Catching the Big Fish in the Little Pond (Effect): Causal Evidence with Cross-National and By Gender Comparisons

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Social comparison theory states that individuals are driven to evaluate their own abilities and that in the absence of objective, non-social criteria they will evaluate their own abilities by making comparisons with the abilities of others (Festinger, 1954).

Students downgrade their belief in their own ability in a particular subject (their *academic self-concept* in that subject) when they perceive other students are more likely to excel in that subject (Huguet et al., 2009).

- Reduction of academic self-concept can have a negative effect on subsequent educational outcomes due to academic self-concept correlated with wide number of outcomes (e.g. Marsh et al., 2005; Marsh & Yeung, 1998)

BFLPE

- Big-Fish-Little-Pond Effect (BFLPE) – the negative effect of class or school average achievement on student' academic self-concept

Generalizability of BFLPE

A large number of studies have shown a negative correlation between average school or class achievement levels and academic self-concept, conditional on student's own achievement level

- for multiple academic subjects (for example, math - Seaton, Marsh, Craven, 2010; science – Chiu, 2012; language – Marsh and Hau, 2003)
- for multiple levels of schooling (Hung and Liou, 2013; Thijs, Verkuyten, and Helmond, 2010; Marsh et al., 2007)
- for students from different social and economic backgrounds
- and psychological predispositions (Seaton et al., 2010).

What's the Problem with BFLPE studies?

There is in fact little causal evidence about whether the BFLPE exists.

- The vast majority of studies have largely been correlational in nature. They use cross-sectional data and control for a small number of baseline characteristics. Some studies use longitudinal data but still have omitted variable bias problem
- We know of no study that utilizes experimental or quasi-experimental research designs.

Research Question

- Is there a strong causal basis for the BFLPE?
- Is BFLPE generalizable across different contexts:
  - across national contexts
  - for different genders

Data

- TIMSS 2011 dataset which contains cross-sectional, nationally representative information on 253,974 8th grade students, their math and science teachers, and school principals in 46 countries.

- Unique Russian longitudinal study “Trajectories in Education and Career” (TrEC – http://trec.hse.ru/).
  - The first wave was TIMSS 2011 (4,893 8th grade students in 231 classrooms in 210 schools).
  - At the second wave PISA 2012 was administered on TIMSS 2011 sample in Russia. 87% of TIMSS sample were covered at PISA wave (4,241 students in 229 classes in 208 schools). Besides students, their math and physics teachers were surveyed.

Variables of Interest

Academic self-concept is measured with the indices
- "Self-confidence in math" and
- "Self-confidence in science" ("self-confidence in physics" for Russia)

We define **BFLPE** as
- effect of class average achievement (conditional on individual achievement)
- effect of student's rank in a class (conditional on individual achievement)

Indicators of **individual achievements**: five TIMSS plausible values in math and science (standardized with m=0, sd=1)

Covariates:
- students' gender, language at home, immigrant status, number books at home, the highest level of parents' education (for OLS)
- teachers' gender, teachers' years of experience, teachers' education and major area of study.

Estimation Strategy

- *Replicating Previous Studies*
- *Estimating Causal Effects*

Replicating Previous Studies - OLS

We use TIMSS 2011 data and run regular multivariate regression (OLS):

$$Y_{ics} = \beta_0 + \beta_1 A_{ics} + \beta_2 T_{ics} + X'_{ics}\alpha + \varepsilon_{ics}\text{ , } i = 1,\ldots N,\ c=1,\ldots C,\ s = 1,\ldots S$$

This model produces causal estimates of BFLPE only if outcome (student self-concept) and treatment variables (conditional class average test score/ student rank in class) are uncorrelated with the error term.

There may be unobserved student-level variations that are jointly correlated with both treatment and outcome variables.

Estimating Causal Effects – Cross-Subjects FE

Causal effect may be ideally measured with difference of outcomes produced by assigning the same object to different conditions - with and without treatment (Rubin, 1980)

We use **within student cross-subjects fixed effects analysis** (Altinok and Kingdon, 2012; Schwerdt and Wupperman, 2011; van Klaveren, 2011; Clotfelter et al., 2010; Dee, 2007) .

