = year of university (age 19)

Distance to university and new universities

Figure: Distribution of parents by year at age 19



Note: *YoU* = year of university (age 19)

Birth municipality characteristics and distance

Table: Distance correlations

Parent	$P(inventor)$	D(MSc parents)	MSc_p	Count	MSc_{cohort}
Maternal	-0.0110	-0.0360	0.0179	0.1088	-0.1958
	(0.1679)	(0.0000)	(0.0251)	(0.0000)	(0.0000)
Paternal	-0.0221	-0.0135	-0.0117	0.0766	-0.1548
	(0.0078)	(0.1039)	(0.1590)	(0.0000)	(0.0000)

Parent	p50	p90	IQ
Maternal	-0.2042	-0.1395	-0.0452
	(0.0000)	(0.0000)	(0.0028)
Paternal	-0.2336	-0.1227	-0.0536
	(0.0000)	(0.0000)	(0.0007)

Note: reported numbers correlation coefficient and p-value. All other variables pertain to parent, or parental muni-year cohort, but IQ is the son's IQ.

Parental education and invention

Table: Estimation results

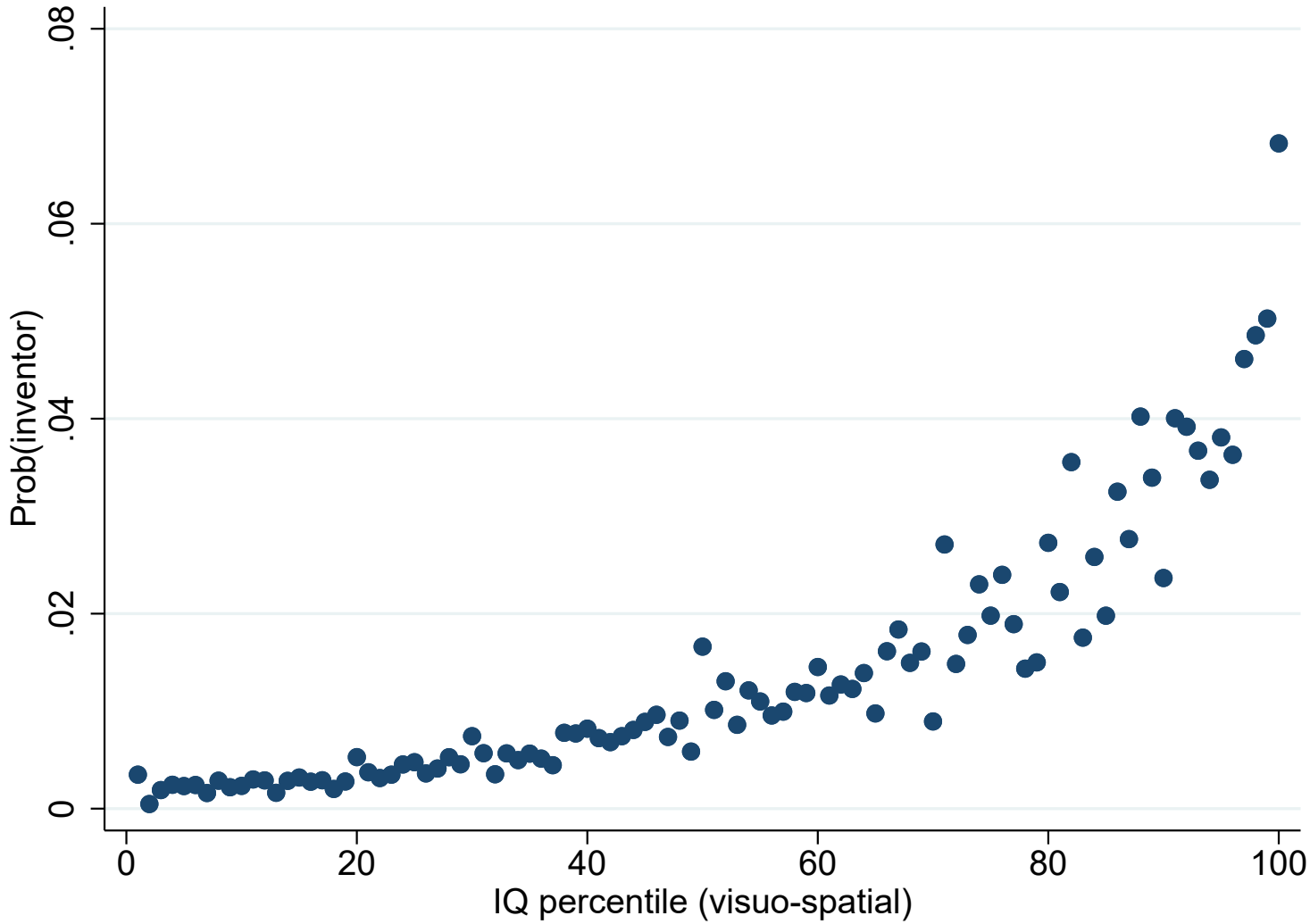
		Panel A. All Children		
	(1)	(2)	(3)	(4)
	OLS	IV	IV	IV
D(MSc parents)	0.0159***	0.0506***	0.0328***	0.0327***
	(0.00132)	(0.0110)	(0.009)	(0.0049)
F	-	251.04	497.453	108.49
Nobs		1 450 789		
		Panel B. Daughters		
D(MSc parents)	0.0049***	0.0100	0.0203**	0.0160***
	(0.0005)	(0.0085)	(0.0086)	(0.0034)
F	-	251.04	497.453	108.49
Nobs		709 117		
		Panel C. Sons		
D(MSc parents)	0.0261***	0.0866***	0.0430**	0.0487***
	(0.0023)	(0.0193)	(0.0205)	(0.0092)
F	-	251.04	497.453	108.49
Nobs		741 671		
		Instruments		
Maternal dist.	NO	YES	NO	YES
Paternal dist	NO	NO	YES	YES

