

The Long Run Effects of Funding for Public Education: Evidence from Land Grants

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Today's talk:

Research Questions:

- Do differential endowment shocks for local public schools matter for the long run development of locations (1860-1940)?
- Do effects operate through changing inhabitants' human capital or through selective migration?

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- Quasi-experiment: Townships with same natural resources get different endowments

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Preview of results:

- School-poor townships: lower population levels and slower occupational transformation
- Effects driven partly by lack of attracting new settlers and local brain drain

Outline

1 Setting

2 Data

3 Empirical Strategy

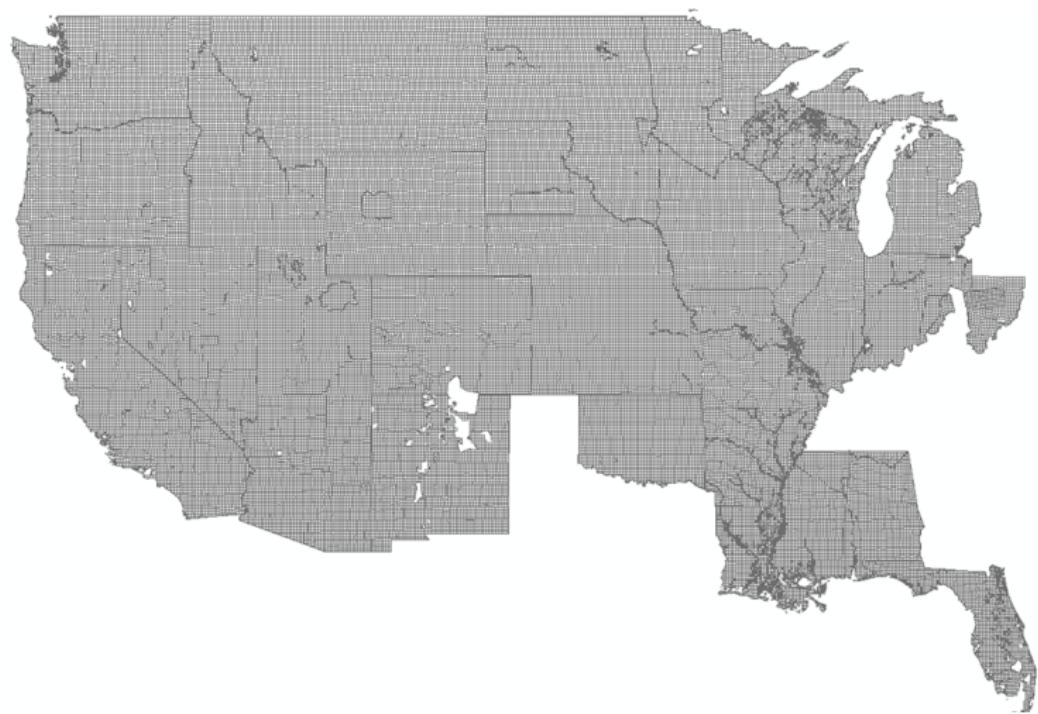
- Effect on schooling outcomes
- Assessing bias for systematic ME
- Proxy historical flood: Levees
- IV: elevation differentials

4 Results: Local economic structure

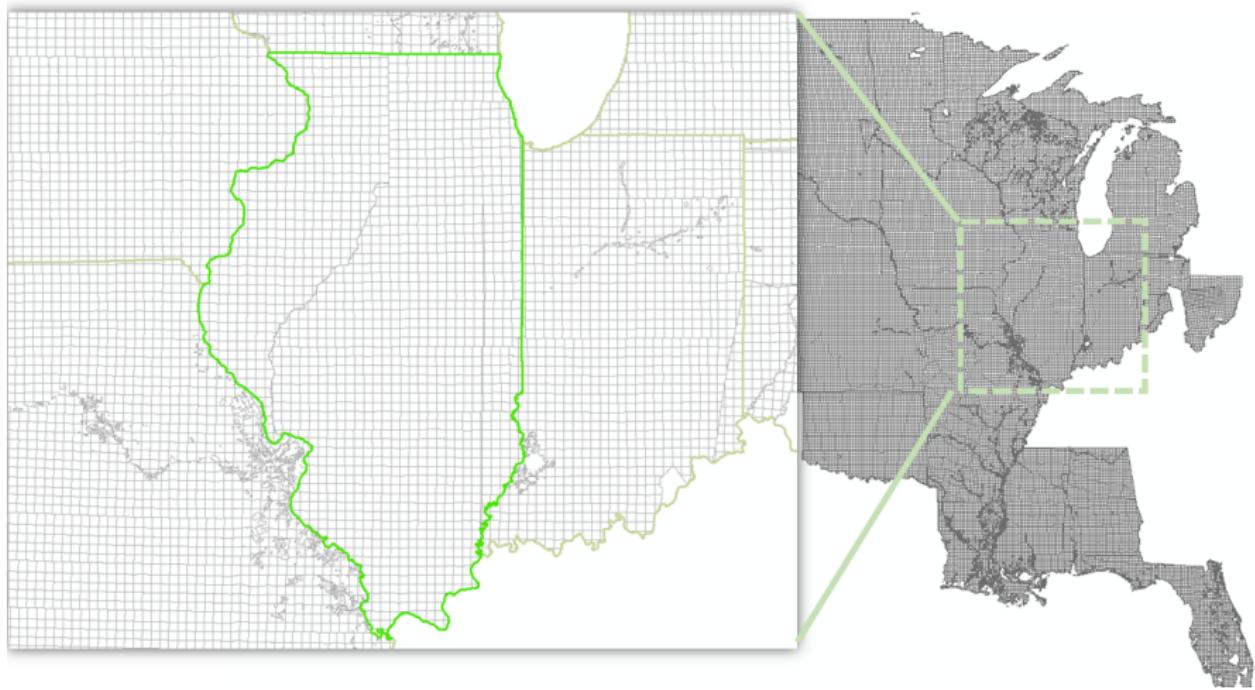
5 Results: Migration patterns

- Township level: arrivals
- Matched sample: departures

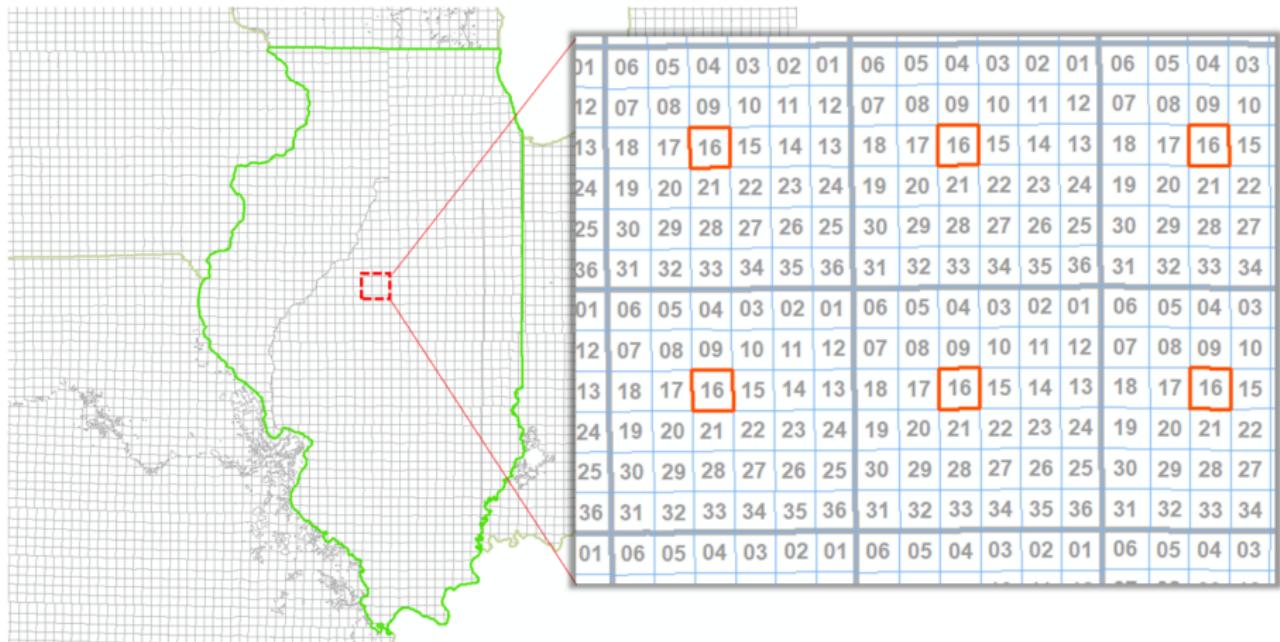
Northwest Ordinance, 1785



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Historic Setting

School endowments in practice

- Two policies: Township vs. state ownership of Section 16 (s16)
- Revenues from renting or selling land on s16 (endowment aspect)
- Township-owner system: OH, LA, MO, IL, AL, MS, AR

