TEST SCORES, NON-COGNITIVE SILLS AND ECONOMIC GROWTH

EE 462 Development Macroeconomics

Reference: Balart, P., Oosterveen, M., and Webbink, D. (2018). Test scores, noncognitive sills and economic growth. *Economics of Education Review*, *68*, 134-153.

Summary

- Objective:

To explore the effects of cognitive vs. non-cognitive skills on economic growth

- Identification strategy:

Use the exogenous variation in the ordering questions asked by the PISA to decompose student performance into 2 components: the starting performance and the declining performance

- Findings:

- Both components are associated with economic growth.
- Non-cognitive skills are partly responsible for the relationship between test scores and economic growth.

Previous Studies

- Role of human capital in explaining economic growth.
  - What are good proxies for human capital?
- Relationship between cognitive test scores and economic growth
  - Main reference: Hanushek & Woessmann (2012)
  - Problems: omitted variables, reversed causality, and measurement errors
- Non-cognitive skills, long-term individual outcomes and cognitive test scores
  - Perry Pre School Program: found causal effect of changes in noncognitive skills on economic and social outcomes.
  - Non-cognitive skills are important for test scores and also have been found to be important for productivity and other social outcomes at individual level.
  - -> Non-cognitive skills might be an important omitted variable in the relationship between cognitive skills and economic outcomes of nations.

Test Score Decomposition

- Measure of cognitive skills:

The starting performance

- Measure of non-cognitive skills:

The decline in performance during the test

Table 1
Rotation design of the 13 PISA booklets.

Booklet	Cluster 1	Cluster 2	Cluster 3	Cluster 4
1	Science 1	Science 2	Science 4	Science 7
2	Science 2	Science 3	Math 3	Reading 1
3	Science 3	Science 4	Math 4	Math 1
4	Science 4	Math 3	Science 5	Math 2
5	Science 5	Science 6	Science 7	Science 3
6	Science 6	Reading 2	Reading 1	Science 4
7	Science 7	Reading 1	Math 2	Math 4
8	Math 1	Math 2	Science 2	Science 6
9	Math 2	Science 1	Science 3	Reading 2
10	Math 3	Math 4	Science 6	Science 1
11	Math 4	Science 5	Reading 2	Science 2
12	Reading 1	Math 1	Science 1	Science 5
13	Reading 2	Science 7	Math 1	Math 3

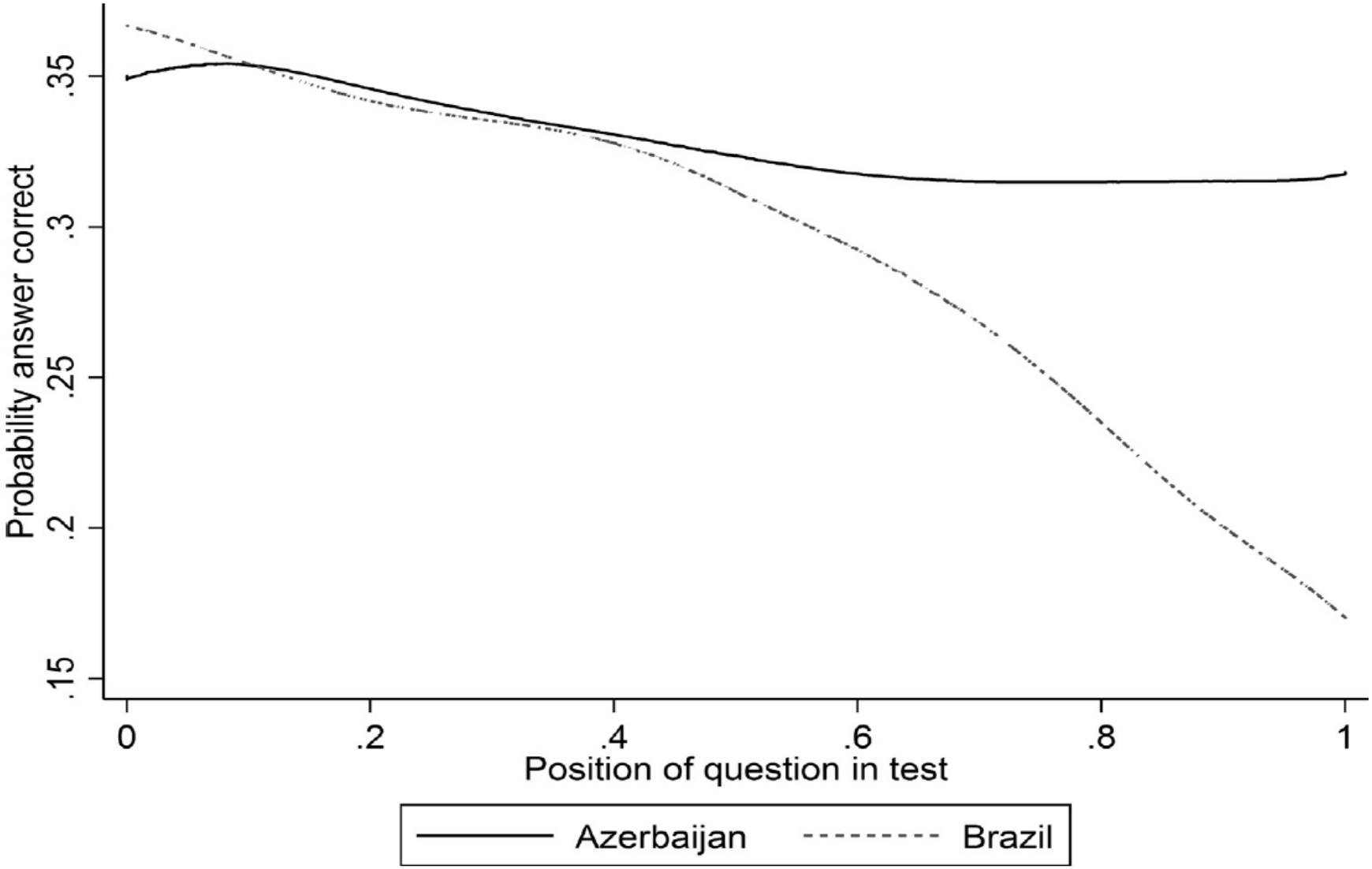
Source: OECD (2009).