Omitted variable bias?

- The new birth-of-municipality controls are designed to alleviate OVB.
- Question is, are they enough?
- Reason to worry: Carneiro and Heckman, 2002 find with US data that distance to college and ability test scores are negatively correlated.
- We have access to IQ data for a subsample (men doing military service 1982-).
- For those individuals, parental distance to college and offspring visuospatial IQ negatively correlated at -0.045 and -0.054 (both significant at 1% level).
- $\rightarrow$ a potential worry, especially if IQ were correlated with probability to invent.

Visuospatial IQ and probability to invent

Figure: IQ percentile and Prob(*Inventor*)



Parental education and invention, controlling for IQ

Table: Estimation results using the IQ subsample

	(1)	(2)	(3)	(4)
	OLS	IV	IV	IV
	Panel A. No IQ variables			
$D(MScparents)$	0.0294***	0.0746***	0.0572**	0.0463***
	(0.0027)	(0.0266)	(0.0218)	(0.0115)
F	-	34.74	51.28	258.51
	Panel B. IQ variables			
$D(MScparents)$	0.0228***	0.0550*	0.0454*	0.0291**
	(0.0022)	(0.0274)	(0.0233)	(0.0121)
F	-	31.25	55.21	262.18
F_{IQ}		217.28	219.87	210.87
Nobs		421 729		
Maternal dist.	NO	YES	NO	YES
Paternal dist	NO	NO	YES	YES

