Does Money Matter? The Effect of Private Educational Expenditures on Academic Performance

Changhui Kang

Department of Economics
National University of Singapore

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Motivation

- Controversies over the effectiveness of educational expenditures
  1. Public school expenditures
     - Positive: Greenwald et al. (1996); Card and Krueger (1996,JEP); Krueger (2003,EJ)
     - Negligible: Hanushek (1986,JEL; 1997,EEPA; 2003,EJ); Betts (1996)

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     - Negligible: Goldhaber (1996); Figlio and Stone (1999); Altonji et al. (2005,JPE)

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  3. Examine the effect of *private* educational expenditures for tutoring on standardized test score.

Private Tutoring in South Korea

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- Two legal forms of tutoring
  1. private for-profit school-like institutions (*hakwon*)
  2. informal private instruction by university students.
- In KEEP, 77.8 percent receive tutoring; 45.5 percent use *hakwons*, 47.4 percent individual tutors.

Obstacles in an Empirical Analysis

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     - Parents' educational investment to compensate for existing differences.

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  2. A spurious positive correlation
     - Children from wealthier families often attend high-resource schools.
     - Parents' educational investment to reinforce existing differences.

Suggested Solutions

1. Random assignment of students to different resource environment
    - Tennessee's Student/Teacher Achievement Ratio (STAR) Project.

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2. Reliable exogenous variation of educational investment

    - Frequently used IVs: religious affiliation of the parents and geographical proximity of Catholic schools
    - Altonji et al. (2005, JHR): Lack of reliable exogenous variation
    - This study employs a student's birth order in the family—First-born indicator (FB).
    - Check: (1) $Cov(T_i, FB_i) \neq 0$, (2) $Cov(u_i, FB_i) = 0$
    - $plim(\widehat{\beta}_{IV}) = \beta_1 + \frac{Cov(u_i, FB_i)}{Cov(T_i, FB_i)}$

Birth Order and Educational Investment: Theories

1. Birth order effect on educational investment
    - The resource dilution model or the quantity/quality tradeoff model: priorities for first-born and last-born children
    - Priorities for later-borns: increasing earnings and child-care experience of parents over time
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2. Birth order effect on intelligence and academic capability
   - Genetic factors: higher birth order tends to have lower birth weight.
   - Intrahousehold allocation of resources to nutrition and health in early childhood
   - A family's intellectual environment: Confluence thoery
   - The optimal fertility-stopping rule

Empirical Evidence

1. Birth order effect on educational investment
   - Behrman and Taubman (1986,JOLE), Black et al. (2005,QJE): significant birth order effect on years of education
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2. Birth order effect on intelligence and academic capability
   - Zajonc (1976,Science), Zajonc and Mullally (1999), Hanushek (1992,JPE): significant (negative) birth order effect
   - Olneck and Bills (1979), Blake (1981), Retherford and Sewell (1991,ASR), Kessler (1991,JOLE): no significant birth order effect
   - Evidence is mixed; recent views seem to be no birth order effects on psychological characteristics (Harris 1998, Pinker 2002)

Data

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- Sample restrictions
  1. 2,000 students of general high school
  2. Exclude those students whose guardian is not one of the parents (85).
  3. Exclude those students who either attend a high school for music, fine arts and athletics, or take tutoring in these subjects (168).
  4. 1,752 students in the final sample

Data

- Main variables
  1. Outcome: math, the Korean language and English subject scores of the 2004 CSAT (in percentile). Both individual subject and average scores.
  2. Expenditures on tutoring: overall expenditures on monthly average ($10 \times ln(T_i+10)$), weekly average tutoring hours for each subject.
  3. Birth order: first-born indicator; first-born boy and girl indicators.