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Knight, 1858:

“The policy of setting aside a section in each township for schools, regardless of the character of the land, gave rise to inequalities”

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“The policy of setting aside a section in each township for schools, regardless of the character of the land, gave rise to inequalities”

“In many instances the section fell upon poor or worthless land ... So long as each township derived its sole government support for learning from its own reserved section, **the quality of the land was an important element in determining the character of the schools in the township.** ...

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Many attempts were made to induce Congress to allow townships having an inferior section to exchange it for better land. Congress ... declined to take a step.”

Early settlers and their schools in IL:

Public education in IL:

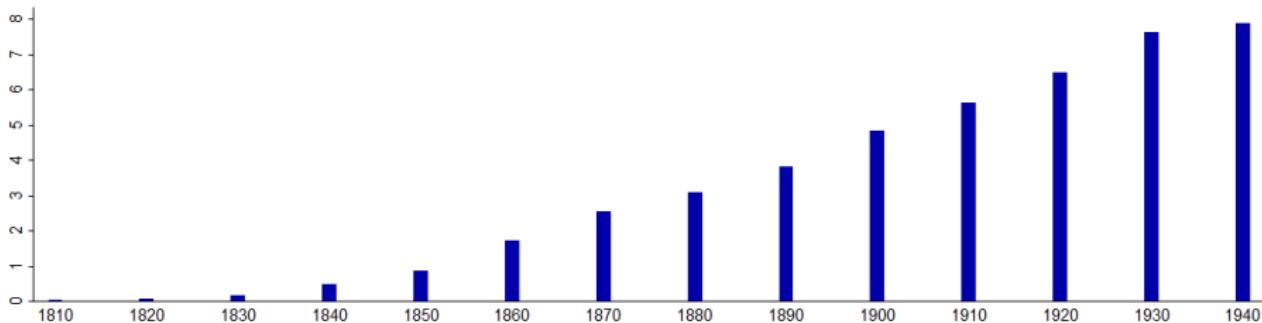
- 1818: Statehood
- 1832: Congress allows sale of s16
- 1855: Free school law and state wide tax
 - share of school expenditures covered by “township fund” drops from ≈ 40% in 1854 to ≈ 10% in 1858
- by 1882: > 99% of s16 lands sold or leased



SCHOOL-HOUSE 1870

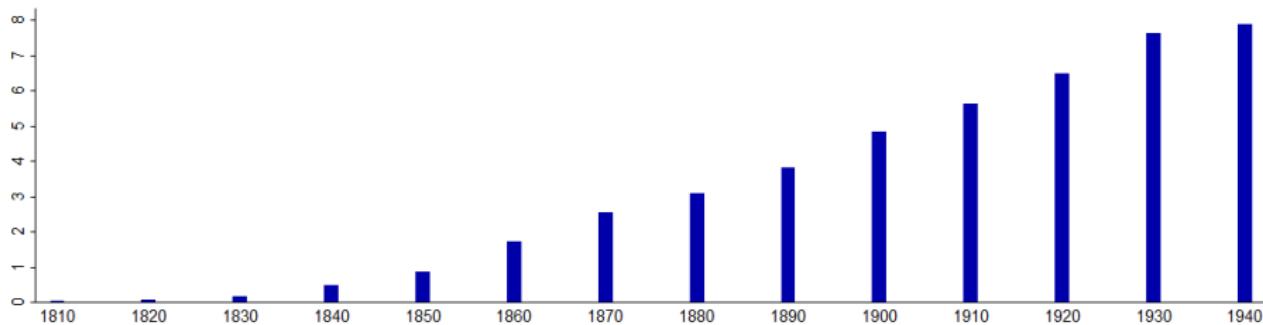
Early settlers in Illinois

Population (in millions):



Early settlers in Illinois

Population (in millions):

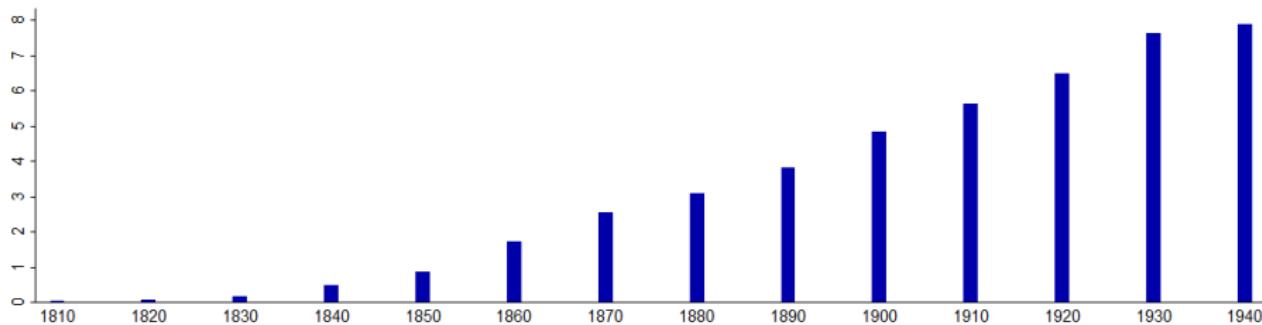


Early settlers:

"A soil of exhaustless fertility ... a country beautifully interspersed with prairies and finest timber, ... healthy and well watered." (Peck's Gazetteer, 1837)

Early settlers in Illinois

Population (in millions):



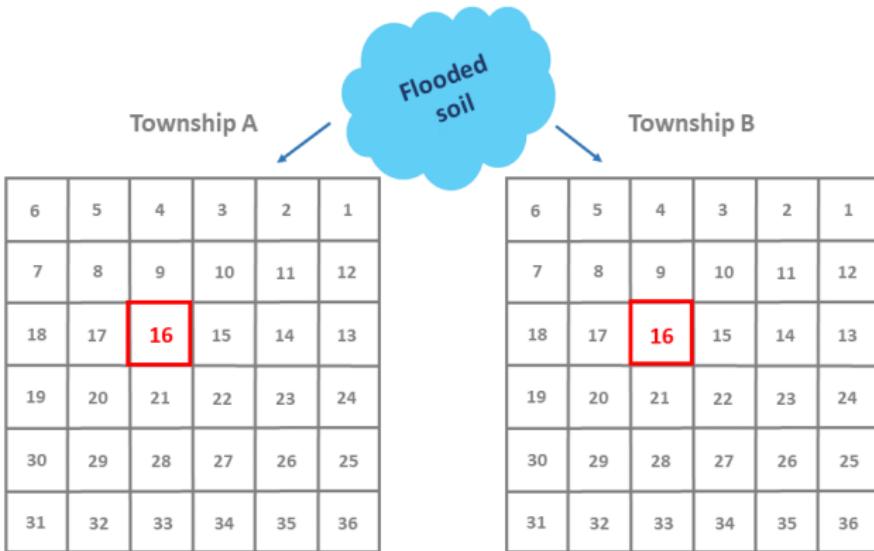
Early settlers:

"A soil of exhaustless fertility ... a country beautifully interspersed with prairies and finest timber, ... healthy and well watered." (Peck's Gazetteer, 1837)

vs.

