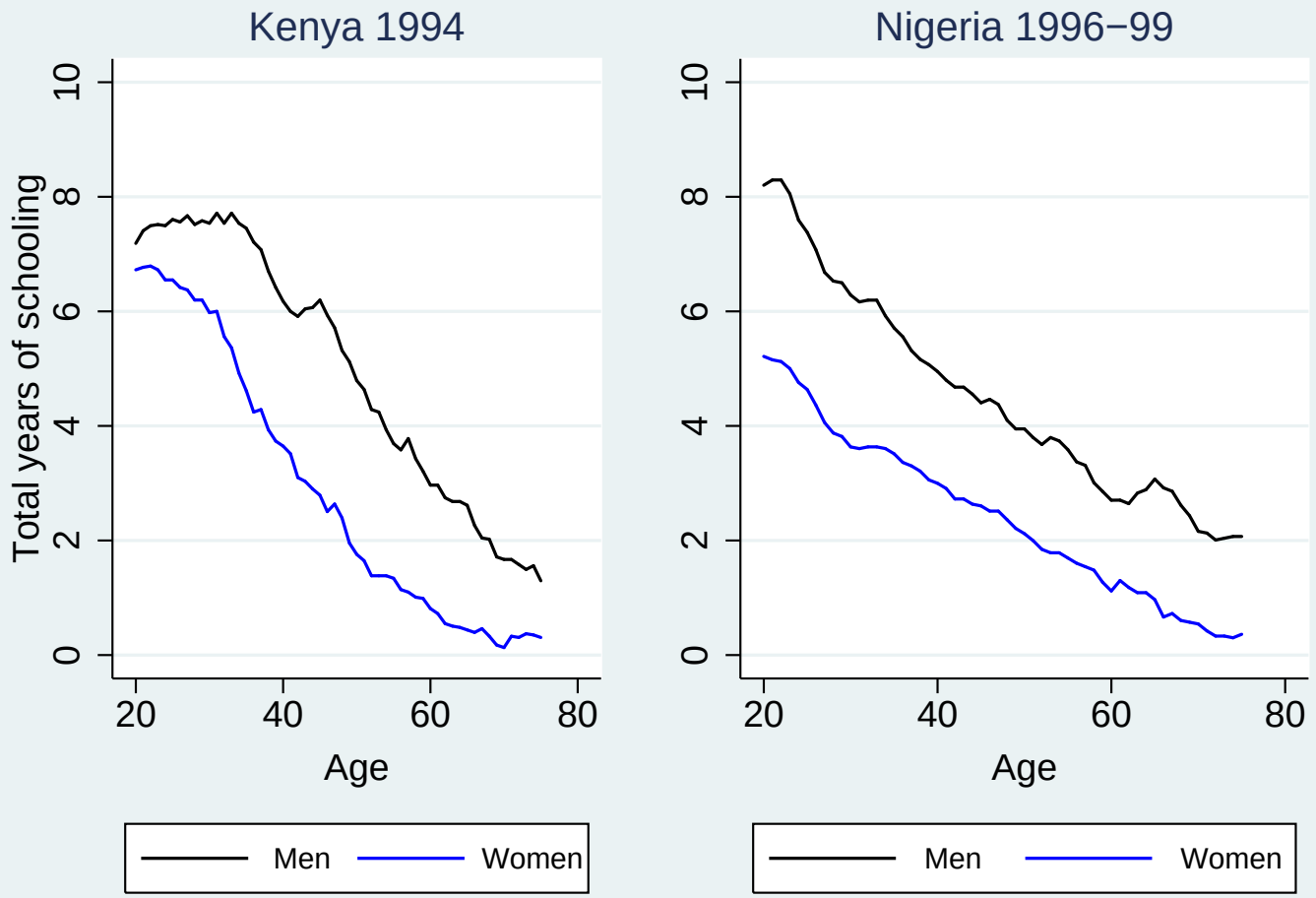
The Impact of Secondary Schooling in Kenya:

A Regression Discontinuity Analysis

(Journal of Human Resources 2018)

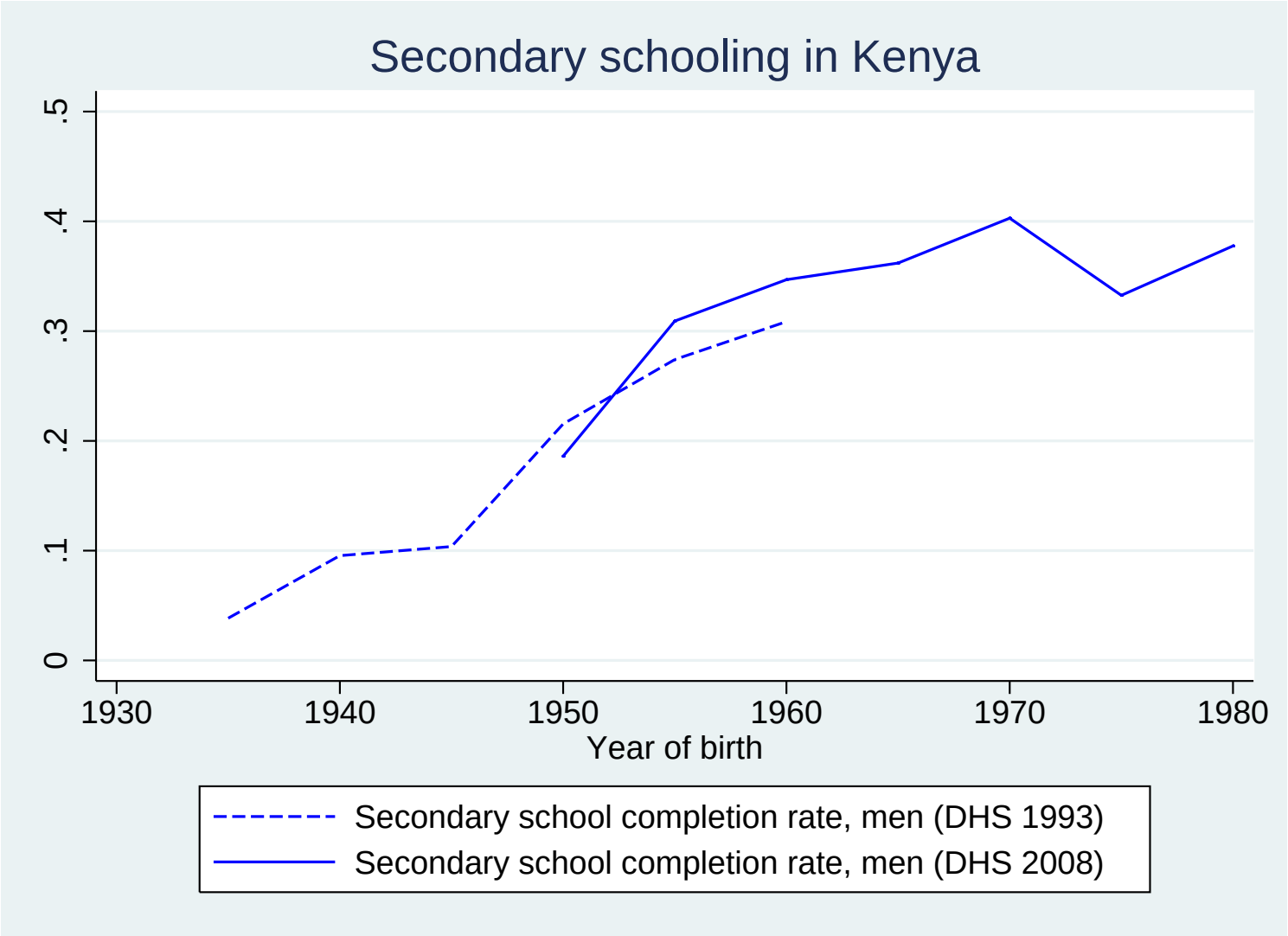
Presented at UMD Econ-626
Oct 2019

Trends in education: Kenya, Nigeria

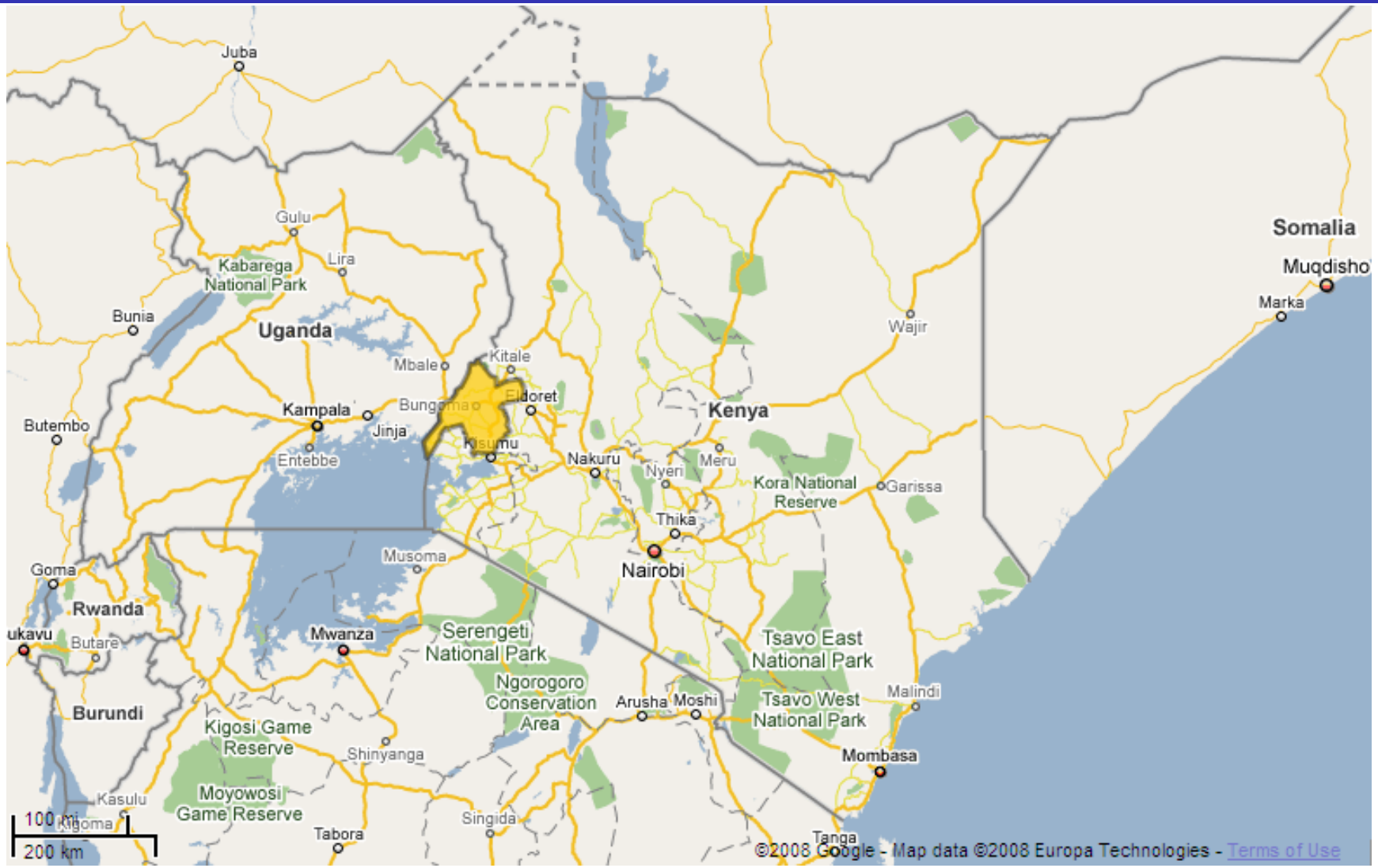


Source: Schultz (2004)

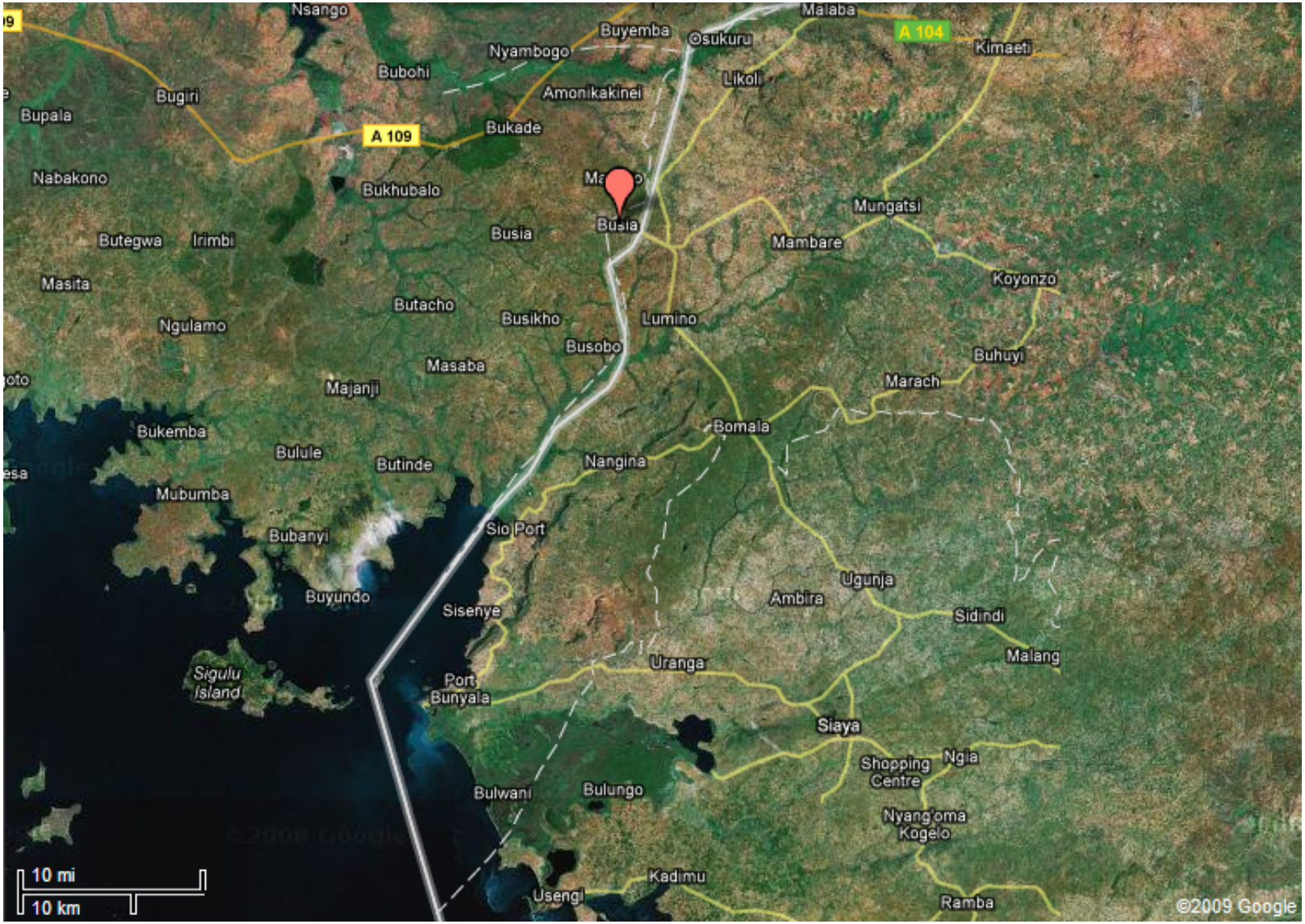
Kenyan secondary school completion by date of birth



