THE LONG-RUN IMPACT OF INCREASING SCHOOL FUNDING ON EDUCATIONAL AND LABOR MARKET OUTCOMES

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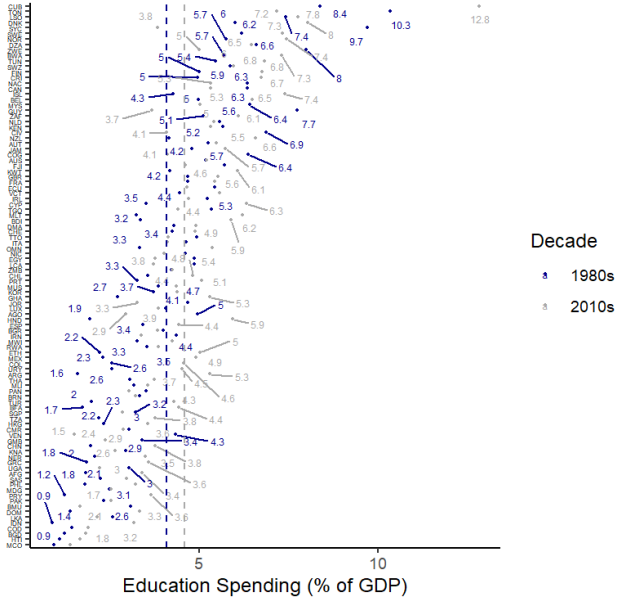
MOTIVATION

- Education is key to individual and societal growth; linked to better health, higher earnings, and higher social mobility.
- Challenge: Achieving universal access to quality education globally, heavily influenced by funding.
- Does it work though? Education spending is around 5% of GDP in developed counties, with a lot of heterogeneity.
  "Increases in public education spending did not generally result in major improvements in average education outcomes." (World Bank, 2019)
- Gap to be filled: Examining the impact of education funding on student long-run outcomes, yet challenging due to data limitations and long-term tracking.

EDUCATION SPENDING IS SCATTERED OVER THE WORLD (BUT GENERALLY INCREASING)



THIS PAPER: OVERVIEW

- Documents the impact of a broad intergovernmental transfers reform on education funding in Norway.
- Employs an event-study design to analyze the timing and long-term effects.
- Consider both efficiency and equity concerns associated with these incentives
- Explore a decade of municipal-level data with comprehensive controls.
- Tracks students into their adulthood, providing detailed effects on a range of outcomes, exploring (i) heterogeneity, (ii) channels and (iii) distributional impacts.

THIS PAPER: DETAILS

- Intergovernmental transfers system fund a large share of municipal spending on education;
- Large funding reform in 1986, which shifted education funding from the Central Administration at the municipal level.
  - The reform lifted the differentiation between educational level in the grant size formula $\rightarrow$ relative increase of transfers level in municipalities with a higher share of younger children.
- Use a cohort DiD framework to trace out the impact of this change across the education and labor market career of students exposed to higher funding by the time they were at school.

KEY TAKE-AWAYS

- Increases of per pupil yearly $ 100 for around 9 years have significant long-run and equality-enhancing effects. Specifically:
  - Higher Educational Attainment by the early 30s;
  - Higher earnings, with increasing effect up to 33;
  - Effect on earnings concentrated in the lower-end of distribution;
  - Effects on most outcomes concentrated on low-SES students;
  - Small but significant effects on migration, concentrated around the mid-20s.
- Though moderate, effects are sizeable enough for the policy to be cost-effective at an discount rate up until 7.5%, on a back-of-the-envelope calculation.

CONTRIBUTIONS

- **Long-run Effects of Education Spending** (e.g., Jackson and Mackevicius (2023); Hyman (2017); Jackson et al. (2016; 2021); Lafortune et al. (2018); Biasi (2023); Baron (2022))
  - This paper brings, to the knowledge of the author, first evidence of long-run effects on earnings with population-wide detailed register data, including distributional impacts, channels and cumulative effects over lifetime.

- **Local Government Responses to Central Government Grants** (e.g., Gordon (2004); Cascio et al. (2013); Litschig and Morrison (2013)

- **School Inputs** (e.g., Angrist and Lavy (1999); Fredriksson et al. (2013); Leuven and Løkken (2020); Borgen et al. (2022))

BACKGROUND

- Municipalities are responsible for primary - 1st-6th grades (7 to 12 years old children) - and lower-secondary education - 7th-9th grades (13 to 15 years old children).
- Education accounts for 40% of all municipal social spending.
- Day-to-day responsibilities are devolved at the school level.
- Municipalities are responsible for defining the level and distribution of resources.
- The Central Administration sets national policy by laws and curriculum regulation.