"IL suffered from widespread belief that its living conditions were unhealthy. Uneducated masses believed that ... noxious vapors arising from ponds, swamps, and sloughs caused disease." (Biles, 2005)

Preview of estimation strategy



Preview of estimation strategy

Township A:
“school-poor”

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Township B:
“school-rich”

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

⇒ Identifying variation arises purely from spatial variation of ‘bad’, keeping overall amount of ‘bad’ constant

Related literature:

Persistent effects of public good investments:

Andrews (2020), Connolly (2020), Dell & Olken (2017), Kline & Moretti (2013)

Effects of schooling expenditures:

Jackson (2018), Miller (2018), Hyman (2017), Jackson, Johnson & Persico (2015), Card & Payne (2015)

Effects of landgrant policies:

Mattheis & Raz (2020), Smith (2020), Iwanovsky (2018), Libecap & Lueck (2011)

Effects of better neighborhoods:

Chetty & Hendren (2018), Chetty, Hendren & Katz (2016), Chetty et al. (2014)

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4 Results: Local economic structure

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- Township level: arrivals
- Matched sample: departures

Data sources I:

Schooling outcomes:

- IL State School Commissioner Report, 1858-64

TABULAR STATEMENT OF CALHOUN COUNTY, for the school year ending September 30, 1864.

Townships.	Principal of the township fund...		Interest of township fund received....		Amount raised by special district tax.		Amount paid for teachers' wages....		Total amount expended for all school purposes...	
	Amount, class and county fund received.....	Average monthly wages paid to female teachers....	Average monthly wages paid to male teachers.....	Number of female teachers.....	Number of male teachers	Total amount received for all school purposes.....	Amount received for teachers' wages....	Total amount expended for all school purposes...		
13 S. 1 W..	240	200	2	200	6	\$25	\$186	\$912	\$306	\$235
8 2 ..	246	170	2	105	6	\$23	20	186	1201	150
9 2 ..	370	235	4	114	6	30	20	281	900	685
10 2 ..	340	225	4	142	6	2	2	40	290	927
11 2 ..	267	215	3	239	6	4	4	37	231	584
12 2 ..	550	322	4	277	6	2	1	35	417	570
13 2 ..	370	220	3	198	6	2	4	27	25	710
8 3 ..	361	240	3	190	6	1	2	27	20	395
9 3 ..	171	120	2	88	6	1	1	30	229	736
10 3 ..	90	68	1	45	6	1	1	47	1152	696
8 4 ..	50	40	1	81	6	1	1	98	700	107
	3055	2055	29	1624	6	17	21	30	2458	10,338
									1060	2024
									5868	4478
									4895	

Data sources II:

Place-based outcomes:

- IPUMS restricted Census, 1860-1940: township where someone lives
- Matched sample: Census Linking Project

Geographical data:

- Soil data: gSSURGO (USDA)
- Townships and sections: PLSS (BLM)
- others: NHD (USGS), NLD (USACE/FEMA), IL 30-DEM (ISGS)

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Empirical Strategy

Equation of interest:

$$y_{m,c,t} = \beta_0 + \beta_1 s16-flood_{m,c} + \beta_2 ts-flood_{m,c} + X_{m,c}\delta + \gamma_c + u_{m,c,t}$$

Empirical Strategy

Equation of interest:

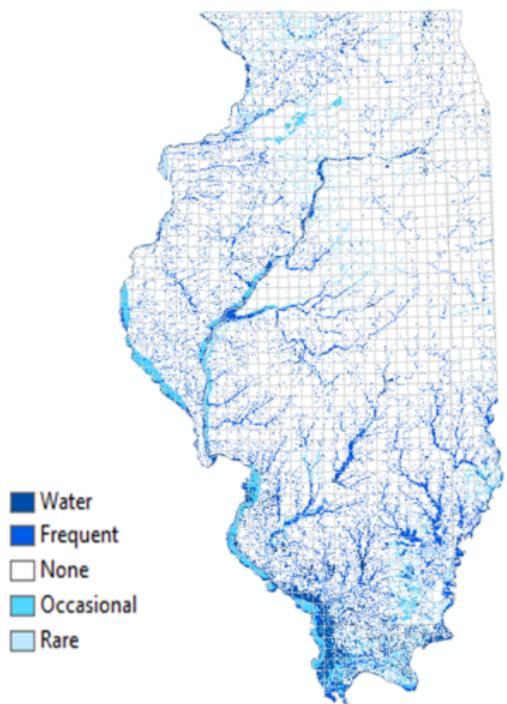
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Assumptions

- Relevance: Residual variation in s16 flooding moves schooling variables of interest ("First stage")
- Measurement Error in flooding data: orthogonal to $u_{m,c,t}$
 - ① Proxy historical flooding
 - ② IV for flooding based on local elevation differentials

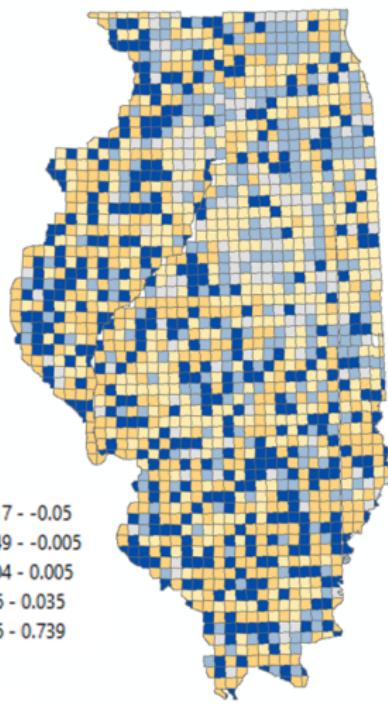
Residual variation in flooding

Flooding map:



Residual flooding:

$$s16\text{-flood}_{m,c} = \alpha ts\text{-flood}_{m,c} + X_{m,c}\delta + \gamma_c + r_{m,c} \rightarrow \hat{r}_{m,c}$$



School expenditures and endowment 1858

$$y_{m,c,t} = \beta_0 + \beta_1 s16\text{-flood}_{m,c} + \beta_2 ts\text{-flood}_{m,c} + X'_{m,c}\delta + \gamma_c + u_{m,c,t}$$

	Log(expenditures)				Log(principal)		
Share flooded	-0.333	-0.381	-0.365	-0.367	-0.408	-0.293	-0.300
s16	(0.130)	(0.133)	(0.128)	(0.135)	(0.124)	(0.135)	(0.134)
County FE		X	X	X	X	X	X
All soil controls			X	X	X	X	X
Water controls				X	X	X	X
Add. controls					X		X
Adj. R^2	0.018	0.229	0.247	0.253	0.311	0.188	0.188
Obs.	1370	1370	1370	1370	1370	1388	1388

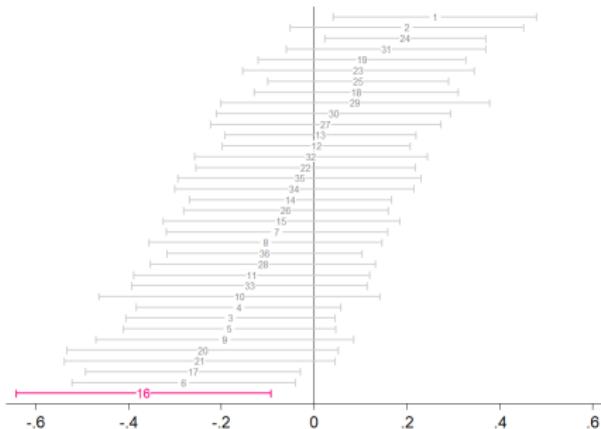
Standard Errors clustered at the township level. All regressions control for overall share flooded soil in township. Soil controls include share of land covered by all other flooding categories (occ, rare, none, na). Water controls include distance to nearest navigable river and share of ts land covered by stream. Add. controls include size of township, quartiles of soil quality, and ruggedness.