Western Province, Kenya



Samia and Bunyala - Former Busia District, Kenya



8th Grade - Kenya Certificate of Primary Education

December 30, 2008

"Out of the over 695,000 candidates who sat the KCPE examination, 350,000 candidates **attained over 250 marks, making them eligible to join secondary school.**"

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  but no government cutoff exists below the 50% mark – at least for boys.
- 1985-2000: 7-subject test; 2001-onward: 5-subject test (100 pts/subject);
  (Kremer, Miguel, and Thornton 2009; Orlale 2000)

Main data: Kenyan Life Panel Survey

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- 7,530 of roughly 22,000 pupils sampled
  KLPS1: 2003-2005
  KLPS2: 2007-2009
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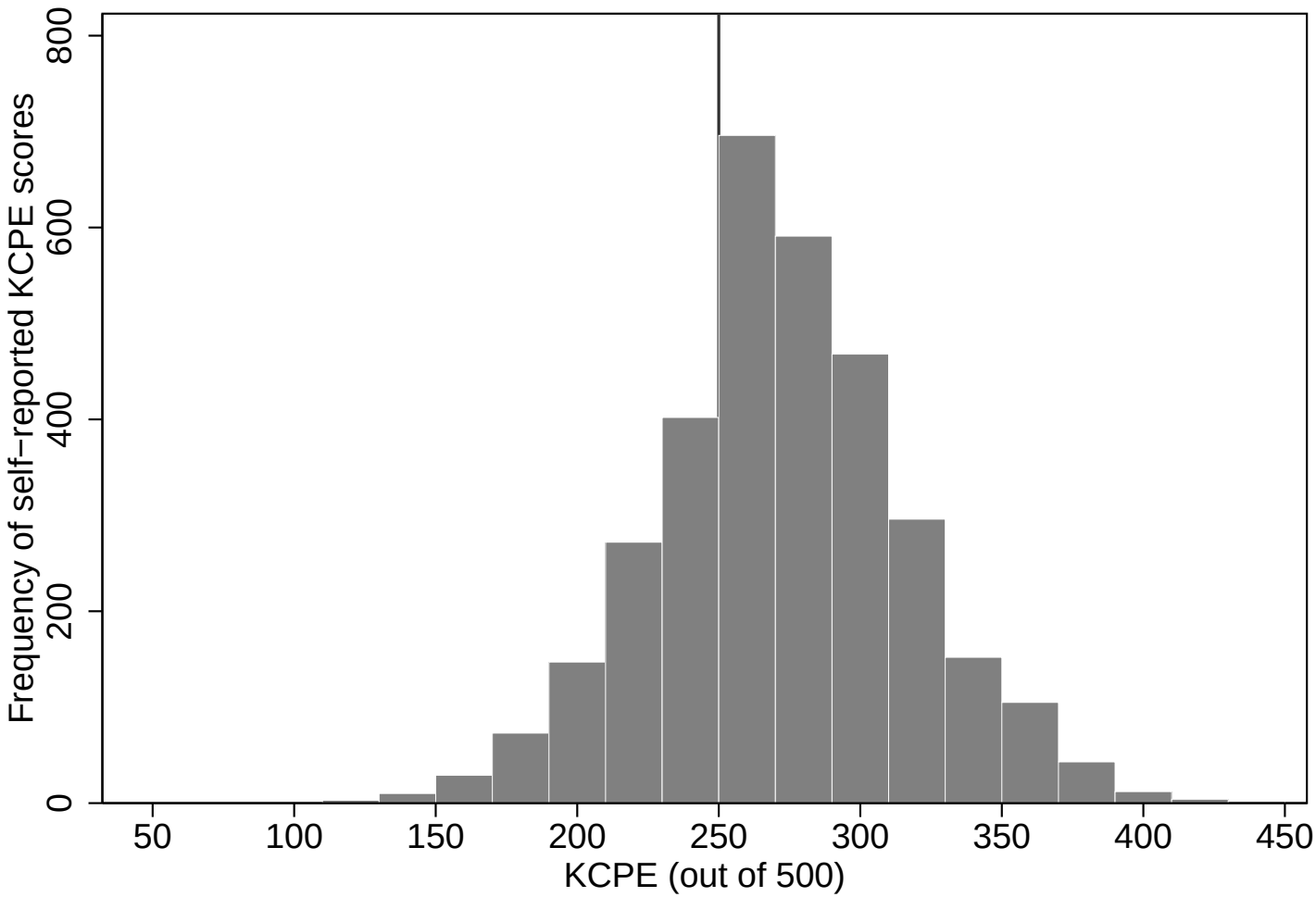
- 7,530 of roughly 22,000 pupils sampled
  KLPS1: 2003-2005
  KLPS2: 2007-2009
  (Baird, Hamory, and Miguel 2008)
- KLPS2 effective tracking rate: $>84\%$;
  In total: 5,084 repondents,
  two thirds of whom take the KCPE

Data: Summary statistics among those reporting a KCPE score

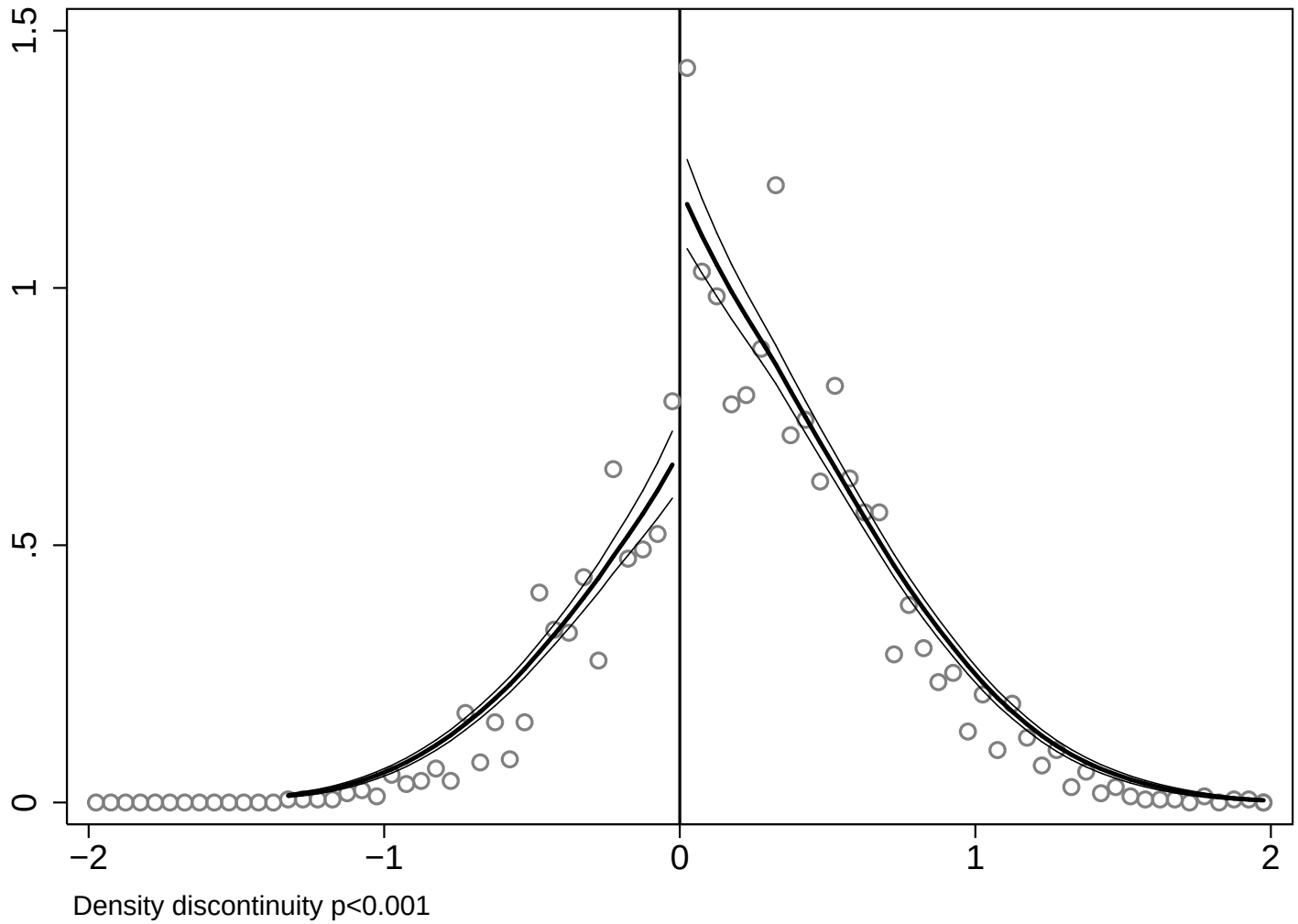
Characteristic	Mean	Std. Dev.	N
Panel A: Respondent Characteristics			
Age	22.05	(2.57)	3305
Female	0.45	(0.50)	3305
Father's level of education	10.06	(4.99)	2953
Mother's level of education	6.61	(4.18)	3049
Panel B: First Stage: Education Characteristics			
Self-reported KCPE Score (out of 500)	254.49	(52.23)	3305
Years of Education	10.14	(2.09)	3305
Still attending school	0.30	(0.46)	3305
Any secondary schooling	0.62	(0.49)	3305
Complete (4y) secondary schooling	0.37	(0.48)	3305
Post-secondary schooling	0.04	(0.18)	3305

Self-reported score distribution



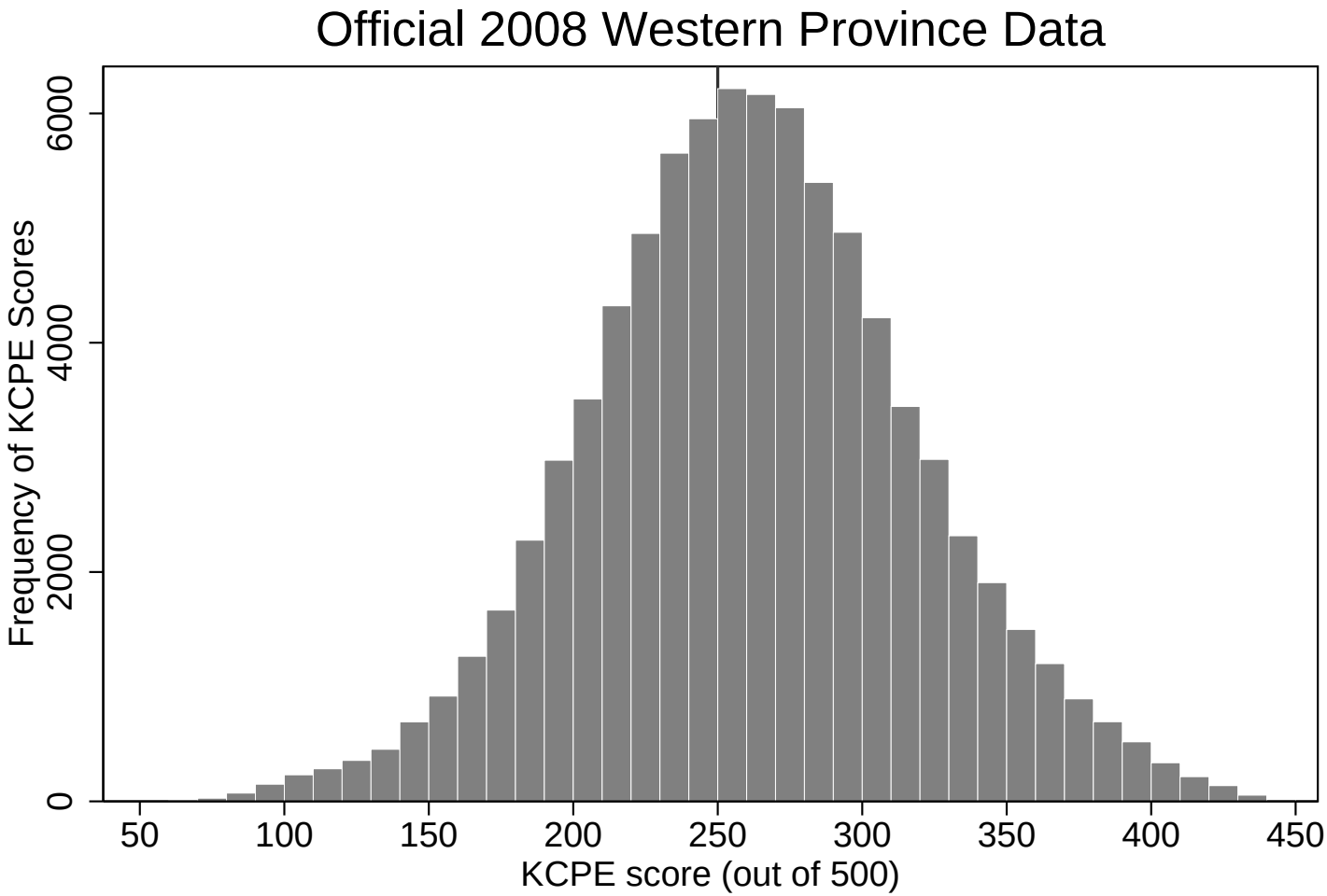
KLPS2 data, N=3305

Self-reported score distribution: McCrary manipulation test



Generated using the routine developed by McCrary (2008).