- Grants for municipal schools until 1985
  - Had to cover 25-85% of local education expenditures, according to teaching hours, which were valued by a certain amount (Cost Factor) + other minor criteria: (e.g. tax revenues)
  - In 1985, Primary Education teaching hours were valued at **NOK 130.05** (2011 PPP $30.2), whereas Lower-Secondary Education were valued at **NOK 146.80** (2011 PPP $34.1).
- New grant distribution scheme in 1986
  - Introduced a block grant, which replaced about 50 earmarked grants.
  - The block grant was distributed according to three sector Cost Matrices, which calculated points based on some 'neutral' characteristics and associated weights.
  - Under this new criteria, there was no differentiation between primary and lower-secondary education

How it used to be:

$$Grant_{m,t} = \sum_{l} (CF_{l,t} \cdot Hours_{l,m,t}) + \epsilon_{l,m,t}$$

How it has changed to:

Criteria	Weight
Teaching hours in 1985	0.47
Number of inhabitants 7-15 years	0.41
Others	0.12

Source: Langørgen et al. (2013)

$\rightarrow$ Municipalities with + primary school students had a relative increase in grants

DATA

- Municipal-wide administrative data from Kommunedatabasen or Statistics Norway
- Population-wide administrative data from Statistics Norway
- Focus on cohorts born from 1964 to 1983
  - Some cohorts were too old (< 1971) and others were are the right age to be exposed to the shock.
- Detailed information on educational level and major choices; labor market outcomes up to 35 years old; IQ for men and migration choices.
- Also information on background characteristics, parental characteristics, and socioeconomic conditions

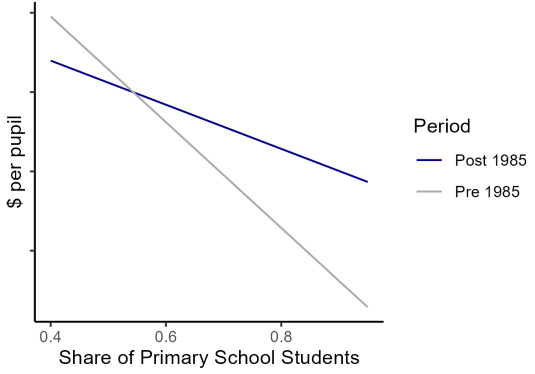
OVERVIEW OF RESEARCH DESIGN

- Policy change should have an impact on students who were at age of enrollment by the time of the reform. Municipalities with a younger pool of children faced an increase on funding.

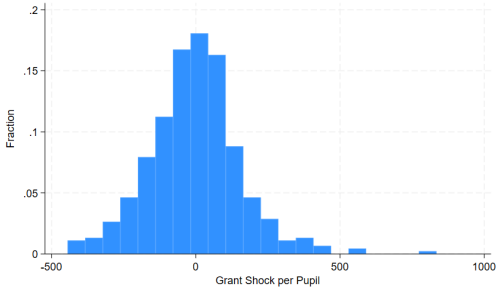
- Challenge: We do not observe the shock size. I estimate it through the application of a formula that captures the transition.

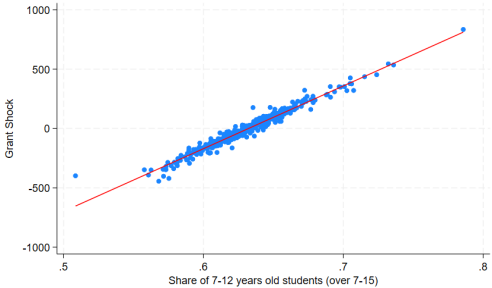
- This transition is quantified by comparing the pre- and post-reform scenarios, reflecting the shift in funding allocations across different levels of education—primary and lower-secondary.

$$Shock_m = SW \cdot \hat{CF} \cdot [(H_p \cdot sh712_m) + (H_s \cdot (1 - sh712_m))] - [(SW \cdot H_p \cdot CF_{\text{primary}} \cdot sh712_m) + (SW \cdot H_s \cdot CF_{\text{secondary}} \cdot (1 - sh712_m))]$$