⇒ Increasing the share flood on s16 by 1 SD (0.2) translates into 7% reduction in schooling expenditures & endowments. ($0.2 * (e^{-0.4} - 1)$)

Robustness

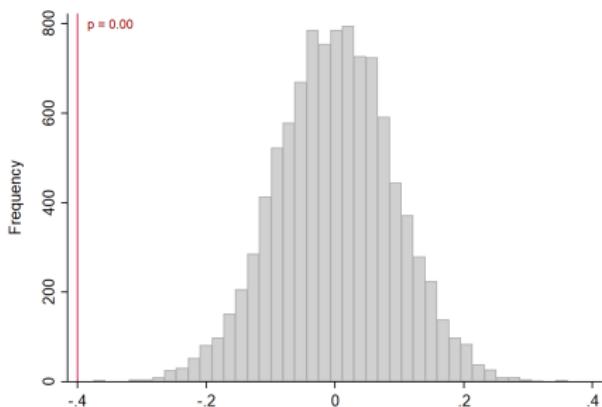
Placebo regressions:

$$\log(\text{expend}_{m,c,t}) = \beta_0 + \beta_1 \text{sX-flood}_{m,c} + \beta_2 \text{ts-flood}_{m,c} + \dots$$



Randomization inference:

$$\log(\text{expend}_{m,c,t}) = \beta_0 + \beta_1 \text{s16-flood}_{X,X} + \beta_2 \text{ts-flood}_{m,c} + \dots$$



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Assessing bias due to systematic measurement error:

Stylized example: Township wealth

- $\text{CoV}(\log(\text{expend}_{m,c,t}), w_{m,c,t}) > 0$
- $\text{CoV}(\hat{r}_{m,c}, w_{m,c,t}) \leq 0$

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 - ① No bias: s16 clean-up = ts clean-up: $\hat{r}_{m,c} \rightarrow$
 - ② Downward bias: s16 clean-up > ts clean-up: $\hat{r}_{m,c} \downarrow$
 - ③ Upward bias: s16 clean-up < ts clean-up: $\hat{r}_{m,c} \uparrow$

⇒ Bias arises from differential within-township 'clean-up', but no clear prior about direction

Example figure

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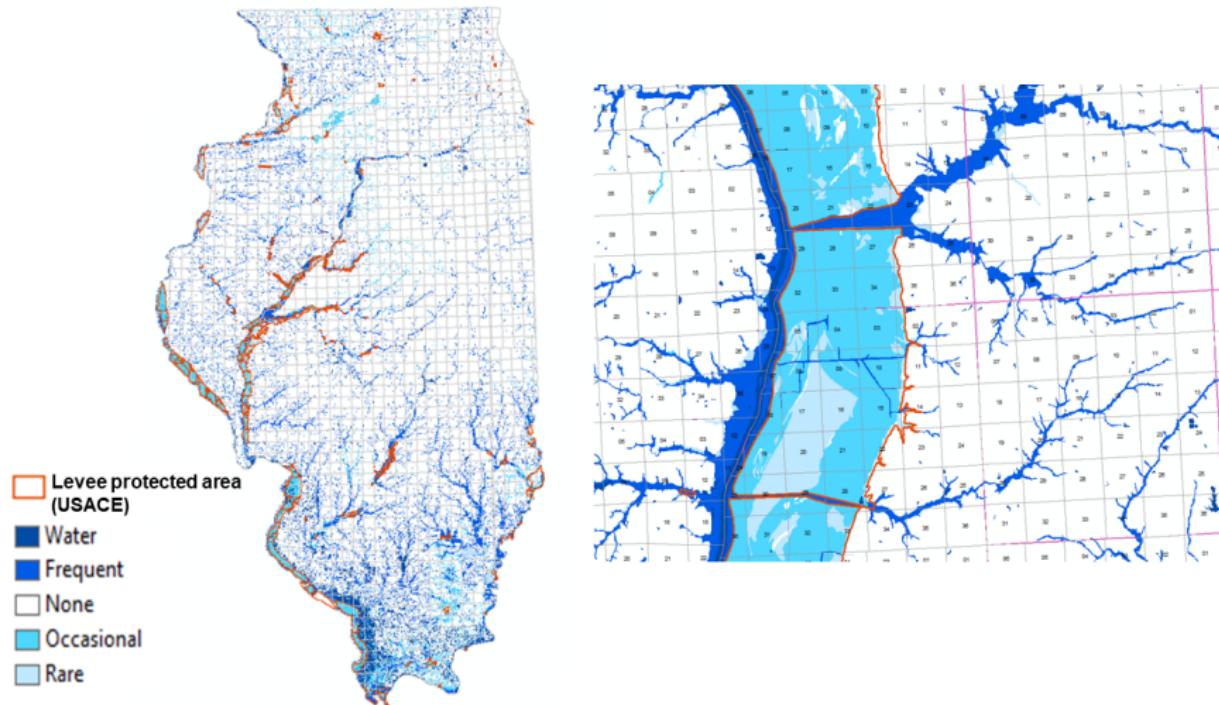
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Levees to proxy for historical flooding 1:



⇒ Re-assign flooding values in zones covered by levees today.

Levee measure

Levees to proxy for historical flooding 3:

$$y_{m,c,t} = \beta_0 + \beta_1 s16\text{-hist-flood}_{m,c} + \beta_2 ts\text{-hist-flood}_{m,c} + X'_{m,c}\delta + \gamma_c + u_{m,c,t}$$

	Log(expend)				Log(principal)		
Share flooded s16, historical	-0.296 (0.124)	-0.297 (0.118)	-0.324 (0.117)	-0.330 (0.120)	-0.368 (0.112)	-0.291 (0.138)	-0.305 (0.137)
County FE		X	X	X	X	X	X
All soil controls			X	X	X	X	X
Water controls				X	X	X	X
Add. controls					X		X
Adj. R^2	0.020	0.245	0.253	0.259	0.314	0.200	0.199
Obs.	1370	1370	1370	1370	1370	1388	1388

Standard Errors clustered at the township level. All regressions control for overall reconstructed historical share flooded soil in township. Soil controls include all categories of flooding by levee status. Same add. controls as Table 1.

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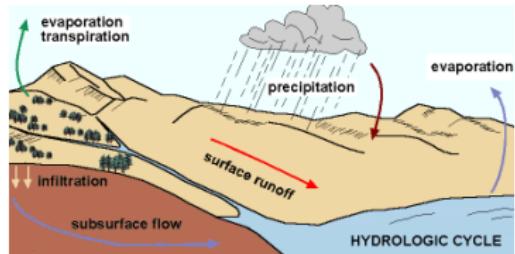
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Elevation differentials to instrument for flooding:

Flood prediction models:

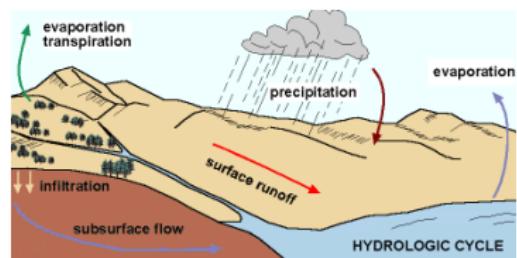
- Beven & Kirkby (1979): Approximate hydraulic slope with topographical slope
- Affects flow speed and therefore local ponding → Key ingredient for flood prediction models used by FEMA



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→ Use elevation of s16 relative to surroundings:
The higher s16, the faster water flows towards local minimum

Elevation differentials:

Relative elevation of s16:

	First Stage		IV			
	Share s16 flood		log(expend)		log(principal)	
Delta elev: s16	-6.975	-8.240				
- mean of surr. min	(0.689)	(0.768)				
Share flooded			-1.284	-0.583	-0.379	-0.452
s16			(0.371)	(0.278)	(0.398)	(0.348)
County FE	X	X	X	X	X	X
All controls		X		X		X
Adj. R^2	0.564	0.605	-0.083	0.065	-0.075	-0.071
Obs.	1370	1370	1370	1370	1326	1326
MOP F^{eff}			102.49	114.99	98.71	106.30

Standard Errors clustered at the township level. All regressions control for overall share flooded soil in township, mean elevation and maximum elevation differential across sections within township. Additional controls as in Table 1.