True administrative distribution from 2008



KCPE 2008 Western Province data, N=84989

Possible explanation: Re-taking

KLPS1 (2003-05) survey asked how many times respondents took the KCPE.
Among oldest two cohorts reporting ever taking KCPE:

KCPE attempts	N	Percent
1	656	86.66
2	100	13.21
3	1	0.13
Total:	881	

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Re-taking is costly, however, mainly because it requires repeating Standard 8:

	Attempts			
Repeat Std 8?	1x	2x	3x	Total
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Yes	17	98	1	116
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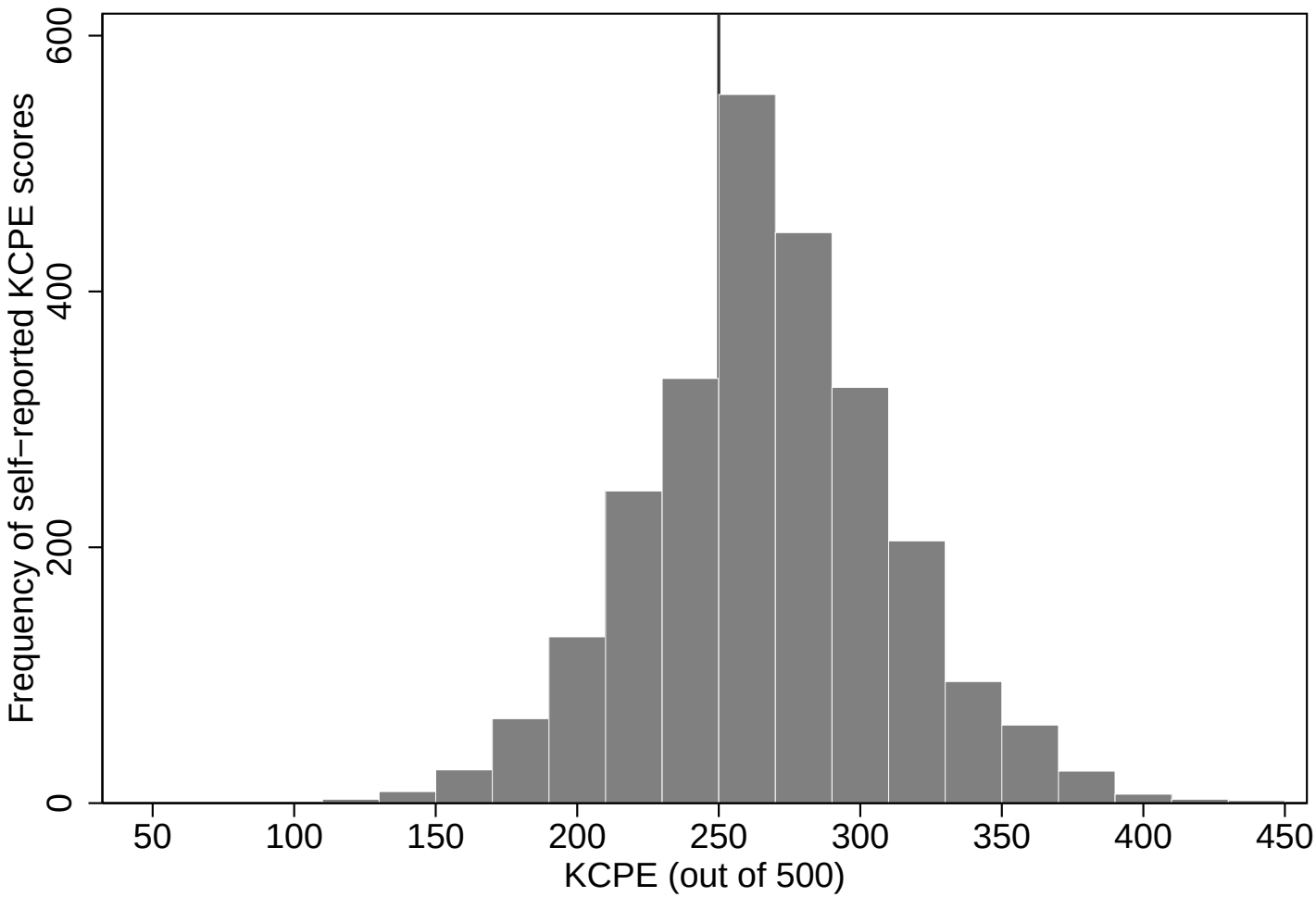
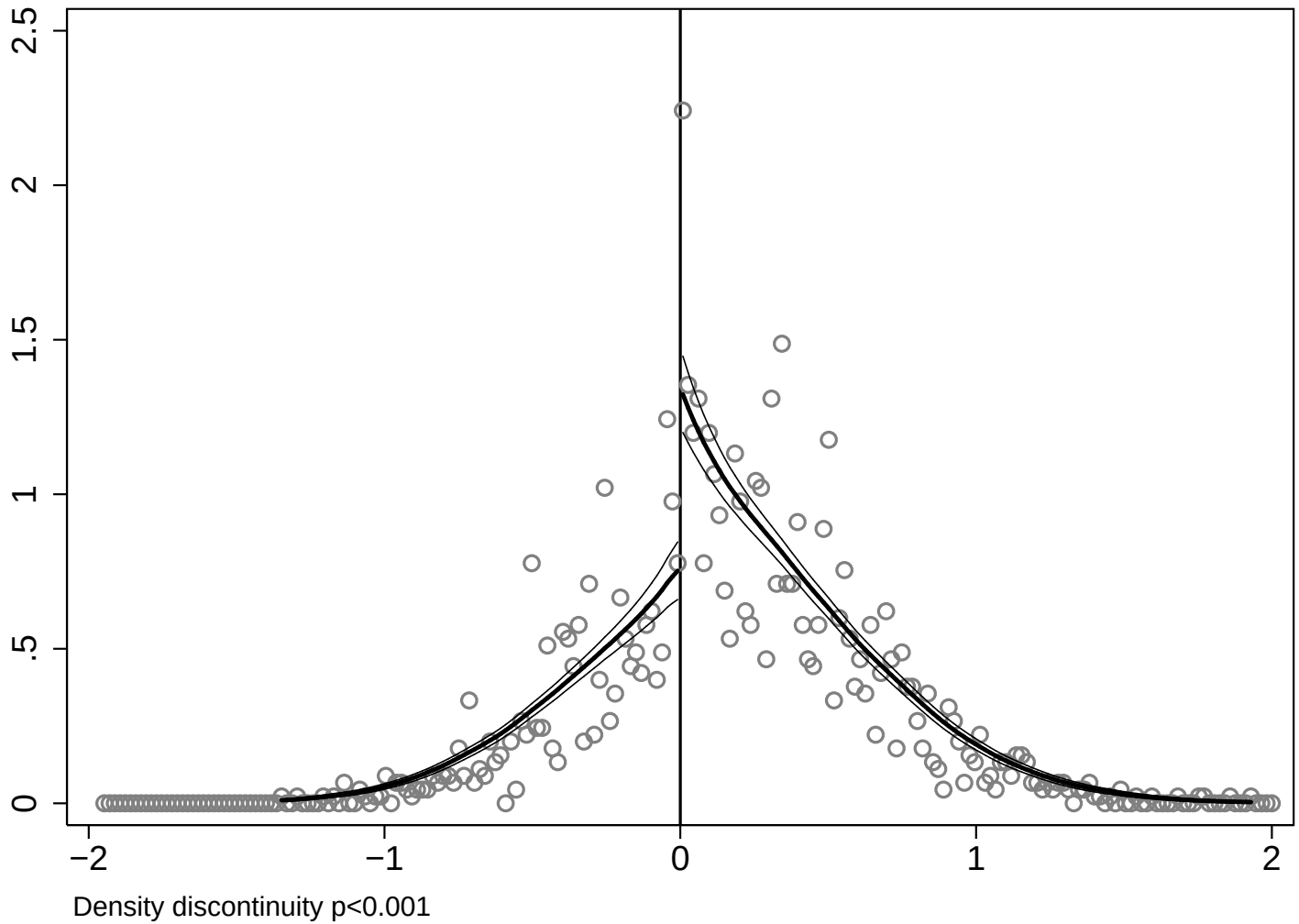
Even without the survey question, a good measure of re-taking ($R^2 > 0.8$).

Self-reported score distribution, non-repeaters



KLPS2 data, N=2533, restricted to those who enroll in Std 8 only once

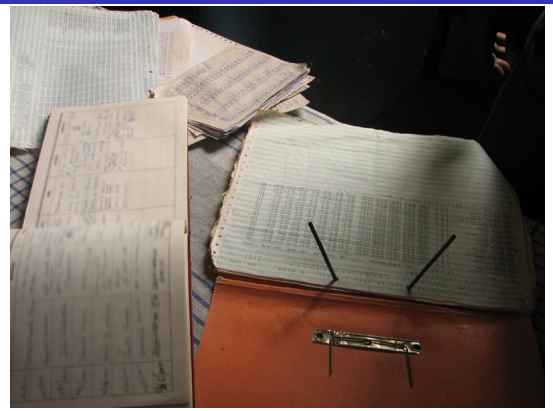
Self-reported score distribution: McCrary manipulation test, non-repeaters

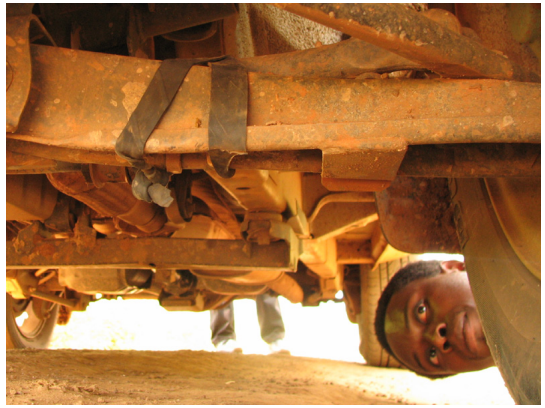


Generated using the routine developed by McCrary (2008).

Gathering administrative data








Administrative data

Kenya Certificate of Primary Education
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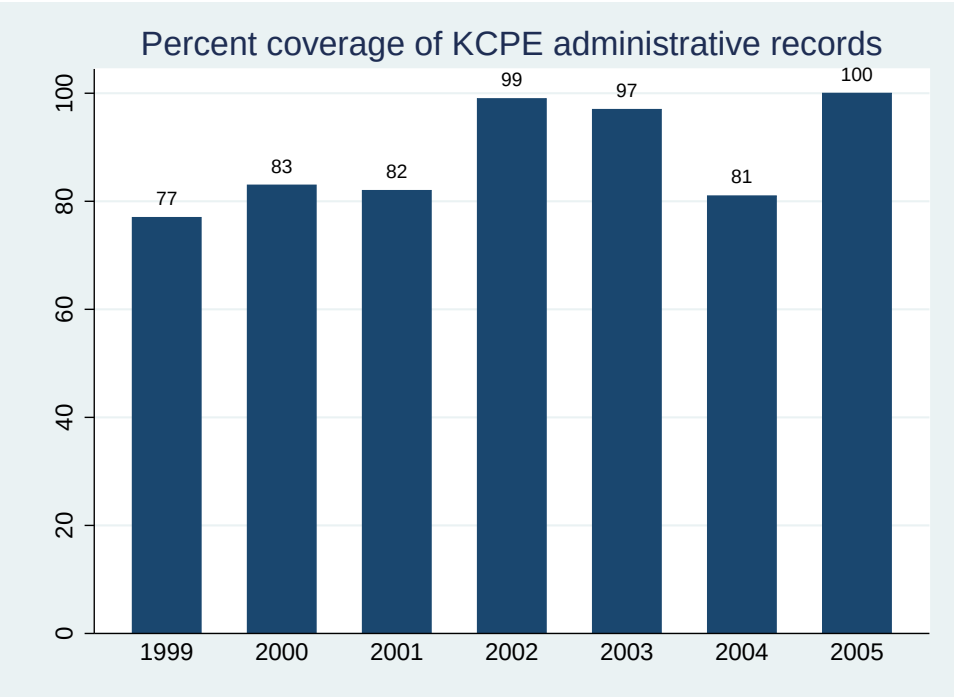
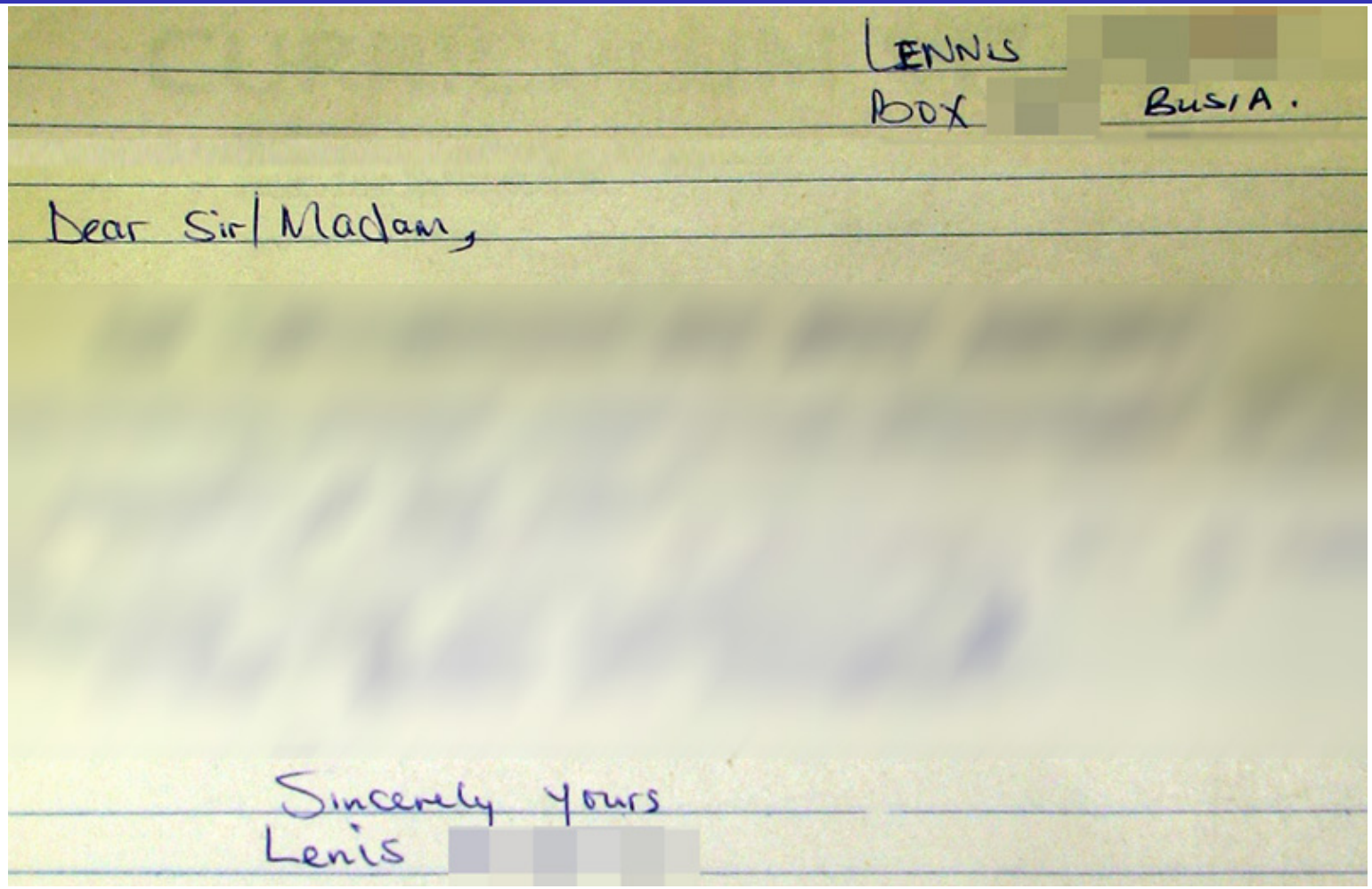
- 88% coverage in original schools/years, based on hardcopy availability:



Name matching: challenges



Matching

School(s), Year(s), Names (with soundex-like algorithm customized to Western Kenya):

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Spelling:

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FEDNANT	FERDNAND	ODUORY	ODWORY
FEDNARND	FERDNANT		

Order, subset: WILLKISTER NABWIRE = NABWIRE OMONDI WILKISTA

Density: OJIAMBO, ODUOR, OUMA, WANDERA, JUMA: each exceeds 3% of records. (compare: of surnames, only SMITH exceeds 1% of 1990 US Census records.)