Table A.2
The starting performance and decline in performance per country.

Country	(1) PISA score	(2) $P[Q_0 = 1]$	(3) $P[Q_1 = 1]$	(4) Decline	Country	(1) PISA score	(2) $P[Q_0 = 1]$	(3) $P[Q_1 = 1]$	(4) Decline
Colombia	381	.59	.243	.347	Lithuania	481.3	.737	.64	.097
Uruguay	422.7	.722	.423	.299	United States	481.5	.776	.679	.097
Argentina	382	.636	.359	.277	Luxembourg	485	.807	.71	.097
Tunisia	377	.454	.229	.225	Poland	500.3	.823	.726	.097
Brazil	384.3	.547	.331	.216	China, Macao	509.3	.828	.732	.096
Kyrgyzstan	306	.393	.185	.208	Hungary	492.3	.789	.694	.095
Mexico	408.7	.594	.387	.207	Slovakia	482	.816	.725	.091
Chile	430.3	.714	.508	.207	Sweden	504	.842	.752	.09
Qatar	326.3	.525	.337	.188	Japan	517.3	.877	.791	.086
Israel	445	.686	.506	.18	Azerbaijan	403.7	.584	.499	.085
Russia	465	.832	.654	.177	Canada	529.3	.832	.748	.084
Greece	464	.786	.609	.177	Ireland	508.7	.753	.67	.083
Jordan	402.3	.51	.339	.171	Australia	520	.836	.754	.082
Romania	409.7	.6	.432	.168	Belgium	510.3	.836	.755	.081
Thailand	418.3	.533	.368	.165	Denmark	501	.866	.787	.079
Bulgaria	416.3	.667	.502	.165	Taiwan	525.7	.833	.754	.078
Indonesia	392.3	.574	.411	.163	Czech Republic	502	.845	.766	.078
Italy	468.7	.735	.582	.153	New Zealand	524.3	.814	.737	.077
Turkey	431.7	.537	.388	.149	Slovenia	505.7	.819	.742	.077
Serbia	424	.709	.578	.131	Germany	505	.826	.753	.073
Latvia	485	.761	.638	.123	Estonia	515.7	.829	.756	.072
Portugal	470.7	.779	.658	.121	Netherlands	521	.83	.76	.07
Spain	476.3	.803	.682	.121	Hong Kong	541.7	.817	.746	.07
Montenegro	401	.583	.467	.117	Korea	541.7	.823	.755	.067
France	493	.807	.693	.114	Switzerland	513.7	.85	.789	.061
United Kingdom	501.7	.762	.652	.11	Liechtenstein	519	.885	.828	.057
Norway	487	.83	.721	.109	Austria	502	.843	.789	.054
Iceland	493.7	.85	.75	.1	Finland	552.7	.898	.856	.042
Croatia	479	.759	.66	.099					

Notes: Probabilities are based on the estimates from Eq. (2), using PISA 2006 and PISA weights.