It allows to compare the outcomes of the same student in different conditions – in different subjects. This approach controls for all characteristics that do not vary across subjects, such as student sex, or age, or parents education level, or area population, or school size etc.

$$Y_{ics} - \bar{Y}_{ic} = \beta_1(A_{ics} - \bar{A}_{ic}) + \beta_2(T_{ics} - \bar{T}_{ic}) + (X_{ics} - \bar{X}_{ic})\alpha + (\varepsilon_{ics} - \bar{\varepsilon}_{ic}),$$

$$\text{where } \bar{Y}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{Y_{ics}}, \bar{X}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{X_{ics}}, \bar{T}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{T_{ics}}, \bar{\varepsilon}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{\varepsilon_{ics}}$$

We still need to regard characteristics other than treatment (student rank in class/ class average test score) that vary with subjects and thus may affect student self-confidence.

Estimating Causal Effects – Cross-Grades FE

Using the data of Russian longitudinal study that has both TIMSS 2011 and PISA 2012 administered on the same sample we do **cross-grades fixed effect analy**sis (Kane, Rockoff and Staiger, 2008; Clotfelter, Ladd and Vigdor, 2007)

$$Y_{ics} - \bar{Y}_{ic} = \beta_1(A_{ics} - \bar{A}_{ic}) + \beta_2(T_{ics} - \bar{T}_{ic}) + (X_{ics} - \bar{X}_{ic})\alpha + (\varepsilon_{ics} - \bar{\varepsilon}_{ic}),$$

where $\bar{Y}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{Y_{ics}}$, $\bar{X}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{X_{ics}}$, $\bar{T}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{T_{ics}}$, $\bar{\varepsilon}_{ic} = \frac{1}{S}\sum_{S=1}^{S} {}_{\varepsilon_{ics}}$

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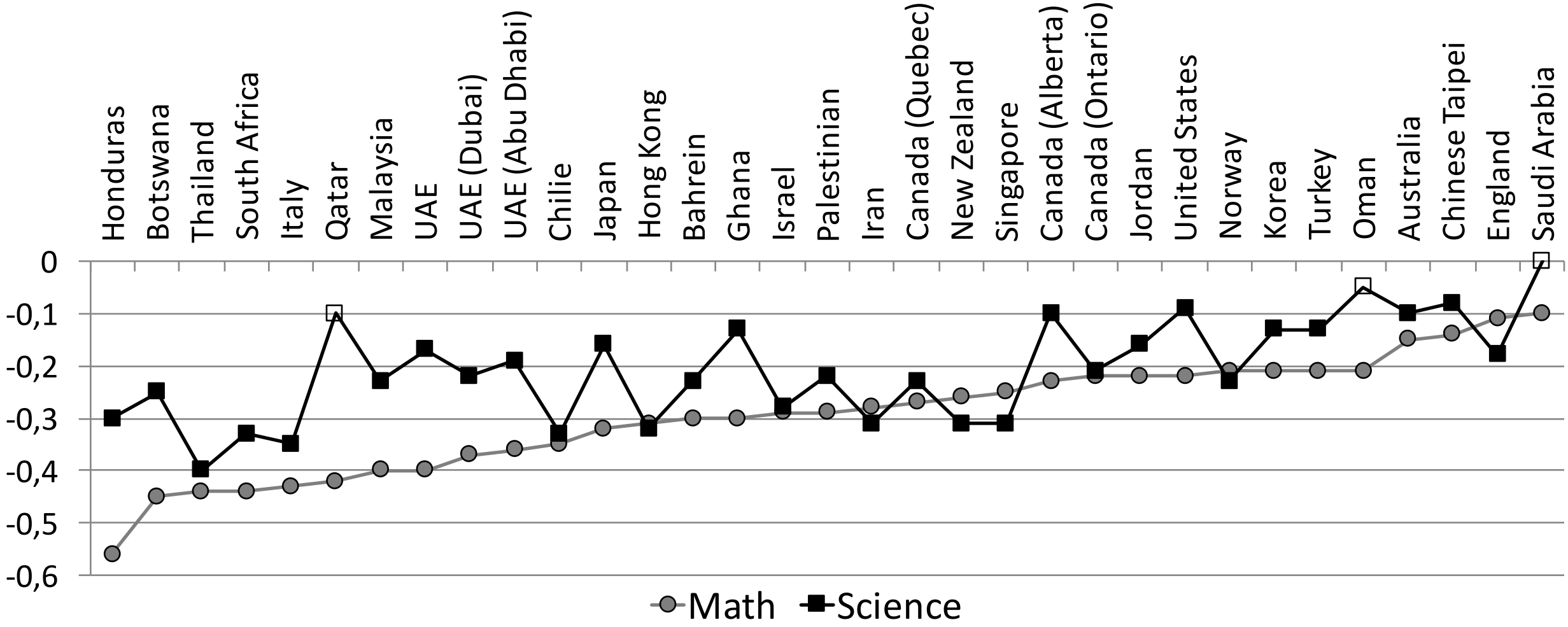
Results