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Among respondents giving a test score in the survey: found **76.7%**

Matched Scores	**N**	**Percent**
Exactly one matched score	2273	68.77
Two (different years: retaking)	263	7.96
Unmatched	769	23.27

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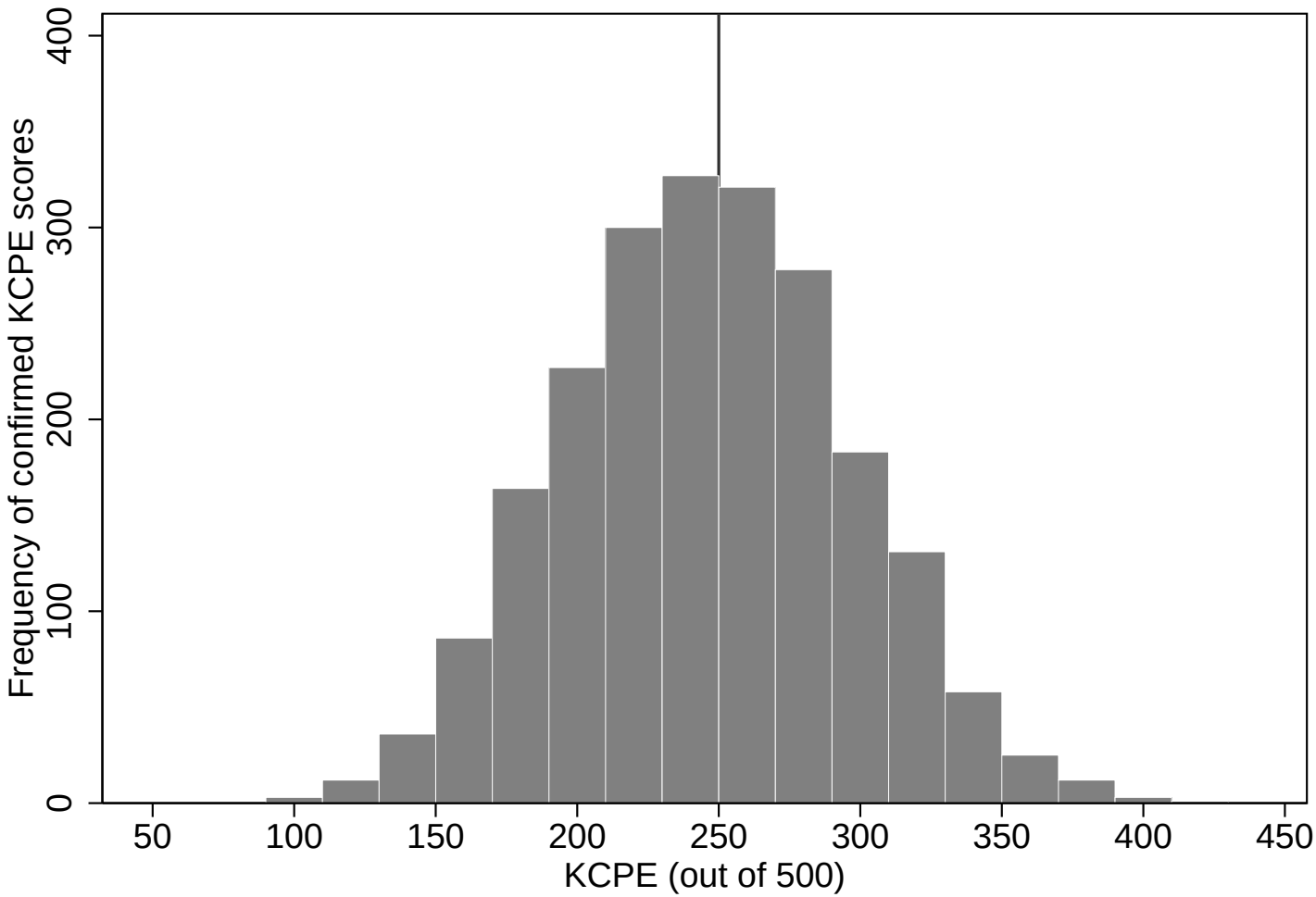
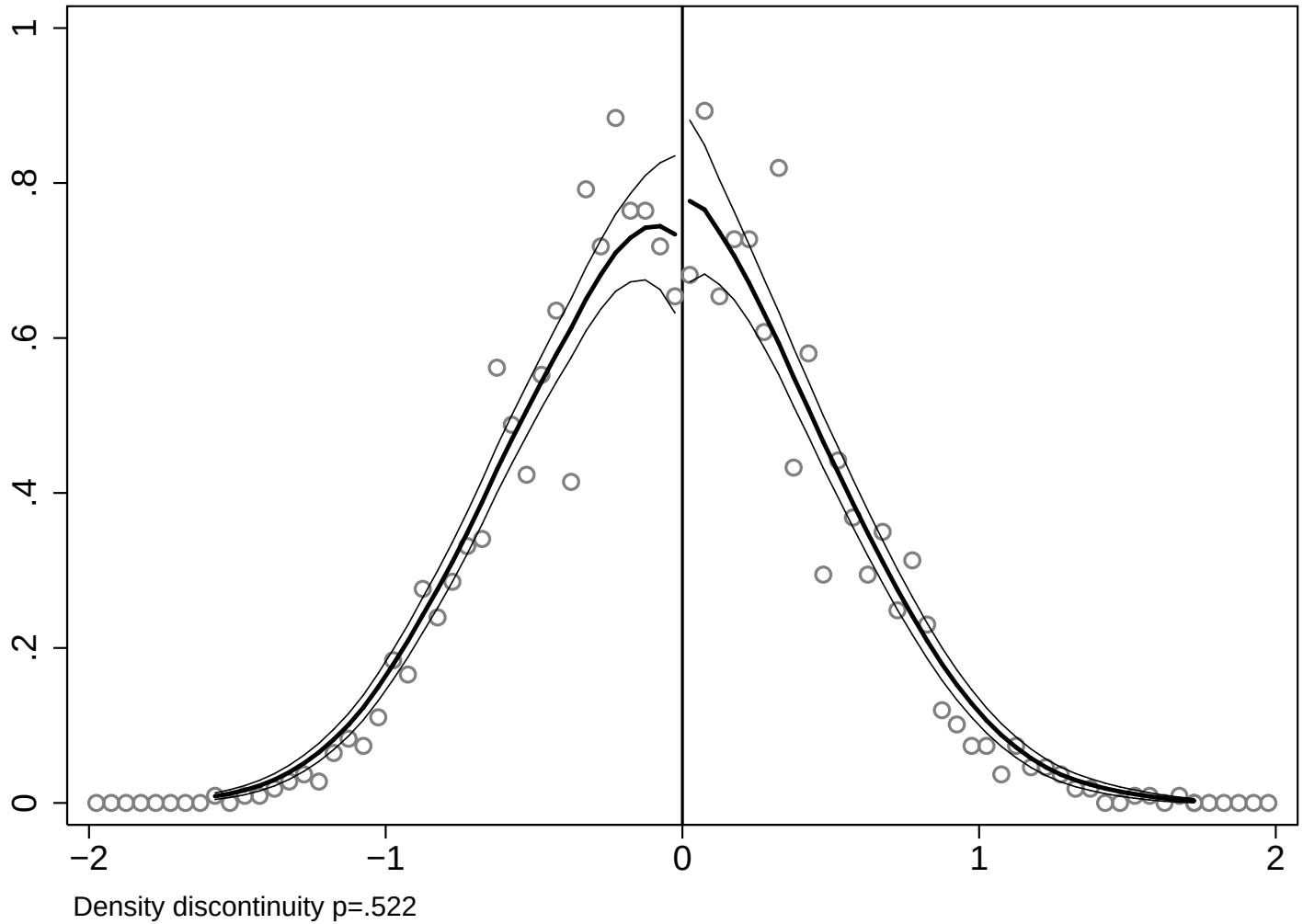
Confirmed first score distribution



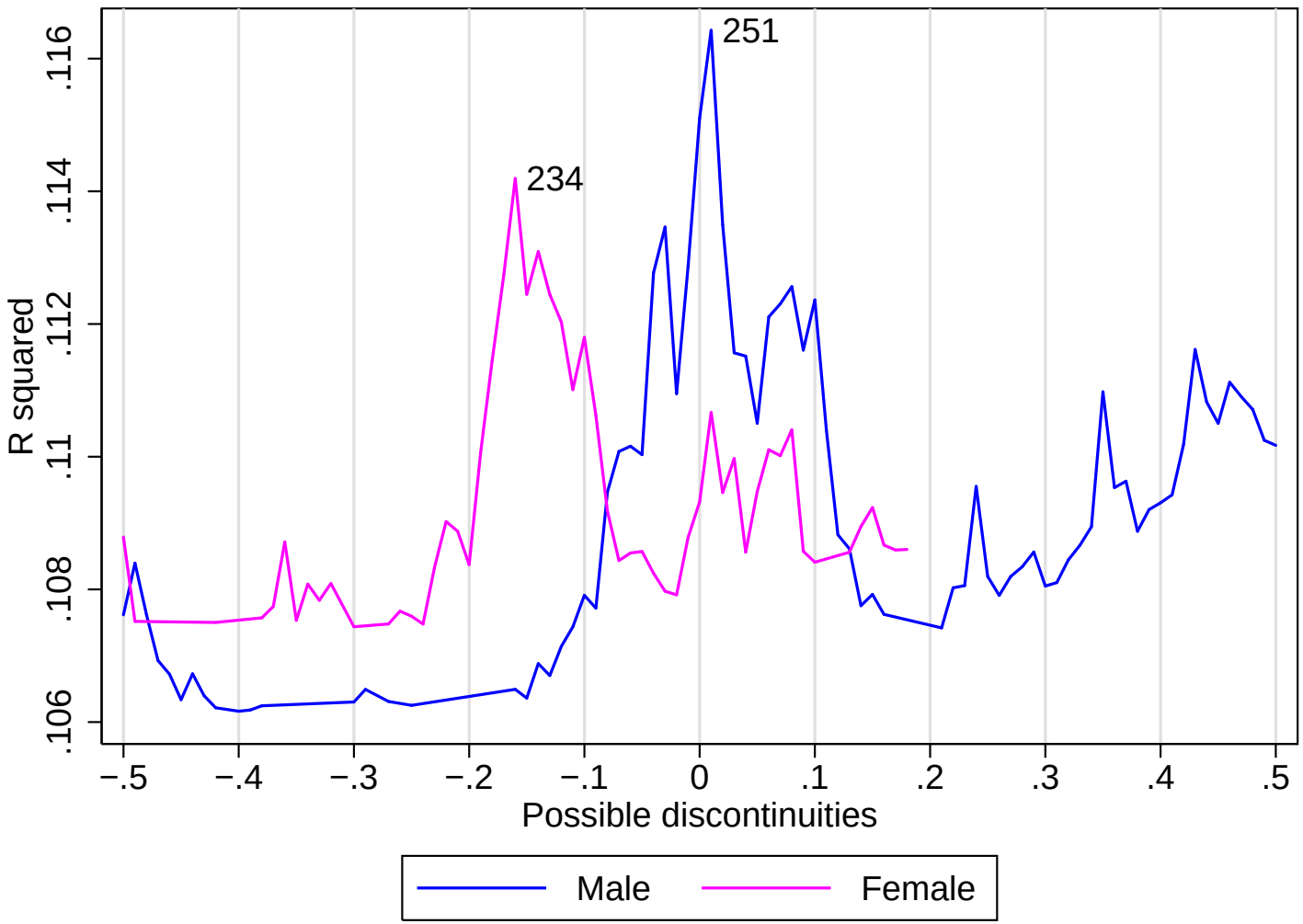
KLPS2 data, N=2167, restricted to confirmed first KCPE scores

Confirmed first score distribution: McCrary manipulation test



Generated using the routine developed by McCrary (2008).

Card-Mas-Rothstein (structural break) discontinuity search



Kane (2003), Chay, McEwan, and Urquiola (2005), inter alia

Re-centered first stage regressions

Center womens' scores at 234, mens' at 251:

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Outcome: Four years of secondary schooling

Regressors:	**Self-reported**	**Confirmed first scores**		
	(1)	(2)	(3)	(4)
KCPE $\geq$ cutoff	0.1^{***}	0.153^{***}	0.17^{***}	0.129^{***}
	(0.023)	(0.031)	(0.043)	(0.049)
KCPE centered at cutoff	0.181^{***}	0.282^{***}	0.325^{***}	0.218^{***}
	(0.04)	(0.035)	(0.048)	(0.056)
(KCPE $\geq$ cutoff) $\times$ KCPE	0.161^{***}	0.015	-0.082	0.161^{*}
	(0.05)	(0.055)	(0.069)	(0.09)
Female	-0.108^{***}	-0.1^{***}	.	.
	(0.017)	(0.02)		
Constant	0.233^{***}	0.382^{***}	0.392^{***}	0.265^{***}
	(0.018)	(0.023)	(0.031)	(0.031)
Restriction	.	.	Male	Female
Discontinuity F-stat	18.356	24.550	15.921	6.973
Observations	3305	2167	1203	964
R^2	0.132	0.193	0.192	0.168

First stage (Fan regression): appropriate bandwidth / polynomial order?

