

Elite individuals, institutions, and economic growth accounting

James Xu

ECON 442, Duke University

2024

Research Question

What is the relationship between elite students, academic institutions, and economic growth?

- ▶ Are there outsized returns to economic growth when there are more academic elites?
- ▶ How can we measure academic competition and education quality beyond means?

Method

Through this paper, I investigate the relationship between the number of top-ranked universities, share of top math students, IMO scores, and GDP per capita growth to analyze these questions.

Data Sources

- ▶ World Bank: World Development Indicators
- ▶ International Math Olympiad
- ▶ ARWU University Rankings
- ▶ Economist Democracy Scores

World Bank Data

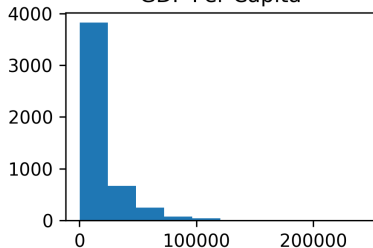
The World Bank collects and publishes development indicators for most countries/economies in the world. In this paper, I use the following variables:

- ▶ GDP Per Capita Growth: % growth in constant 2015 \$USD
- ▶ GDP Per Capita: current \$USD
- ▶ School Completion Rates: % gross of relevant age group
 - ▶ "What % of primary-school-aged population is enrolled in primary school?"
 - ▶ This number can be greater than 100%
 - ▶ Not available for all years and all countries → missing data problem
- ▶ Population: all residents of a country/territory

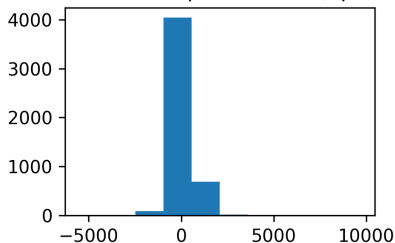
World Bank Data

Distributions

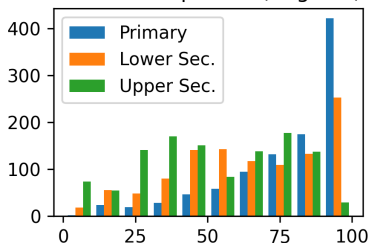
GDP Per Capita



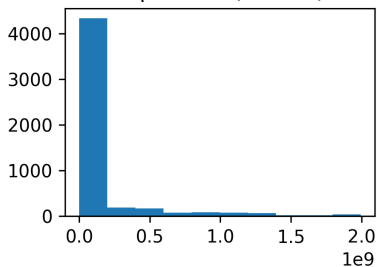
GDP Per Capita Growth (bps)



School Completion (% gross)

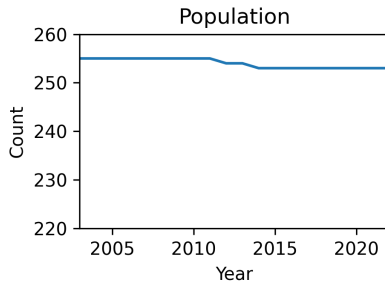
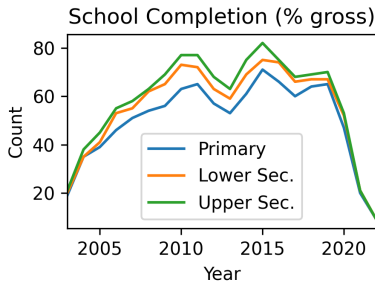
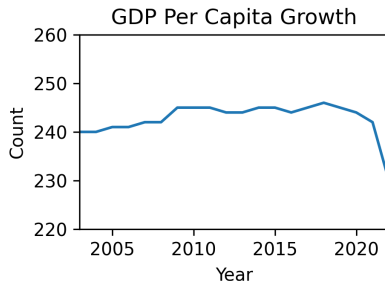
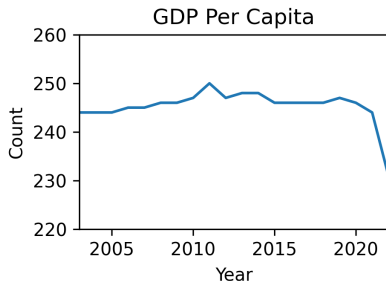


Population (billions)



World Bank Data

Missing data



IMO Scores

The IMO is an international mathematics contest for high school students

Table: Top 10 countries by IMO score.