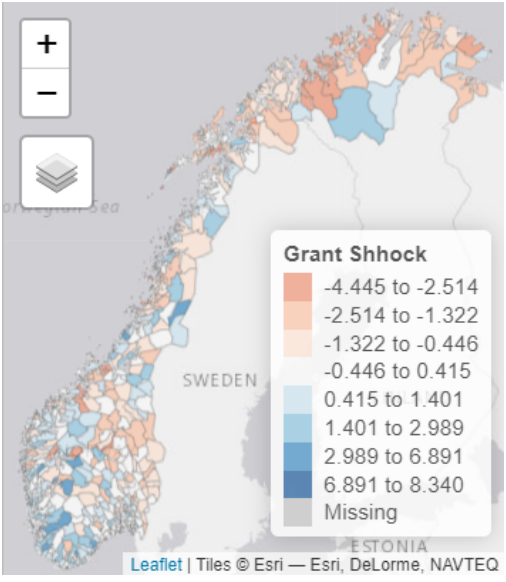
ESTIMATED SHOCK





- Standard deviation of $137, with outliers indicating substantial increases.
- High positive correlation between the proportion of 7-12-year-olds (relative to 7-15-year-olds) and grant shock.
- Estimates will be presented as additional yearly $100 per pupil (2011 PPP dollars), approximating 1% of total 1985 expenditure.

ESTIMATED SHOCK GEOGRAPHICAL DISTRIBUTION



Municipal Responses:

$$Y_{m,t} = \sum_{q=-1985} \pi_q(1[q = t]Shock_m) + \phi X' + \gamma_m + \delta_t + \vartheta_{ct,t} + \epsilon_{m,t} \quad (1)$$

- Controls:
  - Demographic changes;
  - Share of 7-15 years old students over population;
  - 1982-85 Share of Tax Revenue-by-Year;
  - 1980-85 Share of Education Expenditure-by-Year;
  - 1983 Health Sector Matrix Points-by-Year.

INDIVIDUAL LEVEL EFFECTS: COHORT GROUPS

Cohort	Group	1986	1987	1988	1989	1990	1991
1964	Never Exposed	22	23	24	25	26	27
1965		21	22	23	24	25	26
1966		20	21	22	23	24	23
1967		19	20	21	22	23	24
1968	Not exposed	18	19	20	21	22	23
1969		17	18	19	20	21	22
1970	[Baseline in Regressions]	16	17	18	19	20	21
1971	Marginally exposed	**15**	16	17	18	19	20
1972		**14**	**15**	16	17	18	19
1973		**13**	**14**	**15**	16	17	18
1974		**12**	**13**	**14**	**15**	16	17
1975		**11**	**12**	**13**	**14**	**15**	16
1976	Exposed at Lower Secondary School	**10**	**11**	**12**	**13**	**14**	**15**
1977		**9**	**10**	**11**	**12**	**13**	**14**
1978		**8**	**9**	**10**	**11**	**12**	**13**
1979	Exposed at Primary School	**7**	**8**	**9**	**10**	**11**	**12**
1980		6	**7**	**8**	**9**	**10**	**11**
1981		5	6	**7**	**8**	**9**	**10**
1982		4	5	6	**7**	**8**	**9**
1983		3	4	5	6	**7**	**8**

Individual Level Effects (Flexible approach):

$$Y_{i,g} = \sum_{q=-1}^{3} \pi_g(1[q = g]Shock_m) + \phi X'_{m,1985} + \alpha U'_i + \gamma_m + \delta_c + \vartheta_{ct,c} + \epsilon_{i,c} \quad (2)$$

- Individual Controls:
  - Man/Foreigner dummies;
  - Mother and Father Level of Education by Year of Birth;
  - Within siblings birth order;

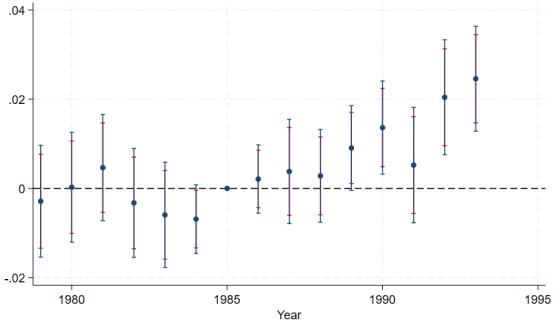
Individual Level Effects (Linear specification approach):

$$Y_{i,c} = \pi Shock_m \cdot \text{Years of Exposure}_{i,c} + \phi X'_{m,1985} + \alpha U' + \gamma_m + \delta_c + \vartheta_{ct,c} + \epsilon_{i,c} \quad (3)$$

- What does this model do?
  - Imposes linear structure, interacting school funding shock with a continuous variable of exposure length.
  - Allows to examine how the average effect size of the shock by an year of exposure;
  - Limitation: Model does not test for pre-trends nor non-linearity.