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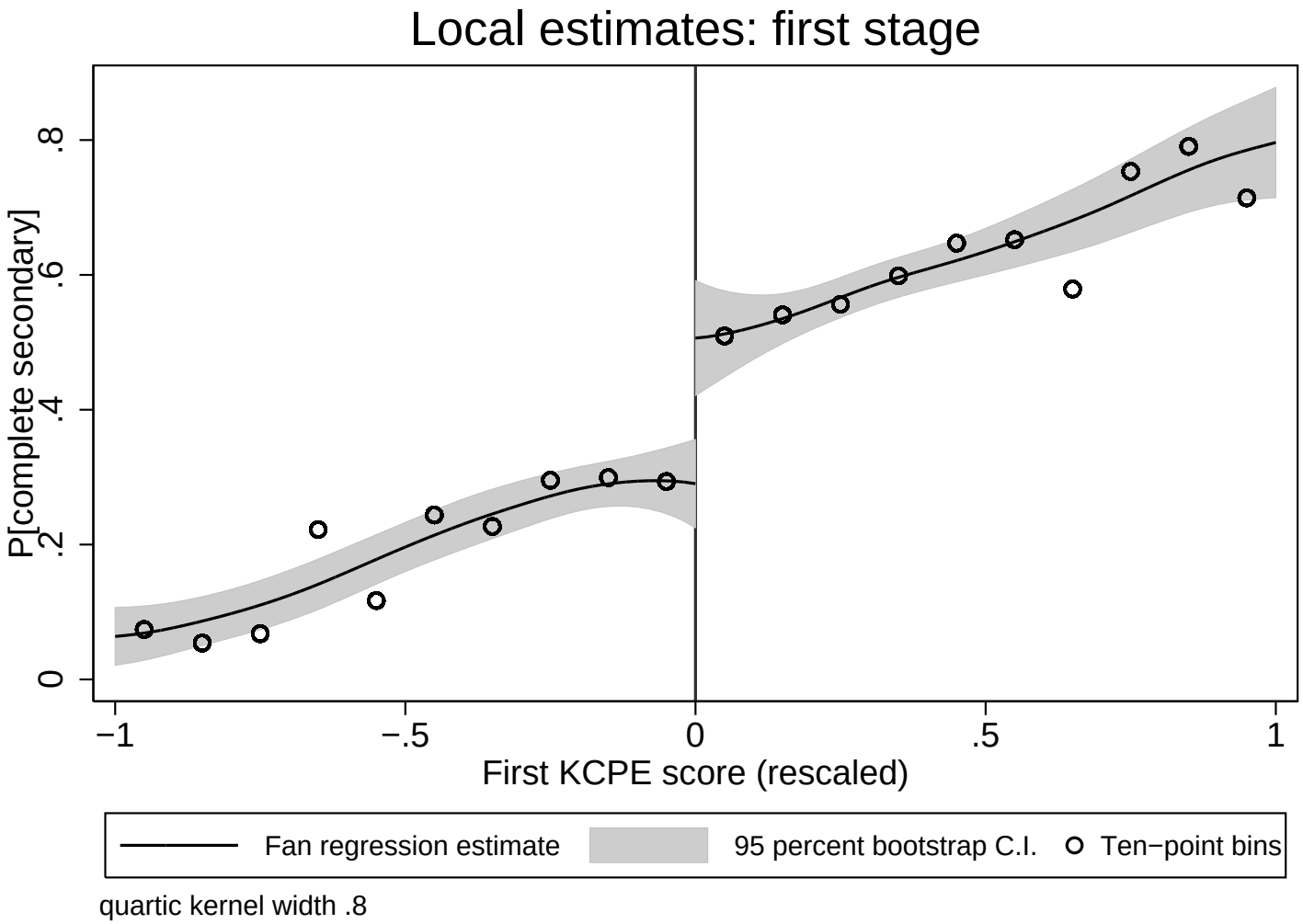
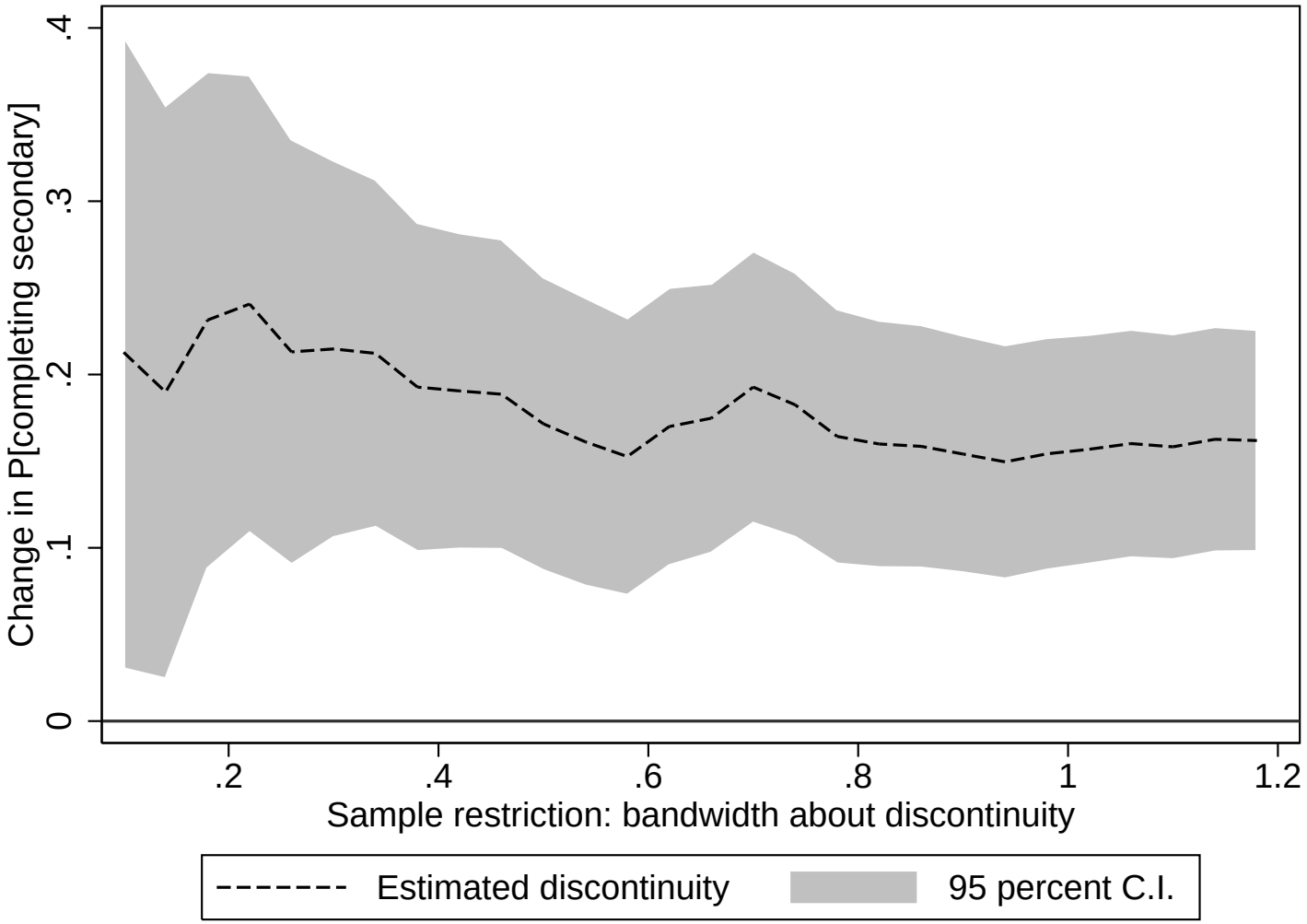


Discontinuity as a function of bandwidth



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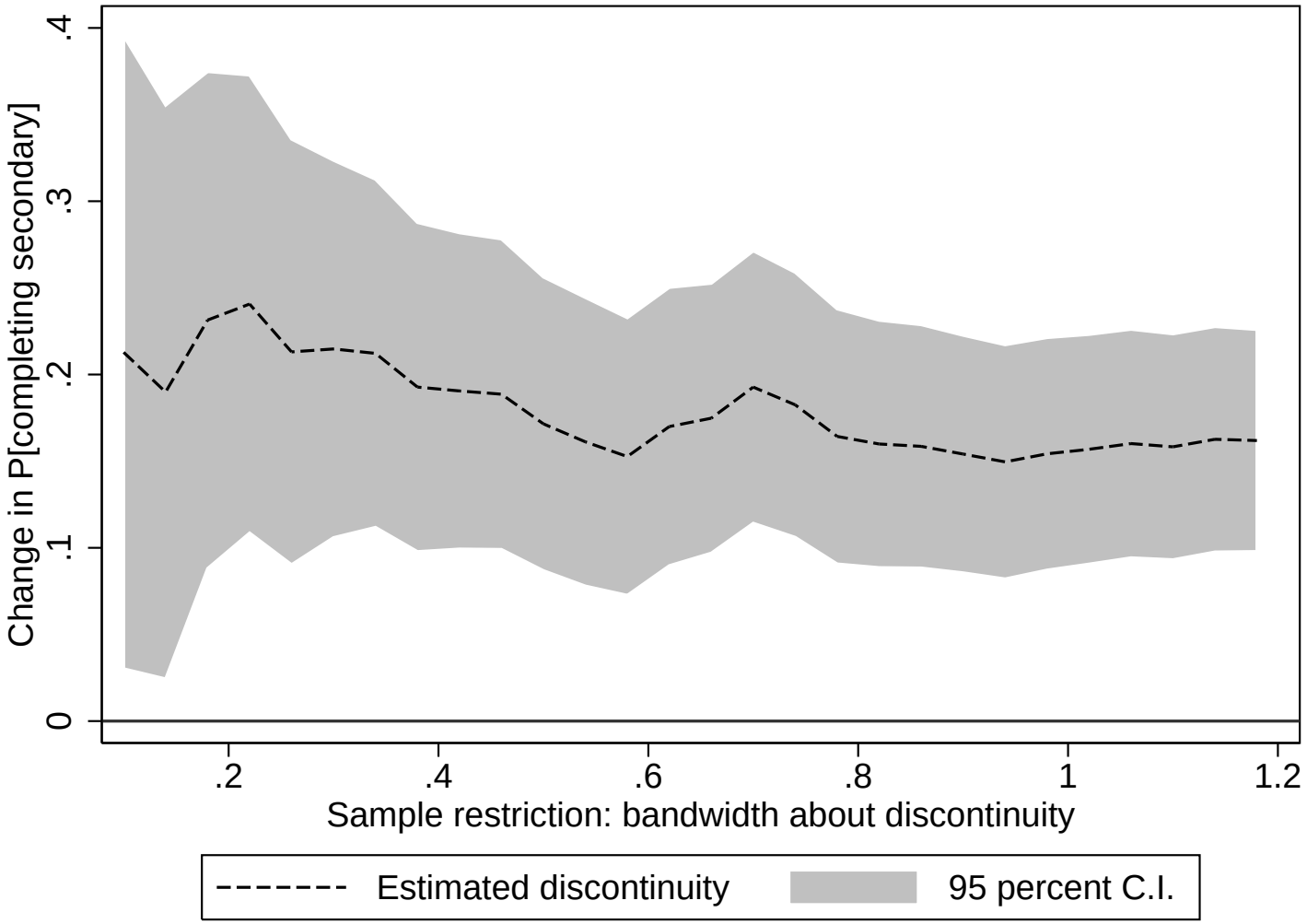

Tradeoff between power and potential misspecification.

Polynomial order, controls

Outcome: Four years of secondary schooling; sample restriction 0 ± 0.8

	(1)	(2)	(3)	(4)	(5)	(6)
KCPE $\geq$ cutoff	0.16***	0.17***	0.17***	0.21***	0.16***	0.12*
	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)	(0.07)
KCPE centered at cutoff	0.27***	0.07	0.3***	0.07	0.24***	0.06
	(0.06)	(0.18)	(0.09)	(0.31)	(0.08)	(0.26)
(KCPE $\geq$ cutoff) $\times$ KCPE	0.02	0.19	-0.02	-0.03	-0.006	0.5
	(0.09)	(0.3)	(0.11)	(0.41)	(0.14)	(0.48)
Constant	0.33***	0.41***	0.39***	0.38**	0.27***	0.32
	(0.02)	(0.14)	(0.04)	(0.18)	(0.04)	(0.19)
Restriction	.	.	Male	Male	Female	Female
Piecewise Quadratic	No	Yes	No	Yes	No	Yes
Controls	No	Yes	No	Yes	No	Yes
Discontinuity F-stat	19.46	14.86	11.13	10.92	7.50	2.71
Observations	1943	1943	1064	1064	879	879
R^2	0.14	0.23	0.14	0.24	0.12	0.2

Controls: age, gender, parents' education, cohort dummies.

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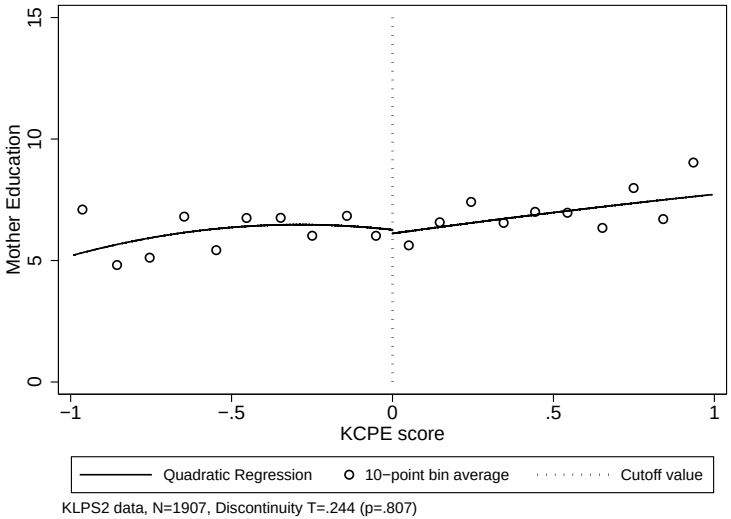
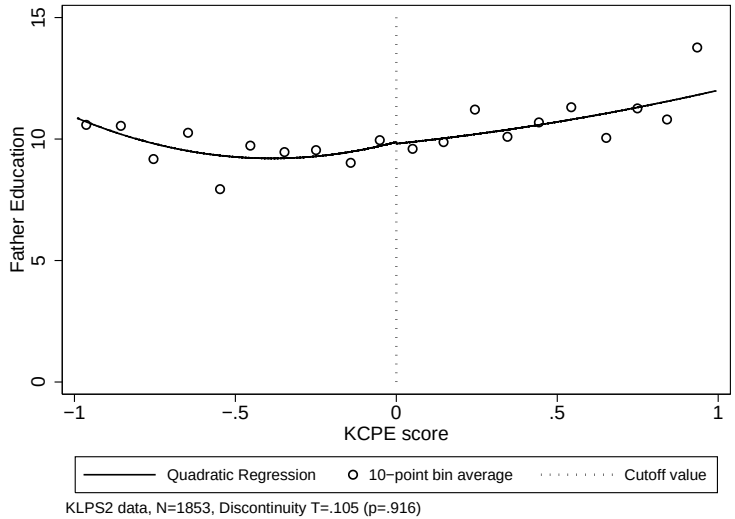
AIC suggests the piecewise linear specification is best for this and a range of other similar window sizes.