Decline in performance for Azerbaijan and Brazil



Estimation

- Starting equation:

$$G_c = \beta_0 + \beta_1 H_c + \beta_2 GDP_{0c} + \sum_n \delta_n Z_{nc} + \epsilon_c \qquad (1)$$

- Modified equation:

$$H_c = f(S_c, PD_c) + \nu_c.$$

$$G_c = \beta_0 + \beta_1 S_c + \beta_2 PD_c + \beta_3 GDP_{0c} + \sum_n \delta_n Z_{nc} + \epsilon_c \qquad (3)$$

Table A.3
Descriptive statistics.

Country	Initial GDP (1960)	GDP growth (1960–2000)	HW-index	Starting performance (st. error)	Performance decline (st. error)	Num. of students
Argentina	6.033	1.258	3.920	.3478 (.0427)	−.710 (.0118)	4339
Australia	15.20	2.061	5.093	.9789 (.0250)	−.292 (.0059)	14170
Austria	10.54	3.173	5.089	1.007 (.0418)	−.204 (.0094)	4908
Belgium	10.16	2.975	5.041	.9766 (.0310)	−.287 (.0072)	8685
Brazil	2.469	2.709	3.637	.1183 (.0338)	−.555 (.0096)	9295
Canada	12.90	2.382	5.037	.9610 (.0284)	−.292 (.0068)	22646
Chile	3.700	2.689	4.049	.5664 (.0358)	−.546 (.0095)	5233
Colombia	2.940	1.758	4.152	.2271 (.0459)	−.924 (.0127)	4478
Denmark	11.60	2.757	4.962	1.107 (.0421)	−.310 (.0096)	4532
Finland	9.034	3.149	5.126	1.271 (.0442)	−.207 (.0094)	4714
France	10.19	2.815	5.040	.8680 (.0369)	−.362 (.0090)	4716
Greece	5.588	3.428	4.607	.7919 (.0371)	−.515 (.0093)	4873
Hong Kong	3.289	5.633	5.194	.9025 (.0413)	−.239 (.0097)	4645
Iceland	14.07	2.584	4.935	1.038 (.0437)	−.363 (.0101)	3789
Indonesia	.6651	3.719	3.879	.1871 (.0343)	−.411 (.0101)	10647
Ireland	7.280	4.008	4.994	.6842 (.0363)	−.245 (.0093)	4585
Israel	6.989	3.133	4.686	.4848 (.0363)	−.470 (.0095)	4584
Italy	8.718	3.174	4.757	.6285 (.0249)	−.420 (.0064)	21773
Japan	5.594	4.521	5.310	1.160 (.0369)	−.349 (.0084)	5952
Jordan	2.721	.8659	4.263	.0257 (.0332)	−.441 (.0092)	6509
Korea	1.670	6.129	5.337	.9255 (.0365)	−.234 (.0090)	5176
Mexico	4.942	2.271	3.997	.2379 (.0278)	−.526 (.0076)	30971
Netherlands	13.43	2.606	5.114	.9557 (.0429)	−.249 (.0099)	4769
New Zealand	14.26	1.661	4.978	.8943 (.0388)	−.259 (.0093)	4823
Norway	12.50	3.286	4.830	.9542 (.0386)	−.369 (.0094)	4692
Portugal	4.181	4.134	4.563	.7694 (.0376)	−.362 (.0095)	5109
Romania	1.362	3.904	4.562	.2532 (.0478)	−.425 (.0127)	5118
Spain	6.333	3.809	4.829	.8522 (.0308)	−.379 (.0075)	19604
Sweden	14.31	1.912	5.013	1.001 (.0407)	−.320 (.0104)	4443
Switzerland	21.02	1.494	5.141	1.035 (.0339)	−.234 (.0077)	12192
Taiwan	1.858	6.459	5.451	.9650 (.0320)	−.276 (.0074)	8815
Thailand	.9620	4.713	4.564	.0835 (.0336)	−.420 (.0094)	6192
Tunisia	1.805	2.945	3.795	−.115 (.0373)	−.627 (.0105)	4640
Turkey	3.183	2.285	4.127	.0923 (.0370)	−.376 (.0103)	4942
United Kingdom	11.20	2.558	4.949	.7134 (.0304)	−.322 (.0077)	13152
United States	15.38	2.373	4.902	.7598 (.0364)	−.294 (.0098)	5611
Uruguay	5.010	1.562	4.300	.5873 (.0409)	−.782 (.0104)	4839

Notes: Descriptive statistics for the sample used in Table 5. GDP per capita in 1960 PPP adjusted (in 2005 international Dollars), shown in thousands. The PISA-components are related to the wave of 2006.