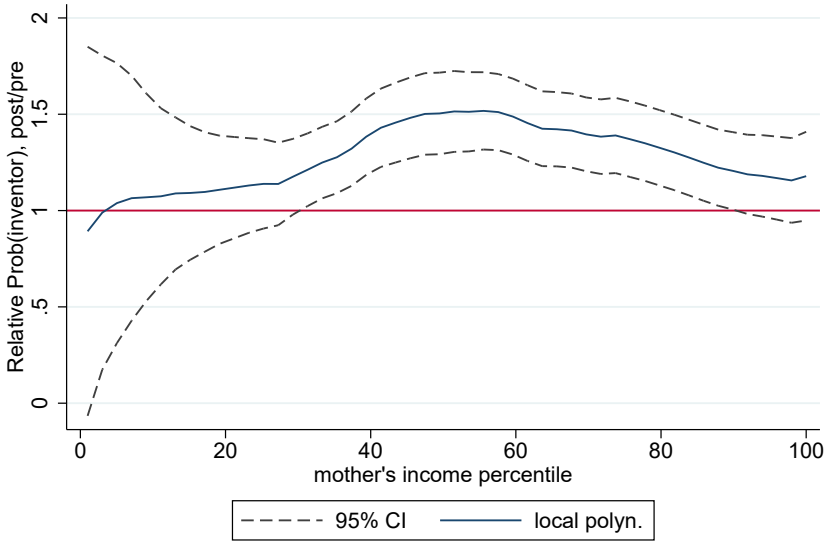
Comprehensive school

- Starting the early 1960s, Finland moved stage-wise from a school system based on tracking to a comprehensive school system.
- This led to more equal access to (higher) education.
- Question: How does this interact with the causal effect of parental education on off-spring invention?

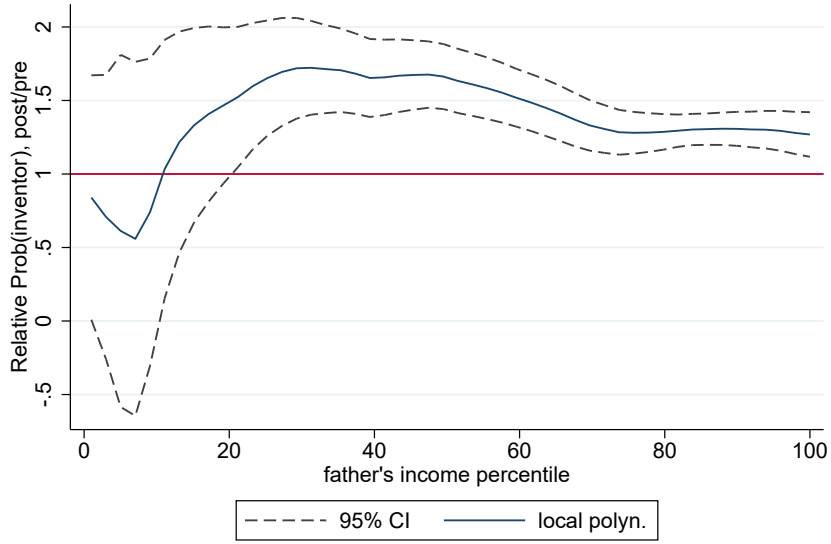
Effect in the raw data

Figure: Relative $P(Inventor)$ 1966-1970 compared to 1956-1960

Maternal income



Paternal income



Parental education and invention, pre- and post school reform cohorts

Table: Estimation results using pre- and post- comprehensive school samples

	(1)	(2)	(3)	(4)
	OLS	IV	IV	IV
Panel A. Pre, 1956-1960				
$D(MScparents)$	0.0151***	0.100***	0.0256	0.0445***
	(0.0017)	(0.0316)	(0.0507)	(0.0123)
F	-	43.16	25.19	65.44
Nobs		234 685		
Panel B: Post, 1966 - 1970				
$D(MScparents)$	0.0221***	0.0116	0.0141	0.0333**
	(0.0016)	(0.0263)	(0.0323)	(0.0125)
F	-	54.60	44.40	79.15
Nobs		203 923		
Maternal dist.	NO	YES	NO	YES
Paternal dist	NO	NO	YES	YES

Additional analyses

- Use # patents and # citations to all patents as the dependent variable.
- Use # parents with at least and MSc as the key explanatory variable.
- Use having at least one parent with a BSc as the key explanatory variable.
- Estimate a so-called Roy model (structural).

Conclusions

- Parental education has a positive causal impact on probability of offspring becoming inventors.
- Effect larger in absolute terms for sons, in relative terms for daughters.
- Results survive when using IQ as additional control.
- Effect larger for cohorts just before than for cohorts just after comprehensive school reform.
- Results robust in a number of ways: different samples, different outcome variables, different measures of parental education, different functional forms...
- The fact that estimated coefficient varies as the instrument is changed suggests that we identify a **Local Average Treatment Effect**, or LATE.