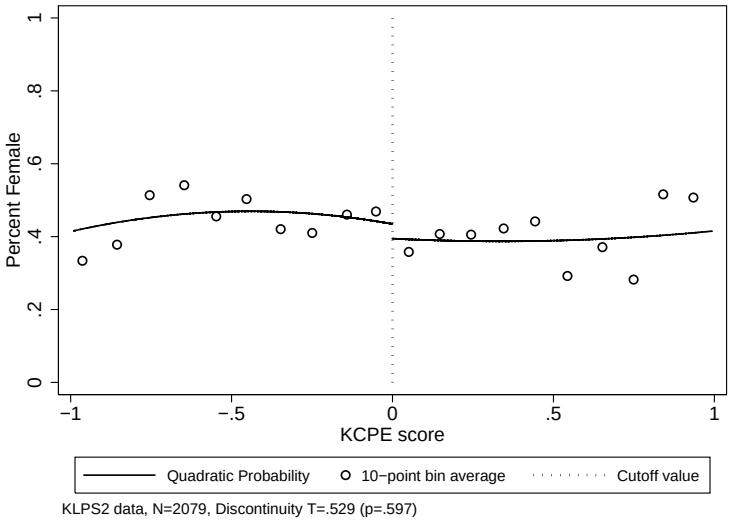
Validity: smooth regressors at discontinuity



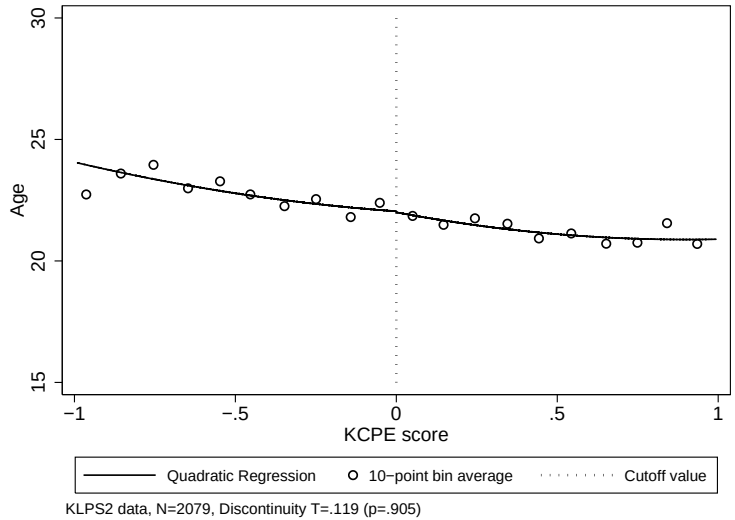
KLPS2 data, N=1907, Discontinuity T=.244 (p=.807)



KLPS2 data, N=1853, Discontinuity T=.105 (p=.916)

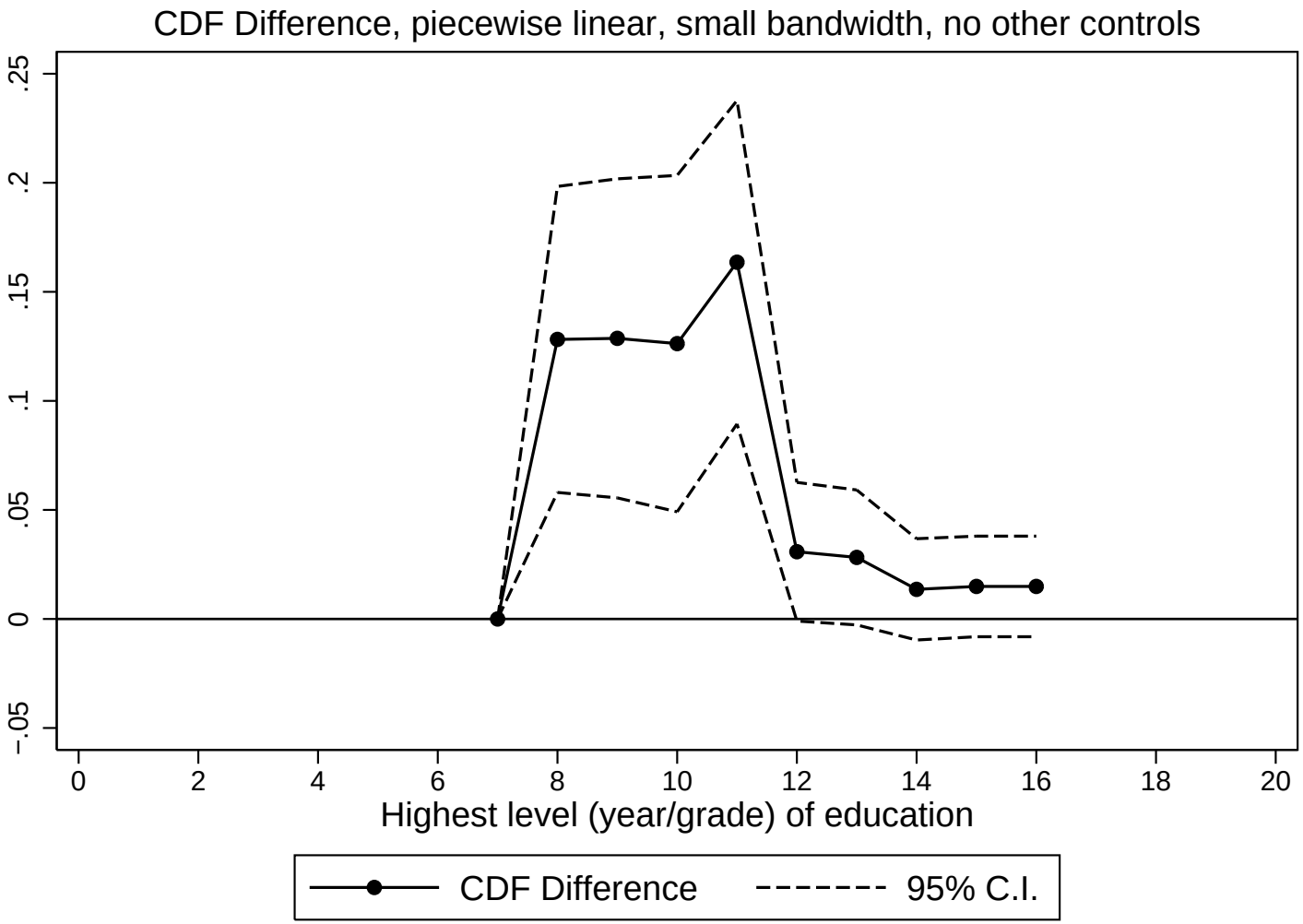


KLPS2 data, N=2079, Discontinuity T=.529 (p=.597)

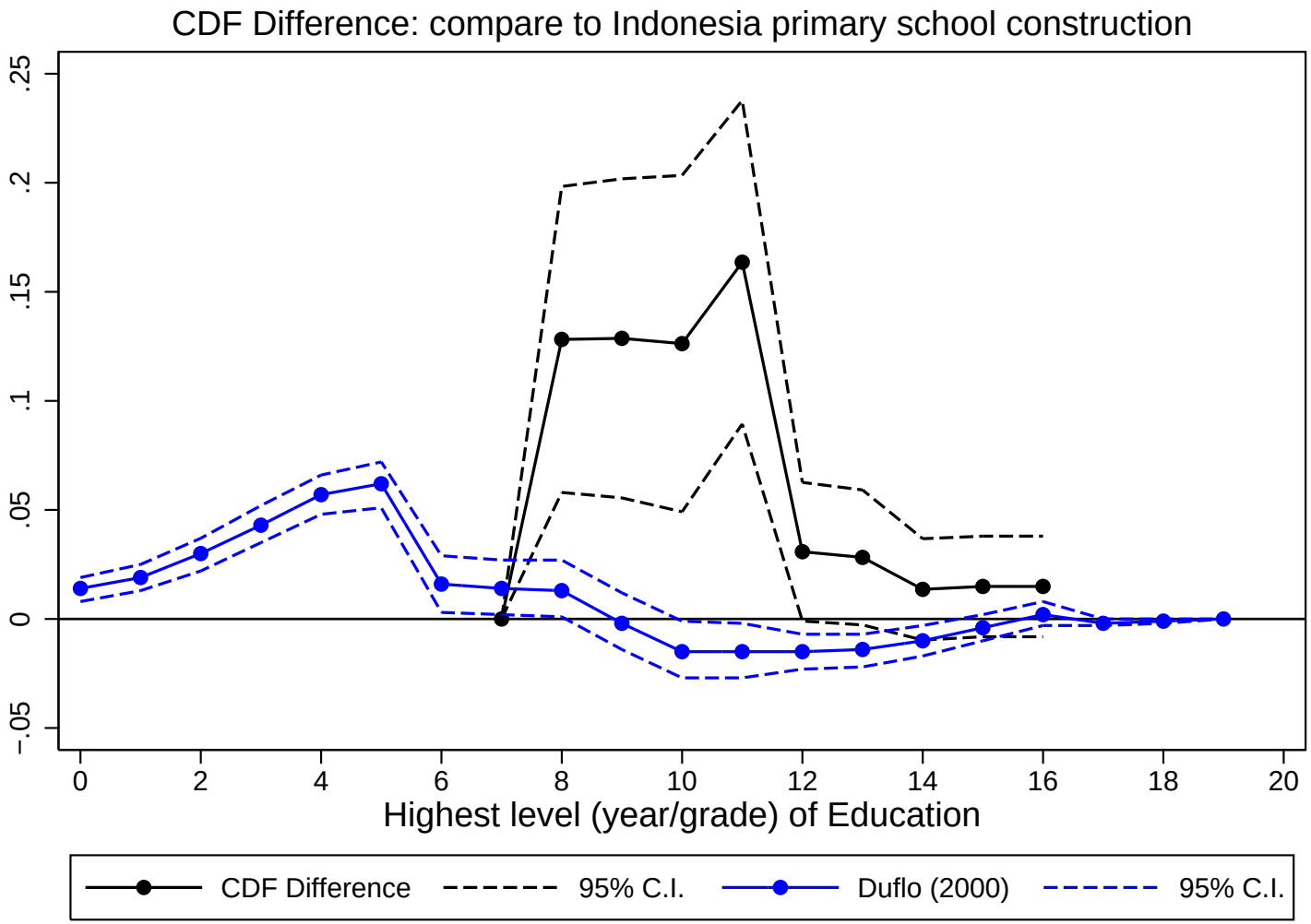


KLPS2 data, N=2079, Discontinuity T=.119 (p=.905)

CDF difference in years of educational attainment



CDF difference in years of educational attainment - compare Duflo (2000)



Data: Summary statistics, restricted to KCPE scores inside ±0.8 window

Characteristic	Mean	Std. Dev.	N
Panel C: Outcome variables			
Vocabulary test (standardized)	0.55	(0.69)	1923
Raven's matrices (standardized)	0.35	(0.91)	1904
Standardized vocabulary + Raven's	0.51	(0.76)	1904
Still attending school | male	0.33	(0.47)	1058
Still attending school | male, oldest two cohorts	0.13	(0.34)	375
Formally employed | male	0.21	(0.41)	1058
Formally employed | male, oldest two cohorts	0.34	(0.47)	375
Self-employed (non-farm) | male	0.10	(0.30)	1058
Self-employed (non-farm) | male, oldest two cohorts	0.16	(0.37)	375
Pregnant by 18 | female, at least 18 years old	0.09	(0.29)	853
First child survival | female	0.94	(0.23)	356

Empirical Strategy

Empirical Strategy

- OLS:

$$Y_i = \pi_0 + \pi_1 Sec_i + \pi_2 K_i + \pi_3 X_i + \varepsilon_i \quad (1)$$

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$$\tau_{FRD} = \frac{\lim_{k \downarrow c} E[Y|K=k] - \lim_{k \uparrow c} E[Y|K=k]}{\lim_{k \downarrow c} E[Sec|K=k] - \lim_{k \uparrow c} E[Sec|K=k]} \tag{2}$$

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- RD is equivalent to IV (2SLS) when bandwidths and polynomial orders are the same across both equations (Imbens and Lemieux J.Econometrics 2008; Lee and Lemieux JEL 2010)

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Binary outcomes: IV Probit may be appropriate when first stage is linear but second is not; is not consistent if first stage is also nonlinear.

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Bivariate Probit (Maddala 1983, Wooldridge 2002, Greene 2007, etc.):

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$$\begin{bmatrix} \tau_i \\ \omega_i \end{bmatrix} \sim \mathcal{N}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix}\right) \tag{5}$$

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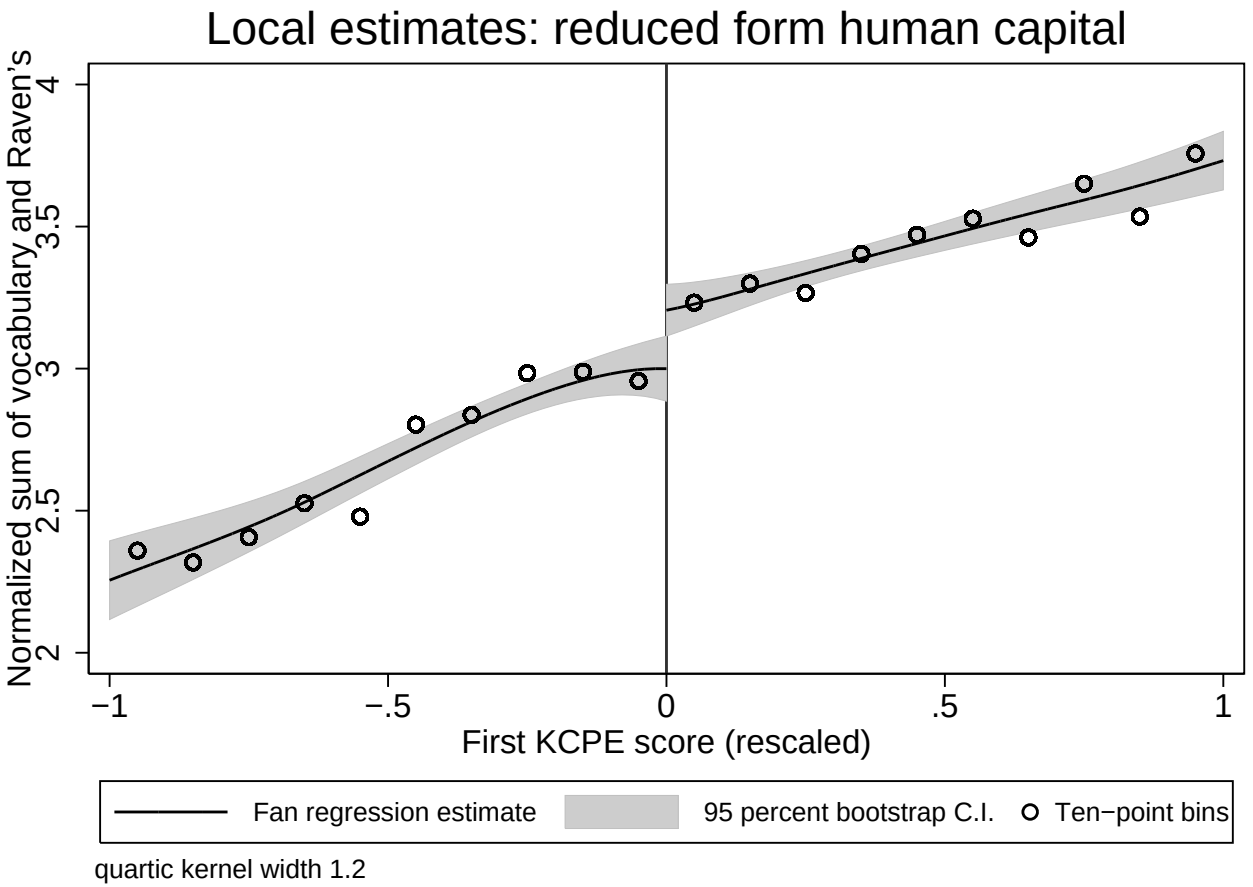
Simulations suggest that IV probit and bivariate probit have better power than 2SLS; while Wald tests for bivariate probit may be slightly incorrectly sized in small samples, likelihood ratio tests appear correctly sized.