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Results:

Quick recap: Effects could operate via two different channels:

1) Improving local human capital:

"In educational matters the citizens of (Oblong) township have always taken a lively interest ... The school lands were sold in 1851 (forming) the basis of the present splendid school fund ... thus bringing the advantages of a good education within the easy reach of all."

Results:

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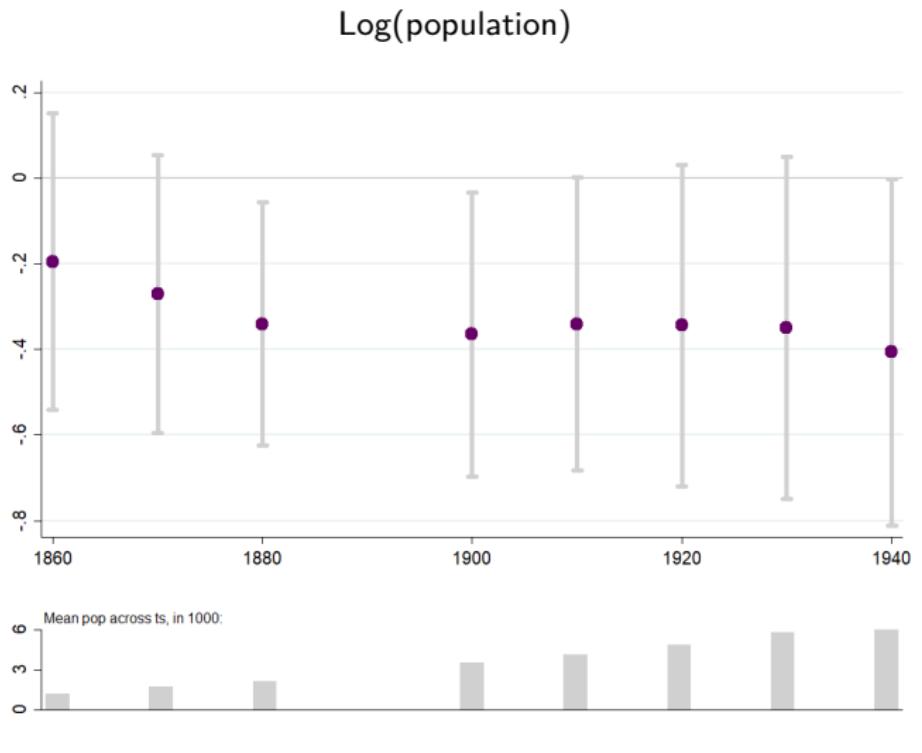
2) Attracting selected sample of settlers:

Wickliff Kitchell, born in NJ, lawyer and later State Attorney:

"In the spring of 1838, he removed to Hillsboro, Montgomery County, Illinois, in order to give his children the advantages of the excellent schools then flourishing at that place."

(Perrin: History of Clark and Crawford Counties, 1883)

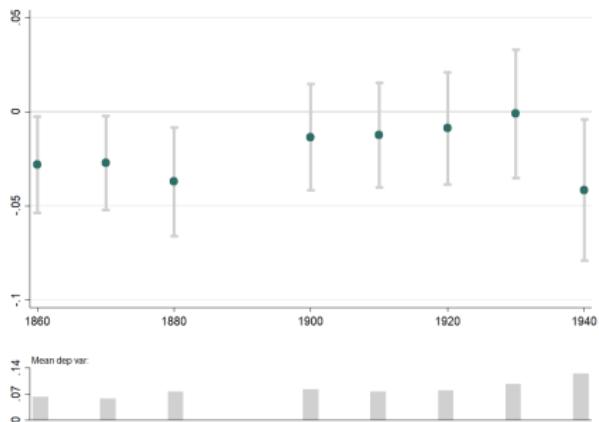
Township level: population size



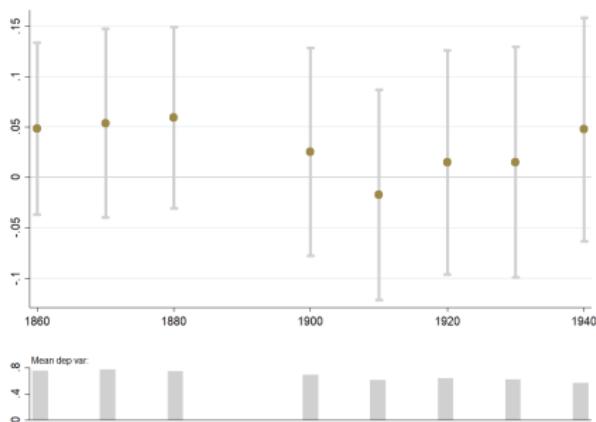
Age structure

Individual level: Occupations

White-collar occupation*



Occupation in agriculture*



Notes:

Individual level regressions, controls for: age, age squared, household head, married, children present. Inverse population weights.

White-collar occupations: Professional-technical (lawyers, teachers, surveyors, nurses...), Managerial: Managers, Proprietors and Officials (buyers and shippers, credit men, rail conductors) and Clerical/Sales (tellers, cashiers, newsboys)

Agriculture occupations: Farmers (owners and tenants), farm laborers, farm managers

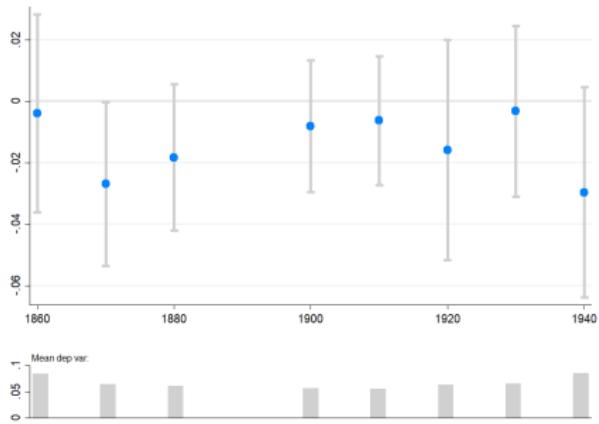
* For 1900-1930, up to 13% of sample's occupation has not yet been classified by IPUMS. No significant impact by treatment status.

detailed

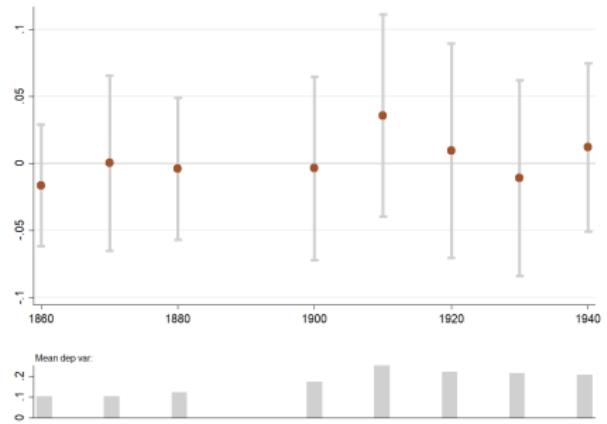
teachers

Individual level: Occupations

Skilled blue collar occupation*



Low skilled occupation*



Notes:

* For 1900-1930, up to 13% of sample's occupation has not yet been classified by IPUMS. No significant impact by treatment status.

Individual level regressions, controls for: age, age squared, household head, married, children present. Inverse population weights.