- *How large is BFLPE? Cross-countries comparison*
- *Are there gender differences? Cross-countries comparison*
- *The case of Russia*
- *Why magnitude/patterns of results differs across countries? Descriptive Analysis*

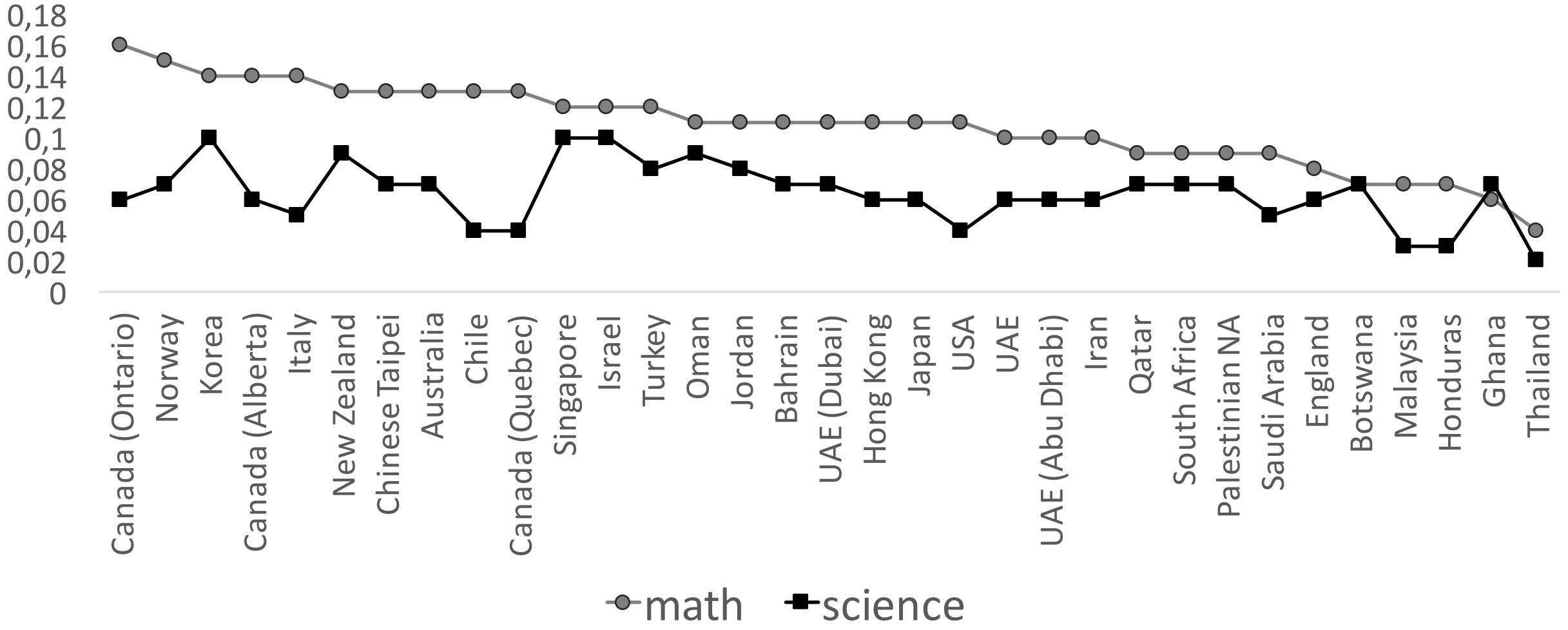
How large is BFLPE? Replicating Previous Studies

Cross-Countries Estimates of BFLPE from OLS Model with Class Average Achievements (Math and Science)



For science, BFLPE is negative but not significant in three countries – Oman, Qatar and Saudi Arabia