Human Capital I

Outcome:	**Mean effect, vocabulary and Raven's Matrices**				**Vocabulary**	**Raven's**
	OLS	2SLS	OLS	2SLS	2SLS	2SLS
Completing Std 12	0.612***	0.67**	0.584***	0.595**	0.644**	0.399
	(0.032)	(0.282)	(0.033)	(0.301)	(0.275)	(0.433)
KCPE centered at cutoff	0.663***	0.637***	0.607***	0.602***	0.608***	0.447*
	(0.085)	(0.168)	(0.086)	(0.17)	(0.16)	(0.232)
(KCPE $\geq$ cutoff) $\times$ KCPE	-0.311**	-0.311**	-0.302**	-0.302**	-0.468***	-0.061
	(0.127)	(0.127)	(0.124)	(0.123)	(0.112)	(0.175)
Female	-0.19***	-0.183***	-0.222***	-0.22***	-0.136***	-0.25***
	(0.029)	(0.042)	(0.03)	(0.051)	(0.047)	(0.073)
Constant	2.980***	2.953***	3.675***	3.669***	3.550***	2.877***
	(0.031)	(0.14)	(0.204)	(0.274)	(0.219)	(0.389)
Controls	No	No	Yes	Yes	Yes	Yes
Discontinuity F-stat	.	20.496	.	23.050	23.050	23.050
Observations	1923	1923	1923	1923	1923	1923
R^2	0.331	0.33	0.345	0.345	0.404	0.153

Note: OLS without KCPE control = 1.226, SD=0.027 (Vocabulary 1.272, Raven's 0.884)

Human capital: local linear regression



Human Capital II - older cohorts

Outcome:	**Mean effect, vocabulary and Raven's Matrices**				**Vocabulary**	**Raven's**
	OLS	2SLS	OLS	2SLS	2SLS	2SLS
Completing Std 12	0.689***	0.685*	0.648***	0.62	0.958**	0.129
	(0.049)	(0.385)	(0.05)	(0.429)	(0.379)	(0.569)
KCPE centered at cutoff	0.653***	0.655***	0.622***	0.634***	0.475**	0.636**
	(0.128)	(0.254)	(0.126)	(0.226)	(0.219)	(0.284)
(KCPE $\geq$ cutoff) $\times$ KCPE	-0.122	-0.122	-0.117	-0.119	-0.359*	0.151
	(0.214)	(0.218)	(0.21)	(0.212)	(0.196)	(0.275)
Female	-0.191***	-0.191***	-0.21***	-0.214**	-0.1	-0.276**
	(0.047)	(0.071)	(0.048)	(0.088)	(0.074)	(0.119)
Constant	2.933***	2.935***	3.431***	3.481***	2.827***	3.271***
	(0.059)	(0.226)	(0.353)	(0.861)	(0.708)	(1.190)
Controls	No	No	Yes	Yes	Yes	Yes
Discontinuity F-stat	.	10.783	.	9.041	9.041	9.041
Observations	693	693	693	693	693	693
R^2	0.42	0.42	0.428	0.428	0.452	0.184

Human Capital III - not a decay story

Is there a decline of this human capital measure after leaving school?

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Outcome:	**Mean effect, Vocabulary and Raven's Matrices**			
Restriction:	Left school at 8th grade All six cohorts		Left school at 8th grade Younger four cohorts	
Years since last in school	0.016**	0.058***	0.026*	0.094***
	(0.008)	(0.016)	(0.014)	(0.02)
Female	.	-0.267***	.	-0.28***
		(0.039)		(0.053)
Constant	-0.298***	1.180***	-0.353***	1.299***
	(0.048)	(0.249)	(0.063)	(0.366)
Controls	No	Yes	No	Yes
Observations	1419	1419	819	819
R^2	0.003	0.056	0.004	0.069

Self-Employment I

	P[Self-employed]			
	OLS	OLS	2SLS	2SLS
Completing Std 12	-0.104***	-0.12**	-0.502*	-0.601*
	(0.04)	(0.049)	(0.273)	(0.359)
KCPE centered at cutoff	-0.169	-0.168	0.043	0.009
	(0.111)	(0.114)	(0.217)	(0.204)
(KCPE≥cutoff)×KCPE	0.212	0.212	0.181	0.19
	(0.185)	(0.184)	(0.207)	(0.207)
Constant	0.182***	0.153	0.403**	1.042
	(0.043)	(0.284)	(0.17)	(0.764)
Controls	No	Yes	No	Yes
Discontinuity F-stat	.	.	9.031	5.986
Observations	378	378	378	378
R^2	0.038	0.051	.	.

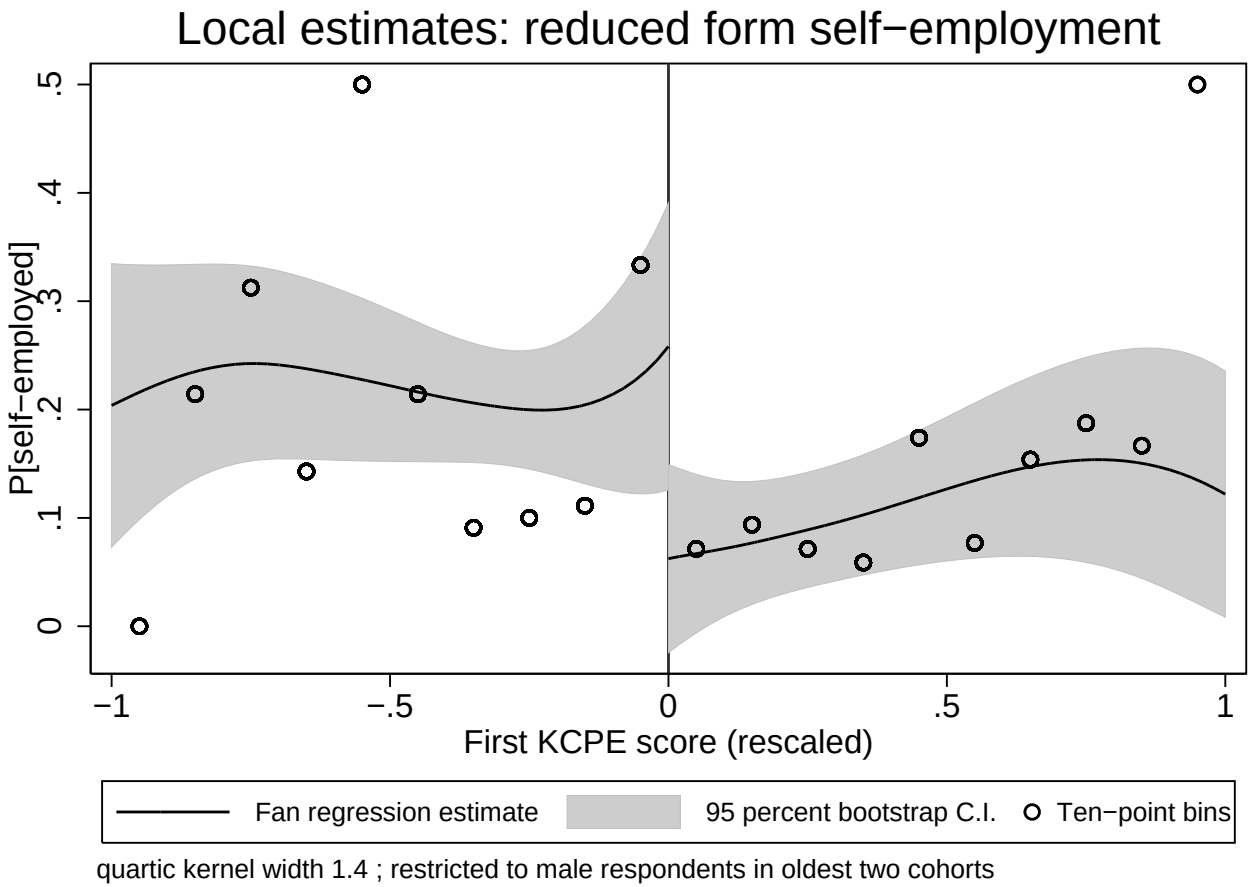
(Restriction: male, oldest two cohorts)
Note: OLS without KCPE control = -0.127, SD=0.037

Self-Employment II

Outcome	Estimation							
	(1) OLS	(2) OLS	(3) IVP	(4) IVP	(5) BVP	(6) BVP	(7) 2SLS	(8) 2SLS
P[Self-employed]	-0.104***	-0.12**	-0.459***	-0.516***	-0.464***	-0.347**	-0.502*	-0.601*
	(0.040)	(0.049)	(0.092)	(0.103)	(0.147)	(0.136)	(0.273)	(0.359)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Discontinuity F-stat	.	.	9.031	5.986	9.031	5.986	9.031	5.986
Observations	378	378	378	378	378	378	378	378

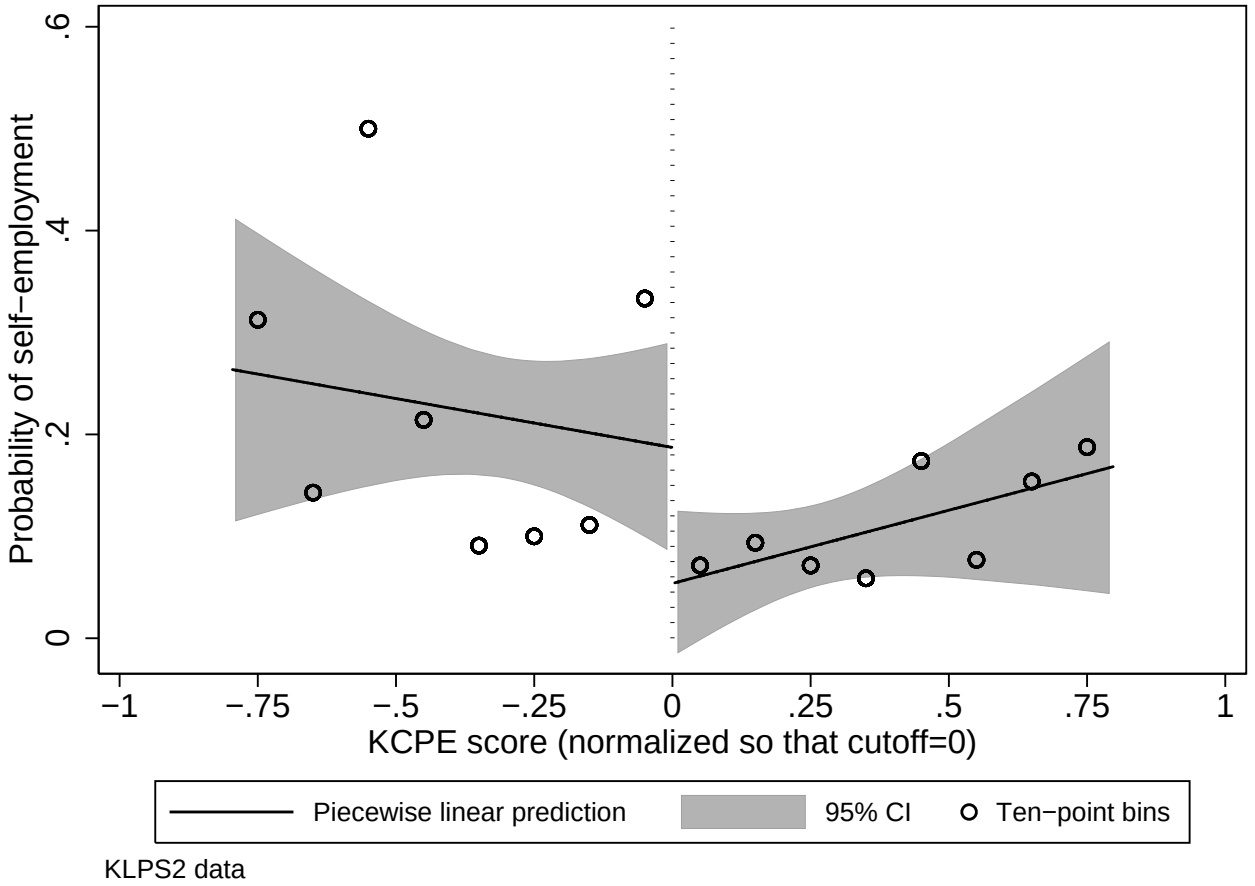
(Only coefficient on secondary schooling is shown.)