Skilled BC occupations: Any craft (bakers, mechanics, carpenters)

Low skilled occupations: Service workers (bootblacks, bartenders, drivers), Household service workers, laborers (miners, meat cutters, heaters)

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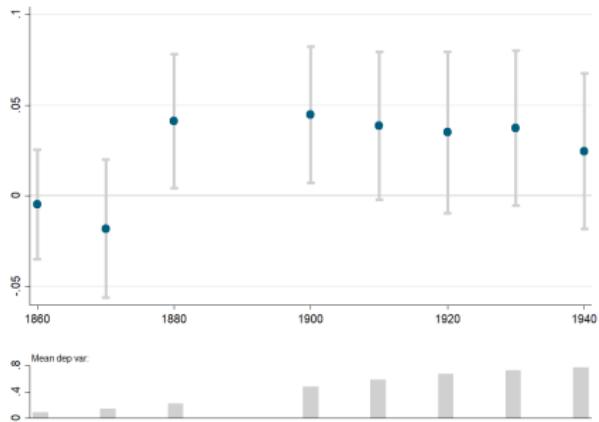
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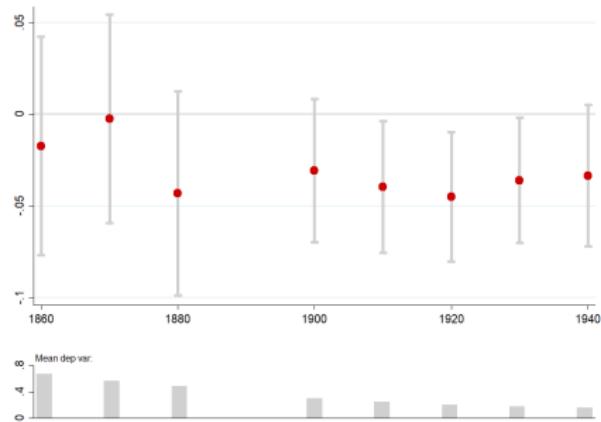
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Township level: Migration patterns

Household head born in IL
(share)

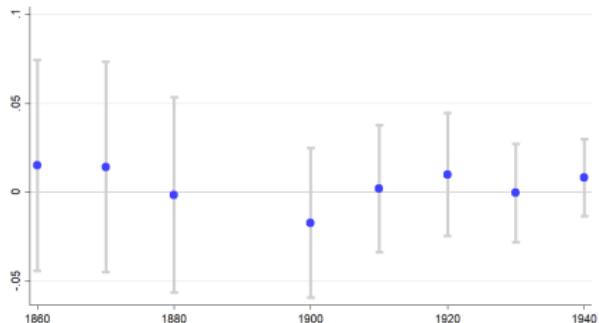


Household head born in US outside IL
(share)

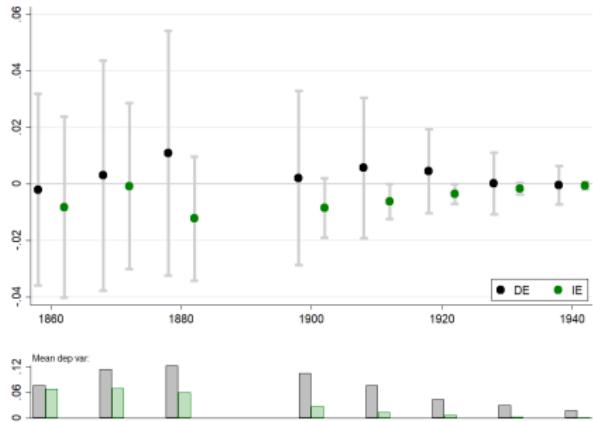


Township level: Migration patterns

Household head born in Europe
(share)



Household head born in Germany or
Ireland (share)



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Matched sample:

Sample construction:

- Merge boys age 0-15 who live in IL townships in 1860 and 1870 to outcomes in 1900
- Match rate at 25%
- Treatment status does not predict match probability [Table](#)
- Locally representative: Socio-economic status equally predictive of match probability between treatment and control [Table](#)

Matched sample I:

Full sample: Leaving childhood township

	same TS	left cty	left IL	in city
Share flooded	-0.012	0.020	0.032	0.004
s16	(0.016)	(0.019)	(0.018)	(0.016)
County FE	X	X	X	X
Ts controls	X	X	X	X
Individ. controls	X	X	X	X
Adj. R^2	0.011	0.016	0.029	0.025
Obs.	164,169	164,169	164,169	164,169
Dep mean	.18	.72	.47	.28

Standard Errors clustered at the township level. Inverse population weights. Township controls as in Table 1, add controls: year of match. Individual controls: Age in 1900.

Matched sample II:

By farm status: Leaving childhood township

Dep var is:	Farm				Non-Farm			
	same TS	left cty	left IL	in city	same TS	left cty	left IL	in city
Share flooded	-0.006	0.016	0.021	-0.004	-0.034	0.035	0.069	0.026
s16	(0.018)	(0.026)	(0.024)	(0.016)	(0.019)	(0.024)	(0.027)	(0.024)
County FE	X	X	X	X	X	X	X	X
Ts controls	X	X	X	X	X	X	X	X
Individ. controls	X	X	X	X	X	X	X	X
Adj. R^2	0.012	0.018	0.032	0.018	0.015	0.019	0.028	0.039
Obs.	89,222	89,222	89,222	89,222	74,947	74,947	74,947	74,947
Dep mean	.16	.71	.46	.18	.2	.73	.47	.41

Standard Errors clustered at the township level. Inverse population weights. Township controls as in Table 1, add controls: year of match. Individual controls: Age in 1900.

Conclusion

Today's talk:

- A SD increase in flooded area on s16 decreases schooling endowments and expenditures by 7% measured in 1858
- “School-poor” townships start lagging behind in population size by 1860.
- Local economic structure in “school-poor” townships as measured by occupations is more agriculturally oriented
- By 1880s: “school-poor” townships have fewer settlers from other places in the US, but attract proportional shares of European migrants
- Young men who did not grow up on a farm in “school-poor” townships are more likely to leave the county, and Illinois.

Where do these results leave us?

- Initial public provision of a public good sets off diverging trends across locations that are sizeable and persistent
- Can this help explain the economic geography of locations?
- Can public provision of an important public good help overcome initial market failures or coordination problems to set off a virtuous cycle?
- Can selective migration explain why initial small differences lead to persistent divergence over time?

Next steps:

- Better disentangle selective migration
- Add 1850 census data and use linked samples
- Digitize more township level schooling variables

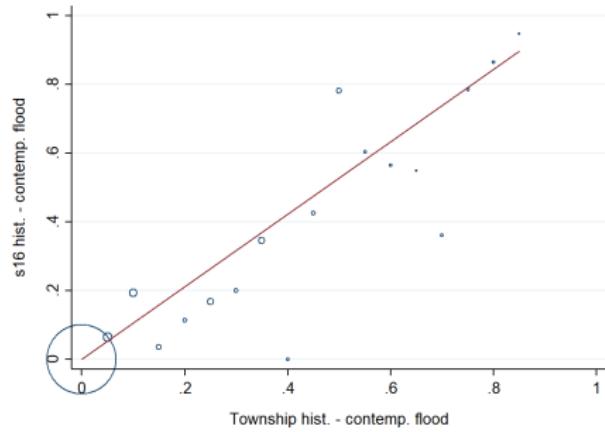
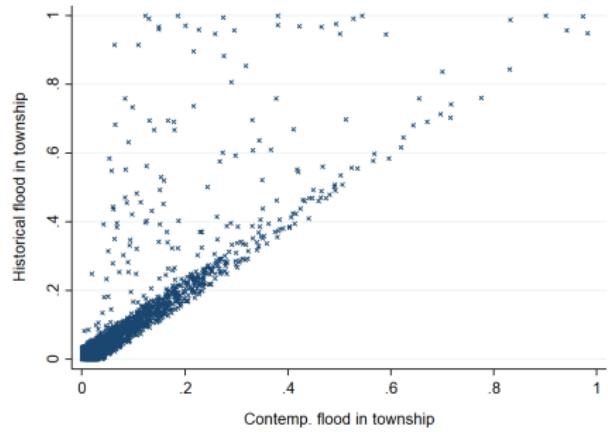
Thank you!