Table: Descriptive Statistics of the Main Sample

Variable	Total Sample N	Total Sample Mean (S.D.)	(1) First-borns Mean (S.D.)	(2) Later-borns Mean (S.D.)	Differences (1)-(2) Mean (S.E.)
Take test (No=1)	1752	0.134 (0.341)	0.135 (0.342)	0.133 (0.339)	0.003 (0.016)
Average score of three tests	1503	49.00 (22.68)	50.65 (22.36)	47.07 (22.90)	3.571 (1.170)**
Test score of Korean	1490	49.75 (25.82)	51.72 (25.59)	47.42 (25.93)	4.302 (1.338)**
Test score of math	1419	48.97 (26.33)	49.22 (26.31)	48.67 (26.36)	0.549 (1.404)
Test score of English	1490	49.37 (26.21)	51.77 (25.86)	46.57 (26.37)	5.195 (1.356)**
Tutoring Expenditure	1749	285.4 (341.1)	323.8 (375.6)	240.5 (289.6)	83.31 (16.25)**
Any tutoring (Yes=1)	1749	0.778 (0.416)	0.830 (0.376)	0.716 (0.451)	0.114 (0.020)**
Tutoring hours for Korean	1752	1.295 (2.504)	1.448 (2.607)	1.116 (2.368)	0.331 (0.120)**
Tutoring for Korean (Yes=1)	1752	0.301 (0.459)	0.338 (0.473)	0.258 (0.438)	0.080 (0.022)**
Tutoring hours for math	1752	2.464 (3.136)	2.746 (3.251)	2.134 (2.963)	0.612 (0.150)**
Tutoring for math (Yes=1)	1752	0.518 (0.500)	0.576 (0.495)	0.451 (0.498)	0.125 (0.024)**
Tutoring hours for English	1752	1.732 (2.627)	1.956 (2.520)	1.471 (2.725)	0.485 (0.125)**
Tutoring for English (Yes=1)	1752	0.410 (0.492)	0.473 (0.500)	0.337 (0.473)	0.136 (0.023)**
Prior quality	1285	46.12 (26.68)	45.13 (26.18)	47.30 (27.23)	-2.169 (1.493)
Hours of self-study	1752	11.34 (10.22)	11.62 (10.35)	11.01 (10.06)	0.613 (0.490)
Number of siblings	1752	2.192 (0.663)	1.997 (0.540)	2.420 (0.719)	-0.423 (0.030)**
First-born child (Yes=1)	1752	0.539 (0.499)			
First-born boy (Yes=1)	1752	0.311 (0.463)			
First-born girl (Yes=1)	1752	0.228 (0.420)			

Table: OLS and 2SLS Estimates: Birth Order Indicator as an IV

Dependent variable:	Reduced form models (OLS) Average test score	
	(1)	(2)
Tutoring Expenditure	0.097 (0.036)**	0.093 (0.037)*
First-born child		1.390 (1.101)
Hours of self-study	0.354 (0.049)**	0.353 (0.049)**
Prior quality (Q2)	13.723 (1.575)**	13.565 (1.583)**
Prior quality (Q3)	21.764 (1.582)**	21.617 (1.586)**
Prior quality (Q4)	34.124 (1.673)**	34.036 (1.677)**
Prior quality missing	19.289 (1.605)**	19.169 (1.608)**
Single father	-5.707 (2.383)*	-5.894 (2.380)*
Single mother	2.181 (2.334)	2.278 (2.338)
Books at home	0.004 (0.002)	0.004 (0.002)
Family income	0.002 (0.003)	0.002 (0.003)
Parents' avg edu	1.067 (0.236)**	1.051 (0.237)**
Parents' avg age	0.061 (0.152)	0.146 (0.166)
Age	-2.601 (0.912)**	-2.647 (0.916)**
Male	0.166 (1.503)	0.266 (1.504)
Only child	-2.624 (2.181)	-3.214 (2.221)
Number of siblings	-0.068 (0.920)	0.046 (0.929)
Intercept	39.69 (17.44)*	36.18 (17.52)*
School characteristics	Yes	Yes
R-square	0.377	0.378
Number of sample	1,480	1,480

Table: OLS and 2SLS Estimates (Continued)