RESULTS

ESTIMATED GRANT SHOCK ON SPENDING



- Increase of $100 in the intergovernmental transfer to education → + 2.5% higher local educational spending by the 1990s.
- Transition to a new grants scheme in 1986 did not lead to major changes in a short time: (i) 1986 and 1987 → previous rule level in the distribution was weighted by 90%; (ii) 1988 → previous year level was weighted by 80%.

Outcomes	(1) Teaching Hours per Pupil	(2) Teachers Per Pupil	(3) Class Size	(4) Teachers' Education	(5) Teachers' Income (ln)	(6) Number of Schools
Short-Term	0.0737	0.0013***	0.0550	-0.00528	-0.000526	0.0285
(1986-88)	(0.0737)	(0.00047)	(0.0451)	(0.0169)	(0.00363)	(0.0186)
Medium-Term	0.262*	0.0015**	0.00450	0.00522	-0.00573	0.0541*
(1989-91)	(0.149)	(0.00063)	(0.0562)	(0.0262)	(0.00568)	(0.0325)
Observations	3,215	4,374	4,374	3,215	3,215	4,374
Pre-Treat. Mean	5.3	0.107	17.7	14.2	12.1	7.6
Number of Mun.	378	402	402	378	378	402

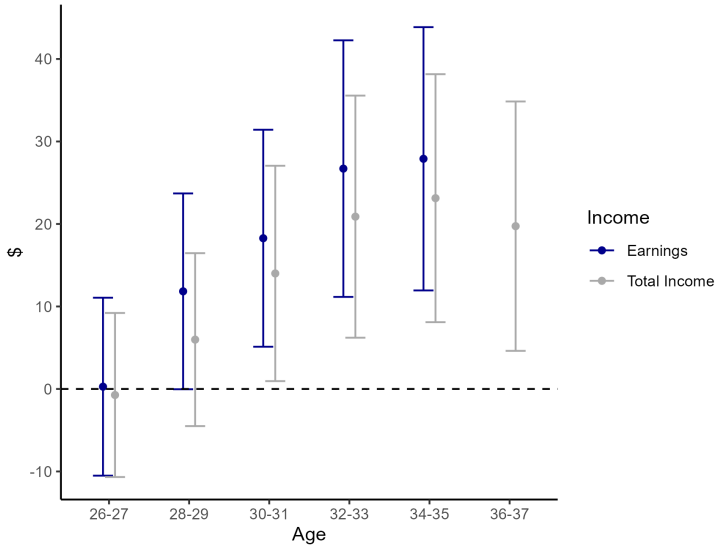
INDIVIDUAL-LEVEL EFFECTS; FLEXIBLE APPROACH

VARIABLES	(1) Years of Study	(2) Higher Education	(3) Labor Income	(4) Earnings Rank by Cohort
Never Exposed	-0.011	-0.0015	31.64	.0007
	(0.009)	(0.002)	(61.04)	(.0010)
Marginally Exposed	-0.002	-0.0006	89.09	.0015*
	(0.00816)	(0.002)	(59.78)	(.0009)
Exposed at Lower-Secondary School	-0.0006	0.0004	144.97*	.0021*
	(0.011)	(0.002)	(84.15)	(.0012)
Exposed at Primary School	**0.025****	**0.0041***	**290.15*****	**.0046*****
	(0.011)	(0.002)	(88.07)	(.0012)
Pre-treatment Mean	12.99	0.328	31,168.1	.5
Pre-treatment SD	2.66	0.470	18,421.7	.29
Observations	1,023,285	1,024,535	981,306	994,205
R-squared	0.231	0.199	0.262	0.215