ursina.schaede@uzh.ch

Summary statistics

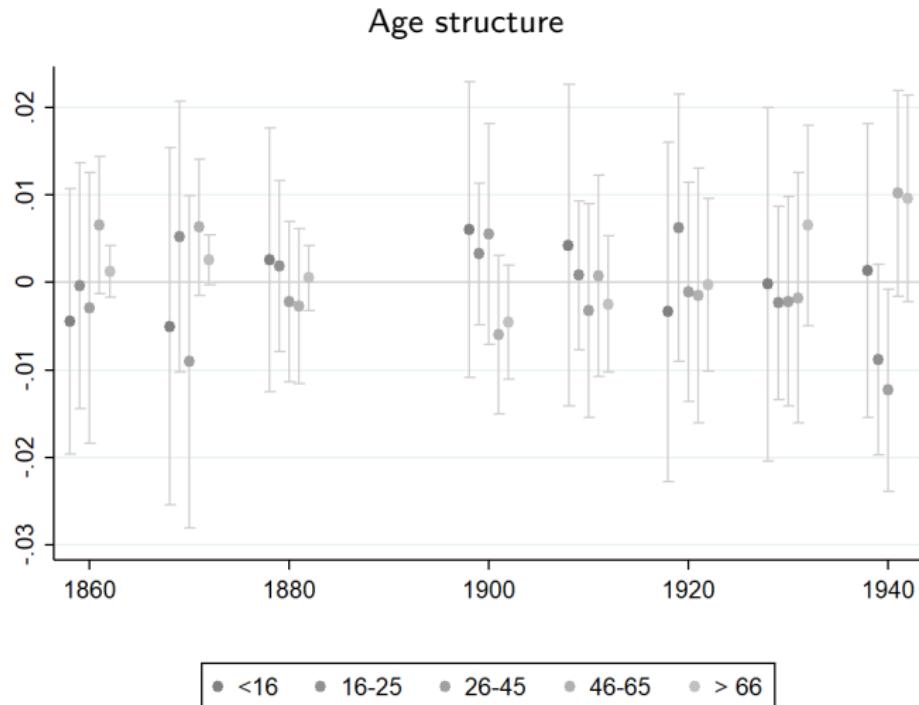
Variable	Avg	Med	SD	Min	Max	Obs
<i>Schooling variables</i>						
School expenditures in USD, 1858	941.17	750.00	1,333.12	34.82	38,027.48	1,370
Township principal in USD, 1858	2,294.30	1,526.30	3,665.70	23.46	101,190.61	1,388
<i>Geographic characteristics</i>						
Share flooded, s16	0.11	0.02	0.20	0.00	1.00	1,580
Share flooded, township	0.10	0.07	0.11	0.00	0.99	1,580
Elevation differential s16, in m	11.20	8.58	9.31	-1.75	81.58	1,580
Average township elevation, in m	189.45	192.39	38.37	94.56	307.27	1,580
Historical share flooded, s16	0.13	0.03	0.24	0.00	1.00	1,580
Historical share flooded, township	0.12	0.07	0.17	0.00	1.00	1,580
Distance to navigable river, km	26.02	17.95	26.46	0.00	115.34	1,580
Distance to Lake Michigan, km	252.05	255.48	122.93	0.00	532.70	1,580
Size of township, sq.mi.	35.09	36.19	4.47	5.33	46.31	1,580
Size of non-fractional ts, sq.mi.	36.25	36.26	1.22	30.91	46.31	1,434

Levees to proxy for historical flooding 2:



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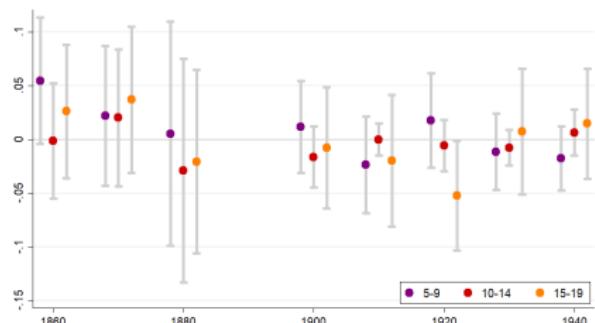
Township level: age structure



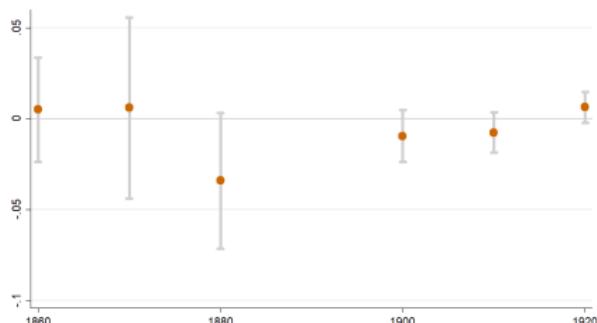
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Township level: school attendance and literacy

Attended school at least 1 day

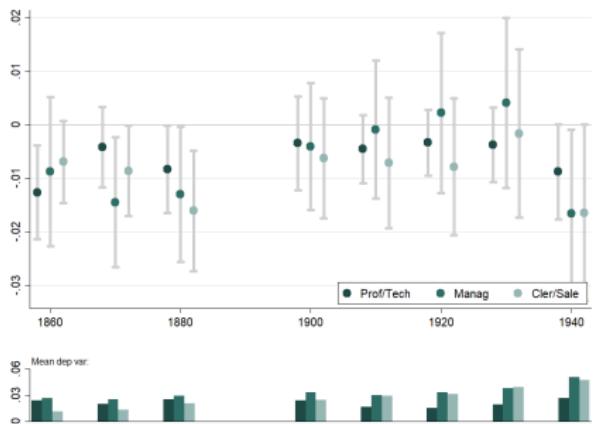


Share illiterate

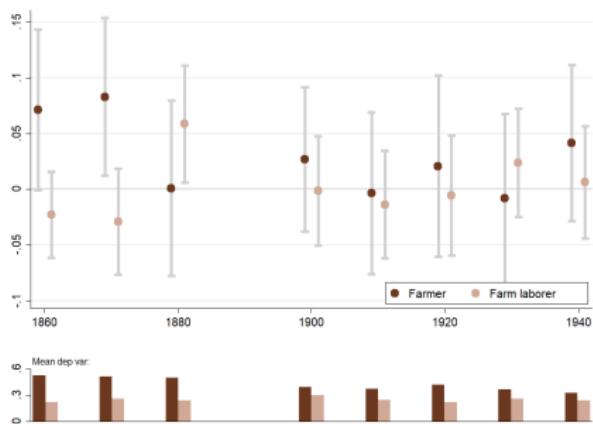


Individual level: Occupations

White-collar occupation



Occupation in agriculture)



Notes:

Individual level regressions, controls for: age, age squared, household head, married, children present. Inverse population weights.

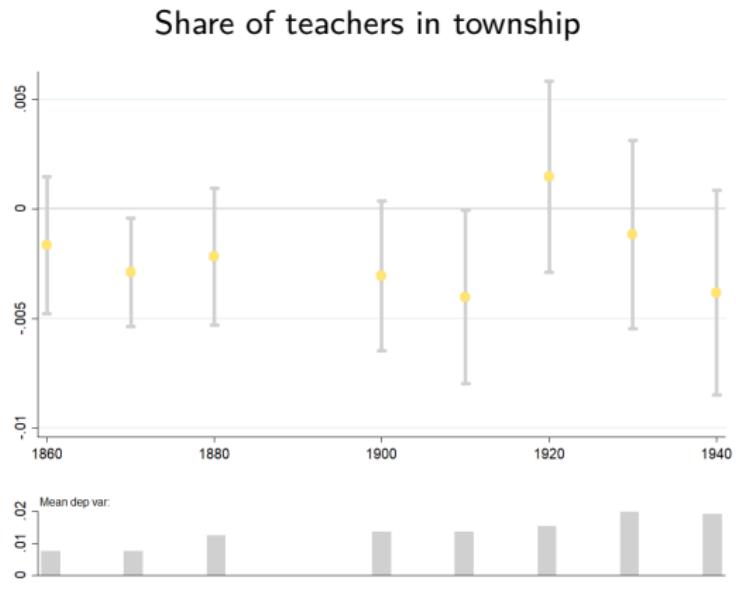
Whitecollar occupations: Professional-technical (lawyers, teachers, surveyors, nurses...), Managerial: Managers, Proprietors and Officials (buyers and shippers, credit men, rail conductors) and Clerical/Sales (tellers, cashiers, newsboys)

Agriculture occupations: Farmers (owners and tenants), farm laborers, farm managers

* For 1900-1930, up to 13% of sample's occupation has not yet been classified by IPUMS. No significant impact by treatment status.