Dependent variable:	Reduced form models (OLS) Tutoring Expenditure (log)		Structural models (2SLS) Average test score	
	(3)	(4)	(5)	(6)
Tutoring Expenditure			0.564 (0.393)	0.536 (0.387)
First-born child	2.952 (0.821)**			
First-born boy		2.611 (1.054)*		
First-born girl		3.351 (1.127)**		
Hours of self-study	0.018 (0.036)	0.019 (0.036)	0.345 (0.051)**	0.345 (0.051)**
Prior quality (Q2)	3.042 (1.304)*	3.045 (1.305)*	12.133 (2.275)**	12.227 (2.253)**
Prior quality (Q3)	1.526 (1.284)	1.544 (1.285)	20.898 (1.953)**	20.949 (1.938)**
Prior quality (Q4)	1.269 (1.321)	1.269 (1.321)	33.438 (1.953)**	33.479 (1.939)**
Prior quality missing	-2.717 (1.260)*	-2.721 (1.260)*	20.449 (2.030)**	20.380 (2.012)**
Estimates for Expend				
LIML			0.564 (0.393)	0.544 (0.391)
Fuller-k			0.530 (0.376)	0.512 (0.374)
95 % CI				
Wald			[-0.207, 1.335]	[-0.222, 1.294]
AR			[-0.394, 2.332]	[-0.598, 2.940]
LM			[-0.166, 1.698]	[-0.196, 1.693]
CLR			[-0.236, 1.980]	[-0.417, 2.095]
F (excluded IVs)	12.92	6.59		
P-value of overid test				0.620
R-square	0.244	0.244	0.051	0.287
Number of sample	1,480	1,480	1,480	1,480

Table: The Effect of Weekly Tutoring Hours on Subject Test Scores

	A. Mathematics ($N = 1,398$) (1)	B. English ($N = 1,467$) (3)	C. Korean ($N = 1,467$) (5)
Dependent variables:			
Weekly hours (log)			
First-born child	1.447 (0.526)**	2.039 (0.482)**	1.035 (0.445)*
F (Excluded IVs)	7.57	17.91	5.42
Subject test scores			
Estimates			
OLS	0.319 (0.076)**	0.032 (0.074)	0.101 (0.082)
2SLS	-0.420 (1.028)	1.376 (0.722)	2.300 (1.610)
LIML	-0.420 (1.028)	1.376 (0.722)	2.300 (1.610)
Fuller-k	-0.333 (0.959)	1.304 (0.695)	2.128 (1.460)
95 % CI			
Wald	[-2.435, 1.595]	[-0.038, 2.790]	[-0.854, 5.455]
AR	[-8.945, 2.990]	[-0.206, 4.334]	[-1.106, ∞]
LM	[-4.045, 1.859]	[0.121, 3.387]	[-0.226, 15.226]
CLR	[-19.372, 2.864]	[0.088, 4.073]	[-0.603, 19.246]

Heterogeneity in Effects

- Specification for IV Estimations

$$
\begin{aligned}
Y_i &= \beta_0 + T_i\beta_1 + \tilde{Y}_i\beta_2 + X_i\beta_3 + u_i \\
T_i &= \gamma_0 + FB_i\gamma_1 + \tilde{Y}_i\gamma_2 + X_i\gamma_3 + \epsilon_i
\end{aligned}
$$

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- Local Average Treatment Effect (LATE): Angrist et al. (1996,JASA)
  1. Causal interpretation for $\widehat{\beta}_1^{IV}$

$$E[Y_i(H) - Y_i(L)|\, T_i(1) = H, T_i(0) = L]$$

  2. If there is heterogeneity in effects,

$$E[Y_i(H) - Y_i(L)|\, T_i(1) = H, T_i(0) = L] \neq E[Y_i(H) - Y_i(L)]$$

  3. Stratify the main sample by (1) the level of pre-tutoring performance, (2) sex and (3) family income.

Table: The Effect by Ability Level

	A. Low-level ($N = 415$) (1)	B. Medium-level ($N = 437$) (3)	C. High-level ($N = 249$) (5)
Dependent variables:			
Expenditure (log)			
First-born child	4.940 (1.358)**	1.623 (1.353)	3.511 (2.015)
F (Excluded IVs)	13.24	1.44	3.04
Average test score			
Estimates			
OLS	0.168 (0.078)*	0.184 (0.070)**	0.164 (0.072)*
2SLS	0.741 (0.429)	0.578 (1.100)	0.689 (0.710)
LIML	0.741 (0.429)	0.578 (1.100)	0.689 (0.710)
Fuller-k	0.699 (0.410)	0.416 (0.821)	0.558 (0.592)
95 % CI			
Wald	[-0.100, 1.582]	[-1.578, 2.733]	[-0.702, 2.081]
AR	[-0.256, 2.698]	$[-\infty, \infty]$	$[-\infty, \infty]$
LM	[-0.035, 2.015]	$[-\infty, \infty]$	$[-\infty, \infty]$
CLR	[-0.095, 2.397]	$[-\infty, \infty]$	$[-\infty, \infty]$