Region	IMO Score	GDPpc	GDPpc Growth
KOR	10.2026	26060.9203	293.8552
CHN	9.8296	6424.4972	786.8171
USA	9.6196	54346.5078	125.7613
RUS	9.0800	10432.8366	277.0704
SGP	9.0642	51652.4651	348.0543
BGR	8.8821	7556.3933	417.7564
ROU	8.7367	9432.6698	439.7522
HUN	8.7153	13979.7009	262.9650
VNM	8.5029	2159.2583	527.6404
UKR	8.3941	3079.8378	131.9303

- ▶ Scores collected from 2003 to 2022
- ▶ Scores are transformed by $t(s) = \frac{s}{\log P}$ where s is the country's raw score and P is population.
 - ▶ Team size of 6 means that larger countries have an advantage due to "genius odds"
 - ▶ Score is capped, so dividing by $\log P$ will correct for theoretical ceiling of performance

Model specification

Let variables of interest be: $math99$, $ARWU$, $ARWU \times GDPpc$, IMO .
For the sake of concision, let E be a 1 by 4 matrix defined as:

$$E_{i,t} = [math99_{i,t} \quad ARWU_{i,t} \quad ARWU_{i,t} \times GDPpc_{i,t} \quad IMO_{i,t}]$$

Let the coefficients of $E_{i,t}$ be a 4 by 1 matrix called λ . For control variables, $C_{i,t}$ is the matrix of variables and α is coefficients..

$$Y_{i,t} = \beta_0 + \lambda E_{i,t} + \alpha C_{i,t} + \epsilon_{i,t} \tag{1}$$

PISA data regression

Highly dependent on model specification due to rich country bias and limited variation

	<i>Dependent variable: GDPpcGrowth</i>			
	(1)	(2)	(3)	(4)
PISA Math in global P99		12.582 (23.160)	16.888 (20.869)	122.288 (79.814)
IMO score per log population	11.744 (7.232)	4.247 (9.102)	10.055 (8.154)	71.462** (29.447)
ARWU insitutions	-586.307*** (198.985)	-559.067** (240.047)	-575.550*** (213.365)	-295.306 (559.483)
ARWU insitutions x GDP PC	0.009** (0.004)	0.009* (0.005)	0.008* (0.004)	-0.007 (0.014)
PISA Math		0.636 (0.949)	-0.273 (0.876)	-4.581 (3.456)
GDP per capita	-0.003** (0.002)	-0.006*** (0.002)	-0.004** (0.002)	-0.007 (0.012)
Primary School Completion Rate	-0.712 (3.868)	-2.406 (4.849)	-0.112 (4.338)	-4.624 (18.411)
Lower Sec. Completion Rate	1.485 (3.255)	0.777 (3.704)	1.568 (3.290)	21.092 (16.364)
Upper Sec. Completion Rate	1.597 (2.515)	1.439 (2.870)	1.542 (2.543)	-15.224 (17.185)
Democracy Rating	0.940 (19.787)	3.972 (23.684)	4.167 (21.249)	-12.702 (128.289)
Time Effects	Yes	No	Yes	Yes
Fixed Effects	No	No	No	Yes
Entities	48	48	48	48
Observations	109	109	109	109
R ²	0.397	0.212	0.402	0.753
Adjusted R ²	0.322	0.122	0.313	0.432
Residual Std. Error	197.737 (df=96)	224.993 (df=97)	199.076 (df=94)	181.047 (df=47)
F Statistic	5.275*** (df=12; 96)	2.367** (df=11; 97)	4.512*** (df=14; 94)	2.345*** (df=61; 47)

Note:

*p<0.1; **p<0.05; ***p<0.01

Non-PISA data regression

	<i>Dependent variable: GDPpcGrowth</i>			
	Model 3 (PISA)	Model 5 (PISA years)	Model 6 (All years)	Model 7 (All years, FE)
IMO score per log population	10.055 (8.154)	18.160*** (6.517)	13.297*** (3.993)	10.006 (10.776)
ARWU insitutions	-575.550*** (213.365)	-446.996** (221.189)	-353.730*** (131.179)	523.241* (292.381)
ARWU insitutions x GDP PC	0.008* (0.004)	0.008* (0.004)	0.005* (0.002)	-0.012** (0.006)
GDP per capita	-0.004** (0.002)	-0.005*** (0.002)	-0.004*** (0.001)	0.002 (0.004)
Primary School Completion Rate	-0.112 (4.338)	-3.530** (1.740)	-1.754 (1.227)	-1.505 (4.983)
Lower Sec. Completion Rate	1.568 (3.290)	5.370** (2.445)	1.911 (1.692)	-0.147 (5.035)
Upper Sec. Completion Rate	1.542 (2.543)	-2.365 (1.946)	0.081 (1.325)	1.981 (3.776)
Democracy Rating	4.167 (21.249)	13.397 (11.913)	19.784*** (7.637)	87.626** (37.349)
Population	-0.000* (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)
Time Effects	Yes	Yes	Yes	Yes
Fixed Effects	No	No	No	Yes
Entities	48	103	137	137
Observations	109	222	746	746
R^2	0.402	0.202	0.380	0.611
Adjusted R^2	0.313	0.156	0.360	0.505
Residual Std. Error	199.076 (df=94)	240.456 (df=209)	288.864 (df=722)	253.976 (df=586)
F Statistic	4.512*** (df=14; 94)	4.417*** (df=12; 209)	19.219*** (df=23; 722)	5.785*** (df=159; 586)

Note:

*p<0.1; **p<0.05; ***p<0.01