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Individual level: Occupations



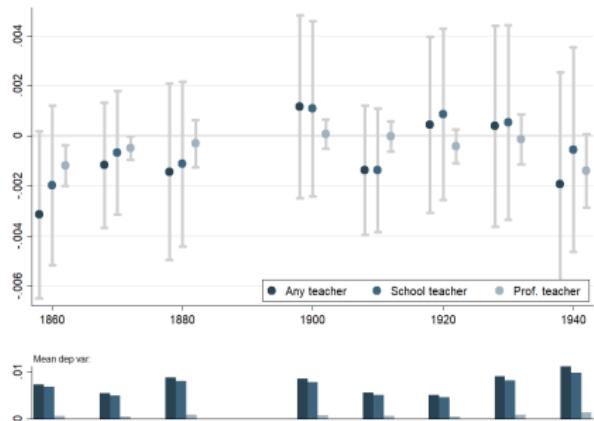
Notes:

Township level regressions, share of teachers over total population aged 16-55.

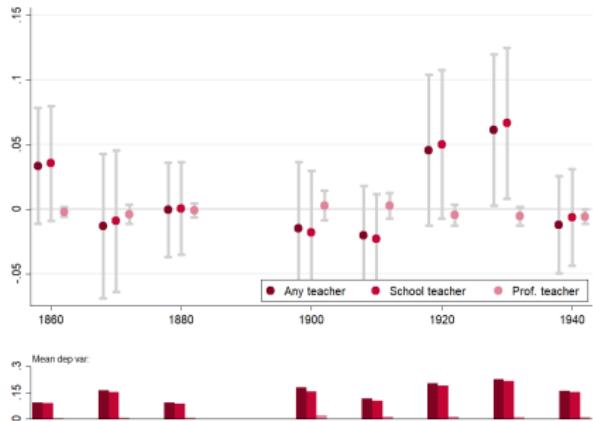
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Individual level: Occupations

Teachers, men



Teachers, women



Notes:

Individual level regressions, controls for: age, age squared, household head, married, children present. Inverse population weights.

* For 1900-1930, up to 13% of sample's occupation has not yet been classified by IPUMS. No significant impact by treatment status.

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Matched sample: Treatment status

Treatment status not predictive of match likelihood:

Dep var is match outcome		1860		1870	
Share flooded	0.008	0.008	0.008	0.008	0.007
s16	(0.009)	(0.009)	(0.009)	(0.013)	(0.011)
County FE	X	X	X	X	X
Ts controls		X	X	X	X
Individ. controls			X	X	X
Adj. R^2	0.006	0.006	0.007	0.008	0.008
Obs.	750,132	750,132	750,132	301,702	448,430
Dep mean	.25	.25	.25	.23	.26

Standard Errors clustered at the township level. Inverse population weights. Township controls as in Table 1, add controls: year of match. Individual controls: Age dummies, number of siblings, household head's birthplace and occupation (whitecollar, skilled blue collar, low skilled, agricultural, non occup. category, missing occ category).

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Matched sample: Treatment status

Socio-economic status of parents not differentially affecting match likelihood:

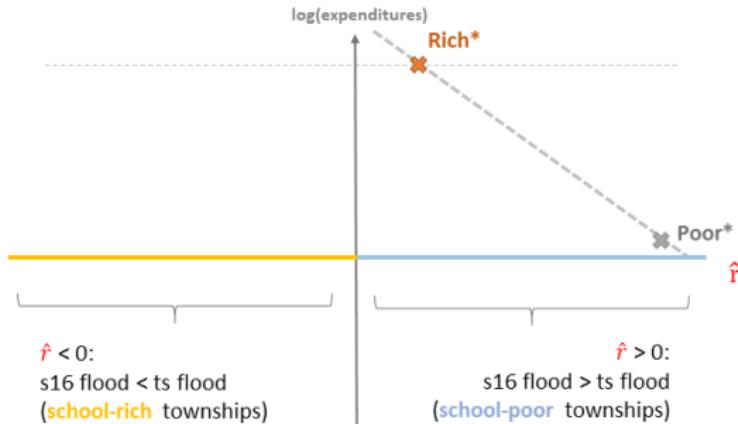
Dep var is match outcome	WC	SBC	LS	Agr	HH moved
Share flooded	0.008	0.008	0.008	0.004	0.004
s16	(0.009)	(0.009)	(0.009)	(0.011)	(0.015)
Occupation	0.015	-0.007	-0.025	0.015	0.030
	(0.003)	(0.004)	(0.003)	(0.002)	(0.114)
Share flood s16	-0.006	-0.005	0.004	0.006	0.005
* occupation	(0.015)	(0.019)	(0.014)	(0.010)	(0.015)
County FE	X	X	X	X	X
Ts controls	X	X	X	X	X
Individ. controls	X	X	X	X	X
Adj. R ²	0.007	0.007	0.007	0.007	0.007
Obs.	750,132	750,132	750,132	750,132	750,132
Dep mean	.25	.25	.25	.25	.25

Standard Errors clustered at the township level. Inverse population weights. Township controls as in Table 1, add controls: year of match. Individual controls: Age dummies, number of siblings, household head's birthplace.

Assessing bias due to systematic measurement error II:

Stylized example: Township wealth

- $\hat{r} \approx s16\text{-flood} - ts\text{-flood}$

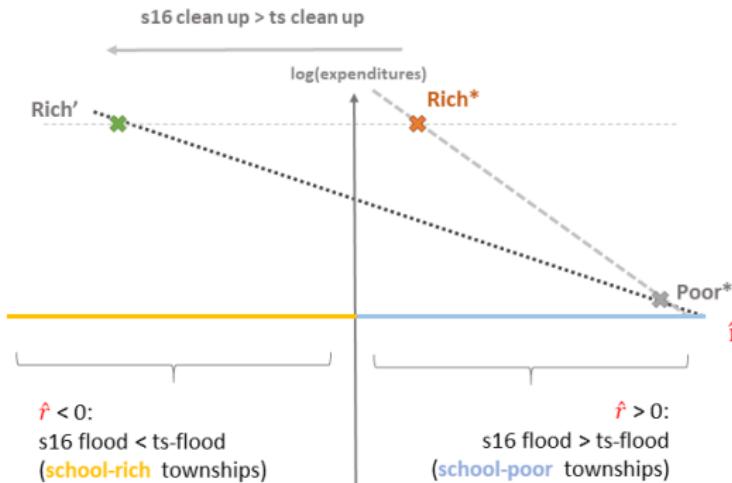


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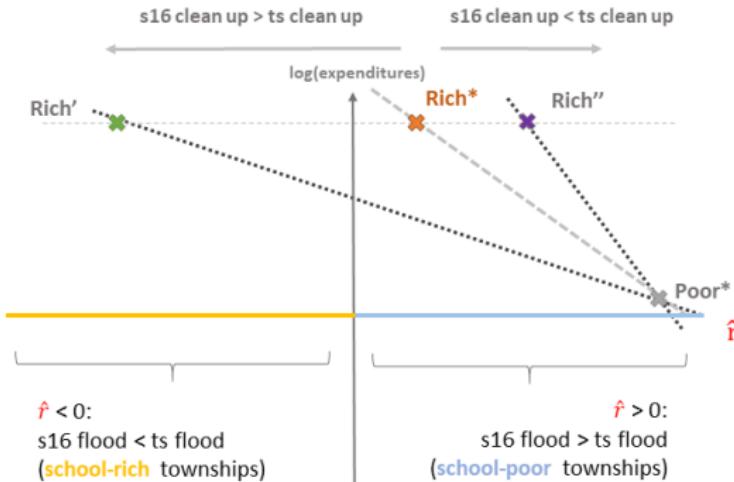


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