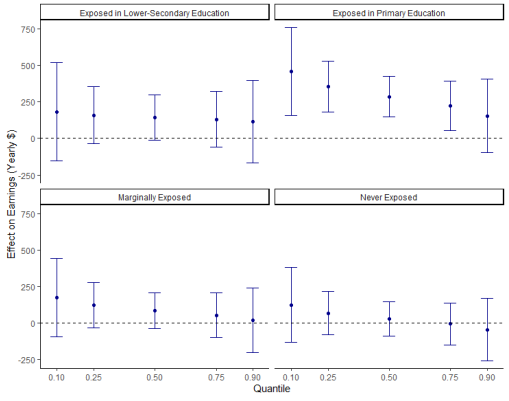
INDIVIDUAL-LEVEL EFFECTS; LINEAR SPECIFICATION APPROACH

VARIABLES	Years of Study	College Diploma	Labor Income	Earnings Rank by Cohort
Shock ·Years of Exposure	0.003**	0.0004**	27.32***	.0004***
	(0.001)	(0.0002)	(8.12)	(.0001)
Pre-treatment Mean	12.99	0.328	31,168.1	.5
Pre-treatment SD	2.66	0.470	18,421.7	.29
Observations	1,023,285	1,024,535	981,270	994,205
R-squared	0.231	0.199	0.262	0.215

IMPACT ON EARNINGS AND TOTAL INCOME OVER LIFE TIME



IMPACT ON EARNINGS ACROSS DISTRIBUTION



Quantiles	0.1	0.25	0.5	0.75	0.9
Shock ·Years of Exposure	33.75***	29.82***	27.15***	24.74***	22.06**
	(13.00)	(7.552)	(5.973)	(7.377)	(10.84)

VARIABLES	IQ (Men at 18-19)	Education Quality
Flexible		
Never Exposed	-0.0741	-44.39
	(0.0712)	(27.95)
Marginally Exposed	-0.00397	4.507
	(0.0735)	(24.74)
Exposed at Lower-Secondary School	-0.00273	-18.57
	(0.0802)	(31.49)
Exposed at Primary School	0.0787	**72.0****
	(0.0746)	(32.04)
Linear specification		
Shock ·Years of Exposure	**0.0108***	**8.147*****
	(0.0235)	(11.02)
Baseline Mean	100.5	10,202
Observations	504,710	1,024,535

HETEROGENEITY - PARENTAL EDUCATION

VARIABLES	Years of Study		Labor Income	
Flexible	(1)	(2)	(3)	(4)
Never Exposed	-0.007	-0.024	60.05	-38.88
	(0.010)	(0.017)	(71.33)	(124.5)
Marginally Exposed	-0.004	-0.0007	67.0	130.20
	(0.010)	(0.014)	(67.65)	(116.79)
Exposed in Lower-Secondary School	0.001	-0.005	95.90	124.61
	(0.0135)	(0.0173)	(103.95)	(123.40)
Exposed in Primary School	**0.0028****	0.019	**413.60*****	169.95
	(0.014)	(0.0172)	(104.05)	(131.73)
Linear specification				
Shock ·Years of Exposure	**0.003****	0.003	**33.7*****	17.87*
	(0.001)	(0.002)	(10.0)	(10.7)
Observations	524,678	498,607	508,233	473,037
Parental Education	Low	High	Low	High

Obs: No association with parental income

EFFECTS ON MIGRATION

	(1)	(2)	(3)	(4)	(5)	(6)
	Living in Different Municipality			Living in a Big City		
Age	21-23	27-29	33-35	21-23	27-29	33-35
All Municipalities	0.000297	**0.0006****	**0.0005***	0.00002	**0.0004****	0.0001
	(0.0002)	(0.0003)	(0.00024)	(0.0001)	(0.0002)	(0.00018)
Observations	986,962	986,962	986,962	986,962	986,962	986,962
Pre treat. Baseline	.2672	.4520	.5131	.1781	.2419	.2313
Rural Municipalities	0.0002	**0.00054****	0.0004	0.0001	**0.0004****	0.0001
	(0.00022)	(0.00026)	(0.00025)	(0.0001)	(0.0002)	(0.0002)
Observations	608,808	608,808	608,808	608,808	608,808	608,808
Pre treat. Baseline	.2702	.4931	.5518	.0561	.1456	.1477
Urban Municipalities	**0.0011***	**0.0011****	**0.0017***	**-0.0005***	0.0001	0.0007
	(0.0006)	(0.0005)	(0.0009)	(0.0003)	(0.0005)	(0.0005)
Observations	378,154	378,154	378,154	378,154	378,154	378,154
Pre treat. Baseline	.2626	.3873	.4524	.3696	.3931	.3624