Table: The Effect by Sex

	A. Male ($N = 840$) (1)	B. Female ($N = 640$) (3)
Dependent variables:		
Expenditure (log)		
First-born boy	2.772 (1.147)*	
First-born girl		2.944 (1.167)*
F (Excluded IVs)	5.84	6.37
Average test score		
Estimates for Expenditure		
OLS	0.088 (0.049)	0.123 (0.056)*
2SLS	0.936 (0.641)	0.118 (0.542)
LIML	0.936 (0.641)	0.118 (0.542)
Fuller-k	0.811 (0.568)	0.119 (0.504)
95 % CI		
Wald	[-0.320, 2.193]	[-0.943, 1.180]
AR	[-0.462, ∞]	[-4.322, 4.724]
LM	[-0.121, 5.176]	[-1.508, 1.910]
CLR	[-0.377, 14.49]	[-19.00, 18.60]

Table: The Effect by Family Income

	A. Low-income ($N = 309$) (1)	B. Mid-income ($N = 767$) (3)	C. High-income ($N = 404$) (5)
Dependent variables: Expenditure			
First-born child	2.845 (1.857)	4.526 (1.157)**	1.937 (1.480)
F (Excluded IVs)	3.13	15.31	1.71
Average test score			
Estimates for Expenditure			
OLS	0.185 (0.082)*	0.047 (0.051)	0.141 (0.083)
2SLS	0.008 (0.858)	0.415 (0.350)	0.921 (1.219)
LIML	0.008 (0.858)	0.415 (0.350)	0.921 (1.219)
Fuller-k	0.062 (0.716)	0.392 (0.338)	0.632 (0.900)
95 % CI			
Wald	[-1.674, 1.691]	[-0.271, 1.101]	[-1.469, 3.311]
AR	$[-\infty, \infty]$	[-0.457, 1.774]	$[-\infty, \infty]$
LM	$[-\infty, \infty]$	[-0.256, 1.352]	$[-\infty, \infty]$
CLR	$[-\infty, \infty]$	[-0.276, 1.553]	$[-\infty, \infty]$

Table: The Effect of Tutoring Expenditures on Test-writing

Dependent variable:	Tutoring Expenditure	Take Test (No=1)	
Estimation method:	OLS-I	2SLS-I	OLS
	(1)	(3)	(5)
Tutoring Expenditure		0.001 (0.005)	-0.0011 (0.0006)
First-born child	3.382 (0.766)**		
Hours of self-study	0.043 (0.034)	-0.003 (0.001)**	-0.003 (0.001)**
Prior quality (Q2)	2.952 (1.186)*	-0.123 (0.033)**	-0.116 (0.032)**
Prior quality (Q3)	2.048 (1.169)	-0.131 (0.031)**	-0.126 (0.031)**
Prior quality (Q4)	2.224 (1.205)	-0.086 (0.032)**	-0.081 (0.033)*
Prior quality missing	-2.047 (1.127)	-0.073 (0.029)*	-0.077 (0.032)*
Single father	-3.559 (2.050)	-0.007 (0.052)	-0.014 (0.048)
Single mother	-3.002 (1.528)*	0.079 (0.041)	0.071 (0.043)
Books at home	0.000 (0.002)	0.000 (0.000)	0.000 (0.000)
Family income	0.019 (0.002)**	0.000 (0.000)	0.000 (0.000)
Parents' avg edu	0.910 (0.155)**	-0.005 (0.006)	-0.003 (0.004)
Parents' avg age	0.199 (0.118)	-0.008 (0.003)**	-0.008 (0.002)**
Age	0.122 (0.645)	-0.006 (0.016)	-0.005 (0.016)
Male	-0.259 (1.000)	0.003 (0.024)	0.002 (0.026)
Only child	-1.863 (1.496)	0.045 (0.035)	0.043 (0.037)
Number of siblings	-1.123 (0.620)	0.027 (0.017)	0.024 (0.016)
Intercept	14.04 (12.41)	0.817 (0.318)*	0.867 (0.301)**
School characteristics	Yes	Yes	Yes
F (Excluded IVs)	19.50		

Potential Explanations

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4. Peer pressure in parents' peer group
   - Cultural factors in parenting (e.g., sleeping arrangement of infants).
   - Prevalence of tutoring among parents' peers.