Self-employment: local linear regression



quartic kernel width 1.4 ; restricted to male respondents in oldest two cohorts

Self-employment: reduced form

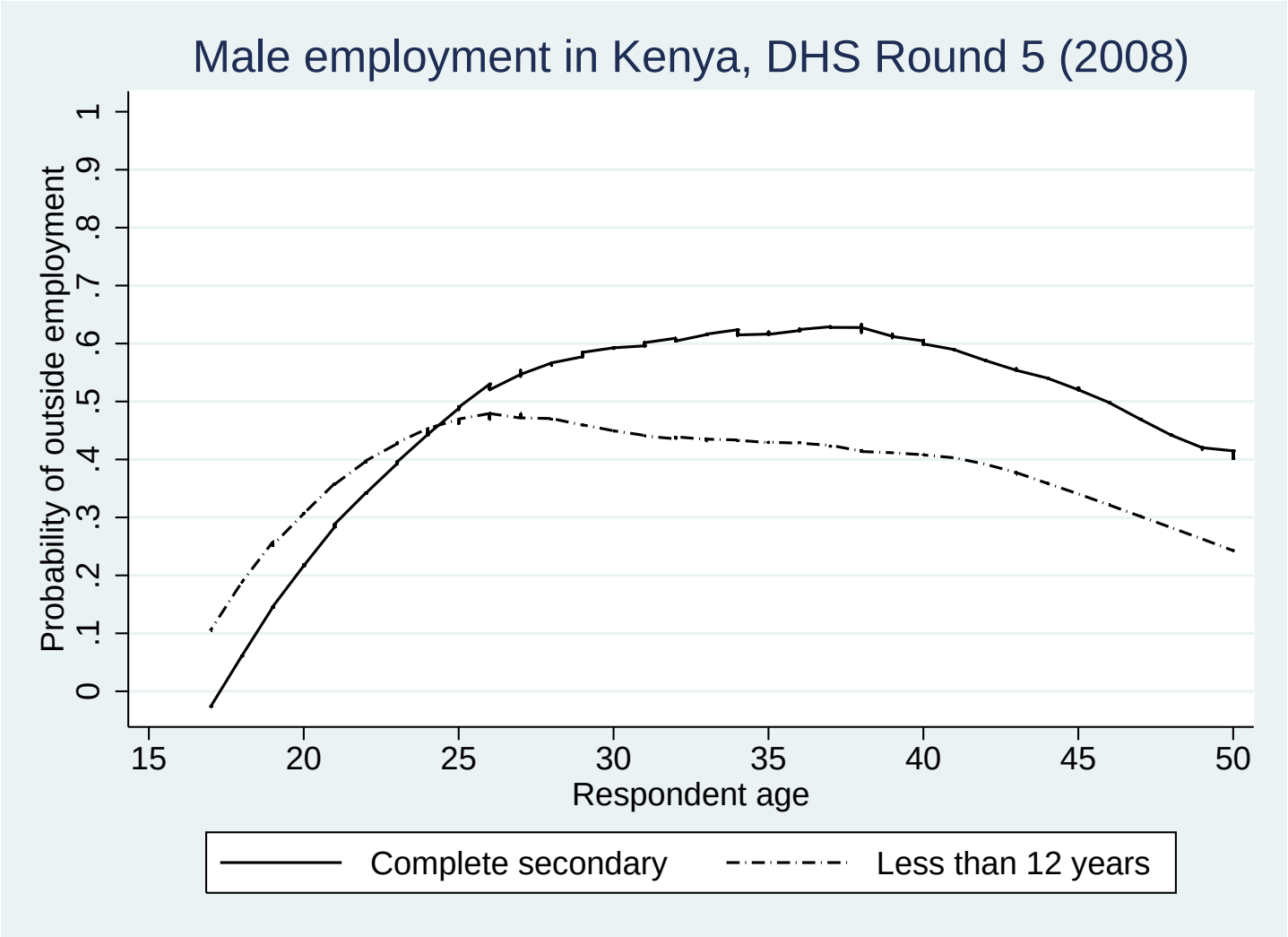


KLPS2 data

Shift away from self-employment

Shift from low-skill to higher-skill occupations

Employment by age in Kenya



Employment I

	P[Employed]			
	OLS	OLS	2SLS	2SLS
Completing Std 12	-0.032	-0.054**	0.083	0.216
	(0.028)	(0.026)	(0.288)	(0.269)
KCPE centered at cutoff	-0.016	0.113	-0.072	-0.022
	(0.072)	(0.073)	(0.163)	(0.165)
(KCPE≥cutoff)×KCPE	-0.085	-0.119	-0.08	-0.102
	(0.113)	(0.11)	(0.116)	(0.118)
Constant	0.244***	-0.936***	0.189	-0.923***
	(0.027)	(0.11)	(0.143)	(0.115)
Controls	No	Yes	No	Yes
Discontinuity F-stat	.	.	11.126	11.952
Observations	1064	1064	1064	1064
R^2	0.007	0.106	.	0.016

(Restriction: male)

Note: OLS without KCPE control = -0.050, SD=0.025

Employment II

	P[Employed]			
	OLS	OLS	2SLS	2SLS
Completing Std 12	-0.036	0.036	0.291	0.549
	(0.055)	(0.058)	(0.352)	(0.486)
KCPE centered at cutoff	0.116	0.195	-0.059	0.006
	(0.133)	(0.137)	(0.233)	(0.236)
(KCPE$\geq$cutoff)$\times$KCPE	-0.262	-0.27	-0.236	-0.247
	(0.224)	(0.225)	(0.234)	(0.252)
Constant	0.405***	-0.761**	0.223	-1.710*
	(0.054)	(0.329)	(0.197)	(0.989)
Controls	No	Yes	No	Yes
Discontinuity F-stat	.	.	9.031	5.986
Observations	378	378	378	378
R^2	0.005	0.054	.	.

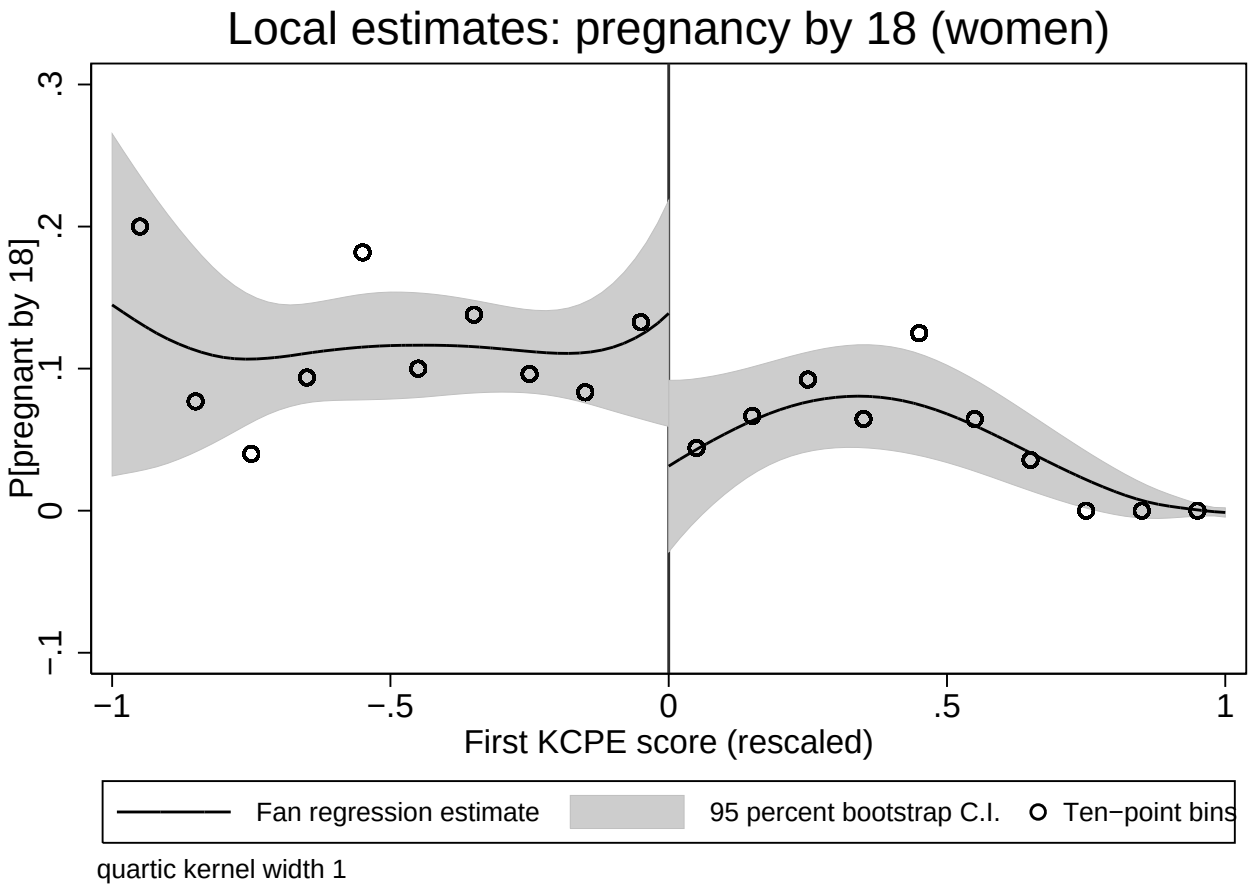
(Restriction: male, oldest two cohorts)
Note: OLS without KCPE control = -0.039, SD=0.049

Employment III

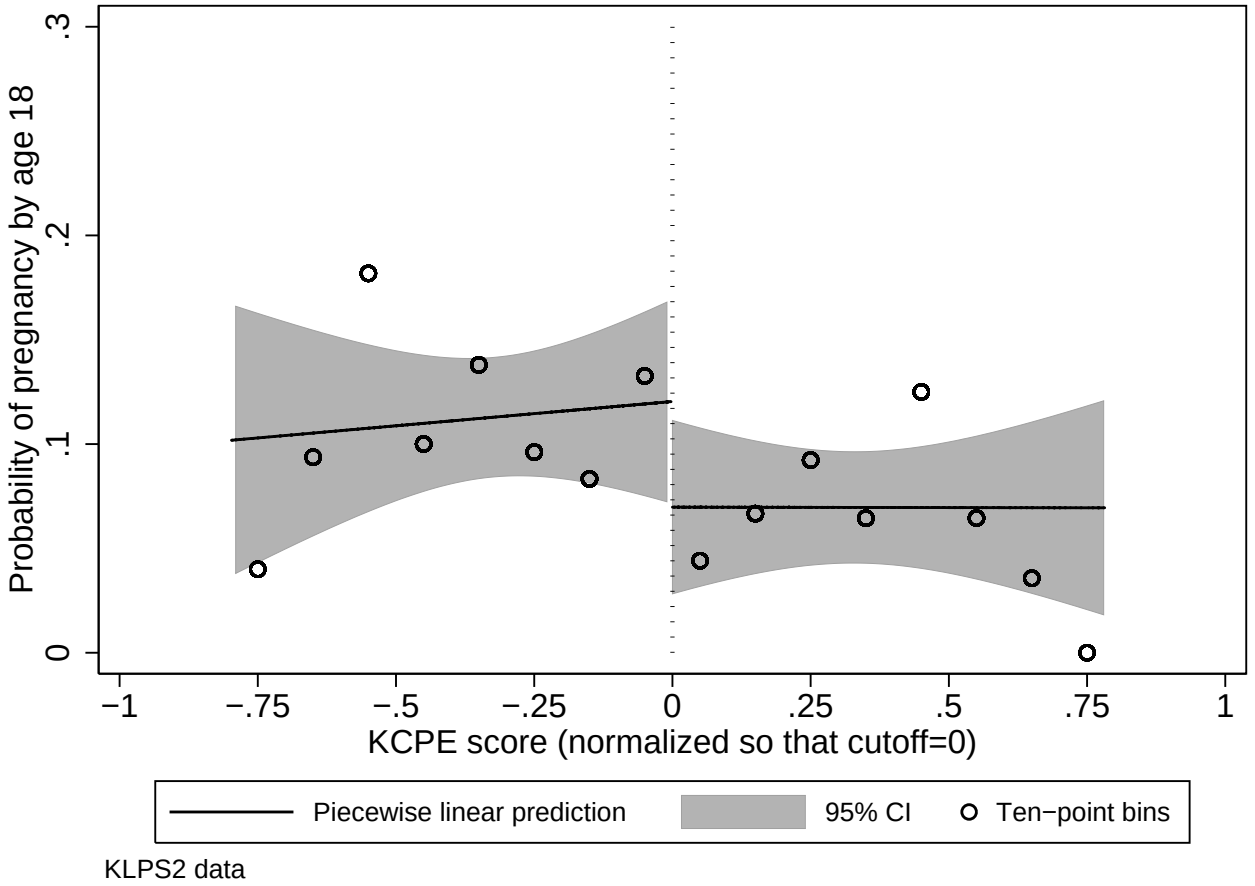
Outcome	**Estimation**							
	(1) OLS	(2) OLS	(3) IVP	(4) IVP	(5) BVP	(6) BVP	(7) 2SLS	(8) 2SLS
P[Formally employed]	-0.036	0.036	0.263	0.427**	0.240	0.359**	0.291	0.549
	(0.055)	(0.058)	(0.253)	(0.216)	(0.192)	(0.171)	(0.352)	(0.486)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Discontinuity F-stat	.	.	9.031	5.986	9.031	5.986	9.031	5.986
Observations	378	378	378	378	378	378	378	378

(Only coefficient on secondary schooling is shown.)

Pregnancy by 18: local estimates



Pregnancy by 18: reduced form



KLPS2 data

Fertility: pregnancy I

	Pregnancy by Age 18			
	OLS		2SLS	
Completing Std 12	-0.119***	-0.138***	-0.333	-0.389
	(0.02)	(0.022)	(0.238)	(0.286)
KCPE centered at cutoff	0.022	0.006	0.108	0.098
	(0.054)	(0.058)	(0.116)	(0.128)
(KCPE≥cutoff)×KCPE	-0.029	0.005	-0.014	0.033
	(0.083)	(0.089)	(0.089)	(0.095)
Constant	0.139***	0.621***	0.214**	0.895**
	(0.022)	(0.188)	(0.089)	(0.35)
Controls	No	Yes	No	Yes
Discontinuity F-stat	.	.	6.993	5.589
Observations	853	853	853	853
R^2	0.037	0.063	.	.

(Restriction: Female, at least 18 years old)
Note: OLS without KCPE control = -0.117, SD=0.020

Fertility: pregnancy II

Outcome	**Estimation**							
	(1) OLS	(2) OLS	(3) IVP	(4) IVP	(5) BVP	(6) BVP	(7) 2SLS	(8) 2SLS
P[Pregnant by 18]	-0.119***	-0.138***	-0.454	-0.583***	-0.199**	-0.184	-0.333	-0.389
	(0.020)	(0.022)	(0.300)	(0.191)	(0.086)	(0.123)	(0.238)	(0.286)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Discontinuity F-statistic	.	.	6.993	5.589	6.993	5.589	6.993	5.589
Observations	853	853	853	853	853	853	853	853

(Restriction: Female, at least 18 years old. Only coefficient on secondary schooling is shown.)

Conclusions

Secondary schooling causes (RD framework):

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Labor market

Human capital gain, commensurate with OLS

Contrast with Lucas and Mbiti (2010), Filmer and Schady (2014)

Drop in self-employment as a young adult

Suggestive: Rise in employment

Consistent with a simple model of labor market decisions

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KLPS3: labor and fertility decisions later in life.

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For other researchers

Possible design: highlights combination of survey and administrative data.

End