Results: Replication

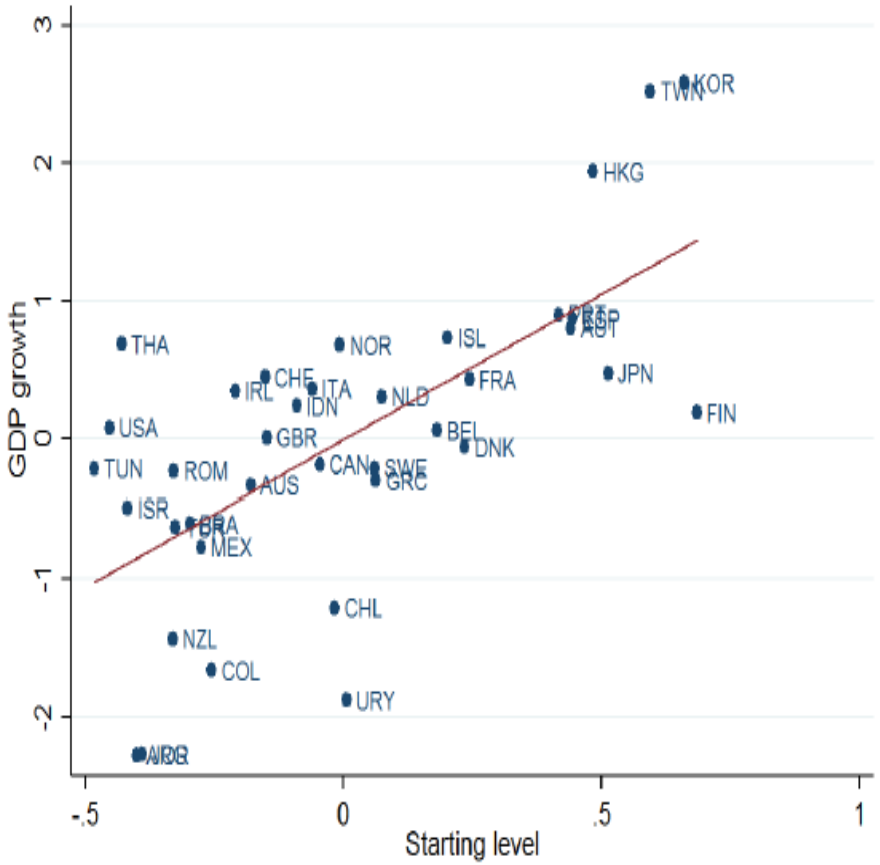
Table 4
Growth regressions with the HW-index and PISA scores using the PISA sample.