- Conducting a cost-benefit analysis of educational spending policy
- Increase of $100 per pupil from grades 1 to 9 (ages 7 to 15)
- Effect on labor market outcomes from age 28 to 60
- Benefit equation: $B = \sum_{t=28}^{60} \frac{\Delta Y}{(1+r)^{t-6}}$
- Cost equation: $C = \sum_{t=7}^{15} \frac{100}{(1+r)^{t-6}}$

- Policy is cost-effective if $B > C$
- Finding the Internal Rate of Return (IRR), that is, the maximum real discount rate (r_{max}) where this holds
- Equation to solve: $\sum_{t=28}^{60} \frac{\Delta Y}{(1+r_{max})^{t-6}} \geqslant \sum_{t=7}^{15} \frac{100}{(1+r_{max})^{t-6}}$
- Considering findings from Haider and Solon (2006) and Böhlmark and Lindquist (2006) for the association between returns to schooling and current earnings
- Using estimates from Linear specification at ages 33 to 35 in the Linear specification model to find r_{max}

- Conclusion that the policy of increasing funding for education has a net positive impact
- IRR for total population = **7.5%**, with a lower bound of **4.5%**.
- Variation in cost-effectiveness depending on the target population
- Considering only students with low-educated parents as beneficiaries increases IRR to around **8.5%**

CONCLUSION

- There is been some evidence of positive effects of increasing educational spending.
- However, the literature on long-run effects on earnings is scarce and lacking of detailed evidence with use of register data.
- This paper fills this gap, leveraging a reform in Norway that changed how grants to fund primary and lower-secondary education were distributed.
- Municipalities that received more grants out of this change spent more on education, especially hiring teachers.
- Long-run effects on students were broad, showing an impact on education and earnings. Policy was cost-effective and equality-enhancing.

Angrist, Joshua D, and Victor Lavy. 1999. "Using Maimonides' rule to estimate the effect of class size on scholastic achievement." The Quarterly journal of economics, 114(2): 533–575.

Baron, E. Jason. 2022. "School Spending and Student Outcomes: Evidence from Revenue Limit Elections in Wisconsin." American Economic Journal: Economic Policy, 14(1): 1–39, URL: https://www.aeaweb.org/articles?id=10.1257/pol.20200226, DOI: http://dx.doi.org/10.1257/pol.20200226.

Biasi, Barbara. 2023. "School finance equalization increases intergenerational Mobility." Journal of Labor Economics, 41(1): 1–38.

Böhlmark, Anders, and Matthew J Lindquist. 2006. "Life-cycle variations in the association between current and lifetime income: Replication and extension for Sweden." Journal of Labor Economics, 24(4): 879–896.

Borgen, Nicolai T, Lars J Kirkebøen, Andreas Kotsadam, and Oddbjorn Raaum. 2022. "Do funds for more teachers improve student outcomes?" CESifo Working Paper.

Cascio, Elizabeth U., Nora Gordon, and Sarah Reber. 2013. "Local Responses to Federal Grants: Evidence from the Introduction of Title I in the South." American Economic Journal: Economic Policy, 5(3): 126–59, URL:

https://www.aeaweb.org/articles?id=10.1257/pol.5.3.126, DOI: http://dx.doi.org/10.1257/pol.5.3.126.

Fredriksson, Peter, Björn Öckert, and Hessel Oosterbeek. 2013. "Long-term effects of class size." The Quarterly journal of economics, 128(1): 249–285.

Gordon, Nora. 2004. "Do federal grants boost school spending? Evidence from Title I." Journal of Public Economics, 88(9): 1771–1792, URL: https://www.sciencedirect.com/science/article/pii/S0047272703001373, DOI: http://dx.doi.org/https://doi.org/10.1016/j.jpubeco.2003.09.002.

Haider, Steven, and Gary Solon. 2006. "Life-cycle variation in the association between current and lifetime earnings." American economic review, 96(4): 1308–1320.

Hyman, Joshua. 2017. "Does money matter in the long run? Effects of school spending on educational attainment." American Economic Journal: Economic Policy, 9(4): 256–80.