Concluding Remarks

- OLS estimates are biased downward.
- IV methods to estimate causality
    1. Birth order significantly affects tutoring expenditures
    2. The IV estimates imply that a 10 percent increase in expenditure leads to a 0.54 percentile point improvement.
    3. Modest and comparable to the effect of public school expenditures on earnings estimated by previous studies (e.g. Card and Krueger 1996).
    4. Teacher quality and peer pressure among parents.

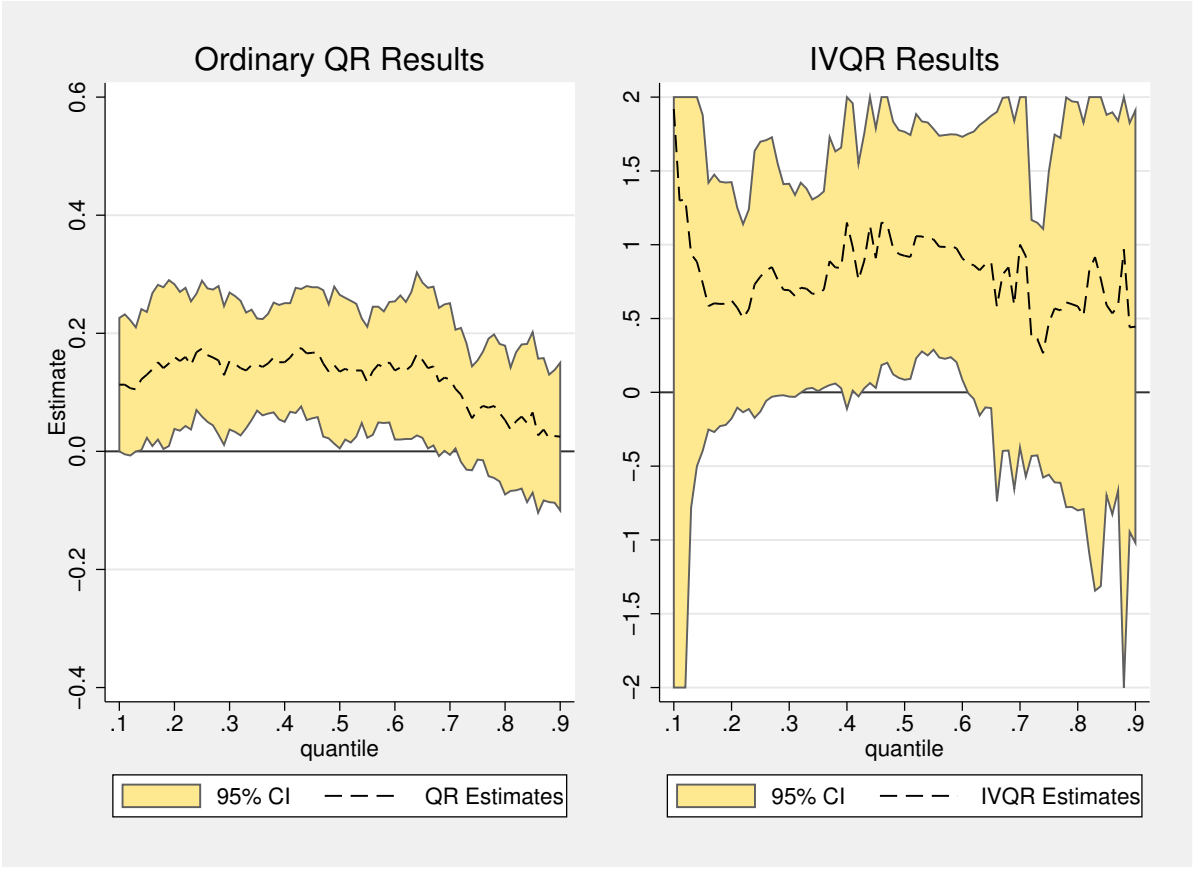

Figure: Quantile IV Estimates: Average Test Score