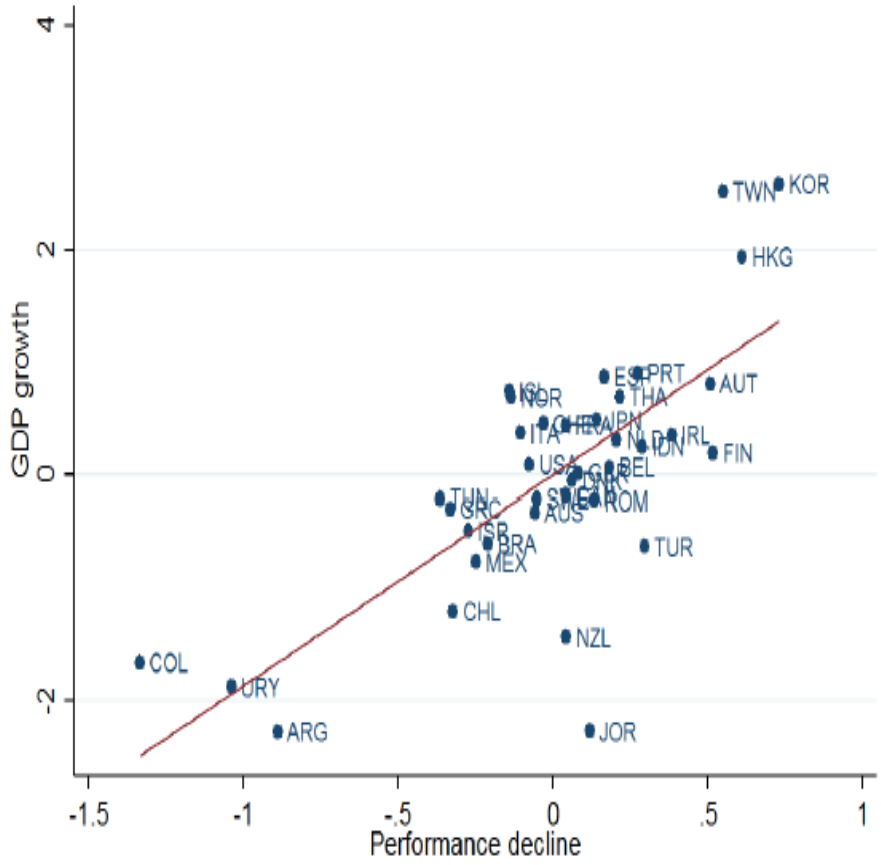
	(1)	(2)	(3)	(4)[a]	(5)[b]	(6)[c]	(7)[d]	(8)[e]	(9)[f]
				Panel A: HW-index as a measure of human capital with restricted sample					
HW-index		2.256***	2.260***	2.310***	2.186***	1.144**	1.399***	1.378***	2.213***
		(9.15)	(9.22)	(9.14)	(9.59)	(2.71)	(3.74)	(3.74)	(9.92)
Years of schooling	0.187*		−0.00375	−0.0320	−0.0661	0.0420	0.0582	0.0115	−0.0250
	(1.80)		(−0.05)	(−0.49)	(−1.02)	(0.51)	(0.85)	(0.15)	(−0.30)
N	37	37	37	37	37	37	36	36	37
Adj. R^2	0.208	0.730	0.722	0.723	0.809	0.784	0.770	0.799	0.717
				Panel B: PISA 2006 as a measure of human capital with restricted sample					
PISA 2006		2.282***	2.245***	2.235***	2.223***	1.181***	1.265***	1.220**	2.299***
		(7.98)	(7.59)	(6.84)	(7.16)	(3.53)	(2.83)	(2.74)	(9.73)
Years of schooling	0.187*		0.0426	0.0316	−0.0241	0.0654	0.104	0.0526	0.0305
	(1.80)		(0.53)	(0.38)	(−0.28)	(0.84)	(1.46)	(0.63)	(0.35)
N	37	37	37	37	37	37	36	36	37
Adj. R^2	0.208	0.700	0.694	0.692	0.691	0.803	0.754	0.781	0.728

Notes: *t* statistics in parentheses, heteroskedasticity robust standard errors * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable: average annual growth rate in GDP per capita, 1960–2000 Regressions include a constant and GDP per capita in 1960.

[a] Measure of years of schooling refers to the average over the period 1960–
[b] Controlling for outliers by using rreg command in Stata.
[c] Includes indicators for the eight world regions.
[d] Controlled for openness of economy and protection against expropriation.
[e] Controls in *d* plus fertility and tropical location.
[f] GDP per capita 1960 measured in logs.

Association between the conditional starting performance and the conditional decline in performance with economic growth during 1960-2000





Results: Regressions of economic growth on the starting performance and performance decline

Table 5

Regressions of economic growth on the starting performance and performance decline.

	(1)	(2)	(3)	(4)[a]	(5)[b]	(6)[c]	(7)[d]	(8)[e]	(9)[f]
Starting performance	2.143***		1.330***	1.345**	1.049***	0.766*	0.701	0.249	1.934***
	(4.84)		(2.76)	(2.69)	(3.05)	(2.00)	(1.38)	(0.49)	(4.45)
Performance decline		1.872***	1.300***	1.257***	1.467***	0.680*	0.917***	1.120***	0.701**
		(6.36)	(4.44)	(4.17)	(5.14)	(1.83)	(3.09)	(4.95)	(2.64)
Years of schooling	0.0415	0.173*	0.0871	0.0651	0.0483	0.0793	0.131*	0.0839	0.0344
	(0.53)	(1.86)	(1.23)	(0.96)	(0.64)	(1.00)	(1.93)	(1.14)	(0.44)
N	37	37	37	37	37	37	36	36	37
Adj. R^2	0.579	0.623	0.726	0.721	0.746	0.787	0.754	0.798	0.716

Notes: t statistics in parentheses, heteroskedasticity robust standard errors * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Dependent variable: average annual growth rate in GDP per capita, 1960–2000; Regressions include a constant and GDP per capita in 1960 [a–f] See the description of Table 4.