Jackson, C. Kirabo, Rucker C. Johnson, and Claudia Persico. 2016. "The Effects of School Spending on Educational and Economic Outcomes: Evidence from School Finance Reforms." The Quarterly Journal of Economics, 131(1): 157–218, URL: https://www.jstor.org/stable/26495136.

Jackson, C Kirabo, and Claire L Mackevicius. 2023. “What impacts can we expect from school spending policy? Evidence from evaluations in the US.” American Economic Journal: Applied Economics.

Jackson, C Kirabo, Cora Wigger, and Heyu Xiong. 2021. “Do school spending cuts matter? Evidence from the Great Recession.” American Economic Journal: Economic Policy, 13(2): 304–335.

Lafortune, Julien, Jesse Rothstein, and Diane Whitmore Schanzenbach. 2018. “School finance reform and the distribution of student achievement.” American Economic Journal: Applied Economics, 10(2): 1–26.

Langørgen, Audun, Sturla Løkken, and Rolf Aaberge. 2013. “Kommunenes økonomiske atferd 1972-2009.”

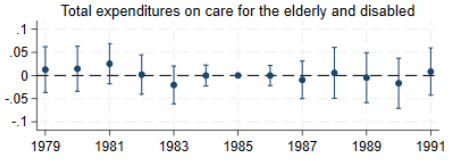
Leuven, Edwin, and Sturla A Løkken. 2020. “Long-term impacts of class size in compulsory school.” Journal of Human Resources, 55(1): 309–348.

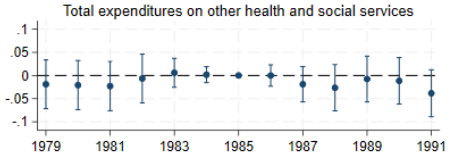
Litschig, Stephan, and Kevin M Morrison. 2013. “The impact of intergovernmental transfers on education outcomes and poverty reduction.” American Economic Journal: Applied Economics, 5(4): 206–240.

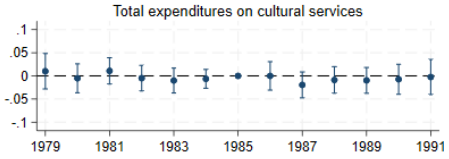
MUNICIPAL-LEVEL AVERAGES PER YEAR

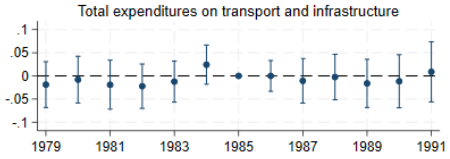
Year	(1) Yearly Expenditure on Education	(2) Public Schools	(3) Students per Teacher	(4) Teaching Hours Per Pupil Proxy	(5) Class Size
1981	13,897.4	7.69	10.96		18.67
1982	13,010.8	7.71	10.79		18.54
1983	12,519.7	7.72	10.62	4.38	18.43
1984	12,297.3	7.68	10.31	4.71	18.24
1985	12,525.1	7.65	9.99	4.90	18.18
1986	12,213.2	7.61	9.36	5.29	17.70
1987	12,394.7	7.60	8.90	5.59	17.40
1988	12,128.0	7.59	8.53	5.91	17.17
1989	12,226.2	7.50	8.41	6.23	17.11
1990	12,249.5	7.43	8.18	6.40	16.92
1991	12,523.0	7.40	7.75	6.49	16.87

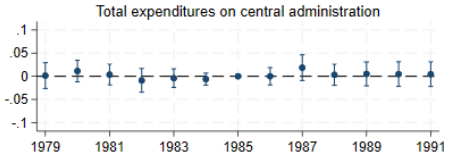
NO CHANGE ON OTHER AREAS

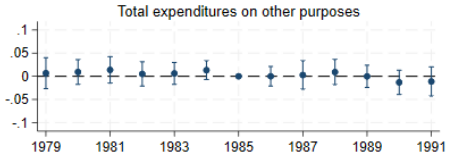












- Sample Limitation: Attrition.

  Grant shock is not fully experienced by the whole sample due to migration.

- All estimates should be seen as Intention to Treat.

- Coefficients are biased towards zero.

	Whole Data	Movers in 1986/91
Sample Size	1,177,056	269,246 (22.9%)
Mothers' Years of Study	11.60	11.54
Fathers' Years of Study	12.14	12.17
Men	.512	.452
Scad. Foreigners	.005	.010
Other. Foreigners	.019	.026