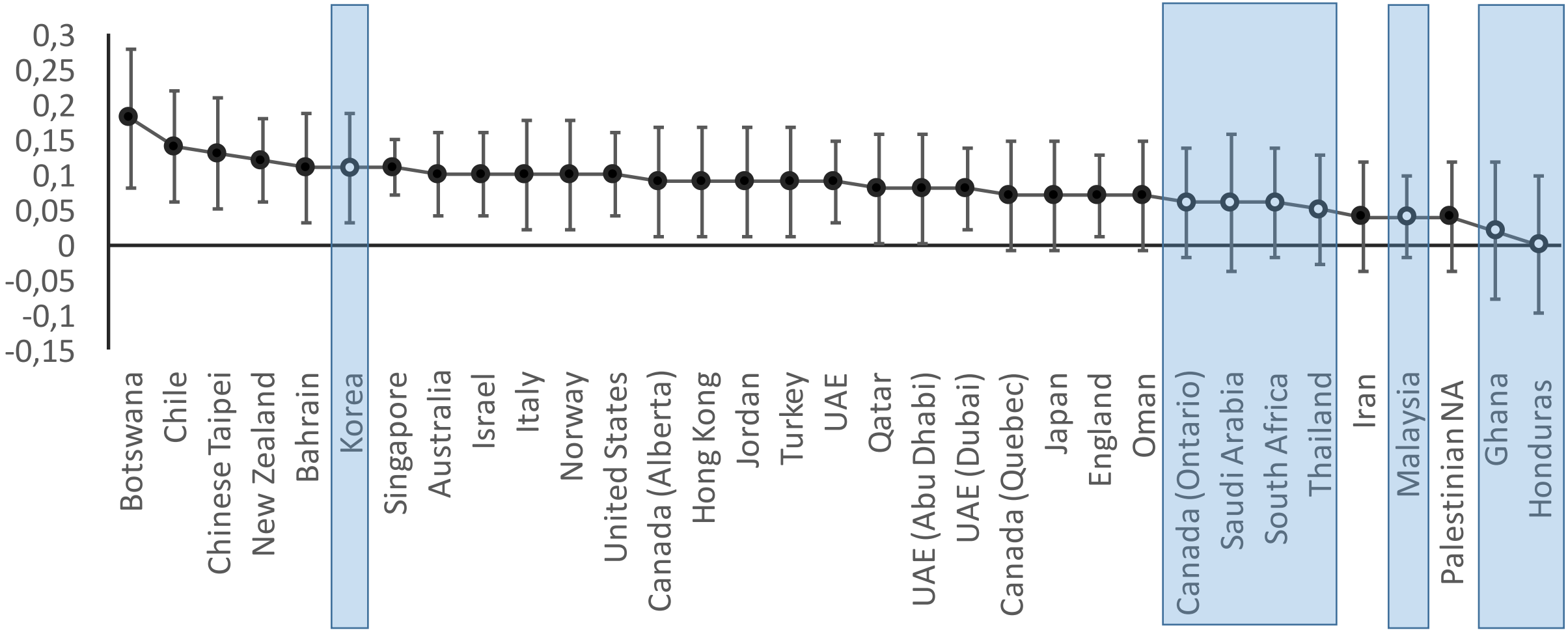
Cross-Countries Estimates of BFLPE from OLS Model with Student's Rank in a Class (Math and Science)



How large is BFLPE? Causal Analysis

- For most countries BFLPE measured with conditional class average TIMSS score is not significant

Cross-Countries Estimates of BFLPE from Cross-Subject Students Fixed Effect Model with Class Rank (Math vs. Science)



Countries with non-significant effect are colored

Are There Gender Differences?

Gender Differences. Cross-Countries Estimates of BFLPE from Cross-Subject Students Fixed Effect Model (Class Rank)

	Boys	**Girls**	**Difference**
All countries	0.08** (0.03)	0.08** (0.04)	0.00 (0.01)
Chinese Taipei	0.14** (0.05)	0.11** (0.05)	0.03*(0.02)
Italy	0.12*** (0.04)	0.08* (0.05)	0.03* (0.02)
Japan	0.09** (0.04)	0.06 (0.04)	0.03* (0.02)
Malaysia	0.03 (0.03)	0.06** (0.03)	-0.03** (0.01)
Oman	0.06 (0.05)	0.09* (0.05)	-0.03* (0.02)
United States	0.09*** (0.03)	0.11*** (0.03)	-0.02* (0.01)

We find no significant gender difference in class rank effect on student self-concept in majority of countries. In 3 countries effect of class rank is significantly larger for girls compared to boys. In 3 countries it is significantly larger for boys

The Case of Russia

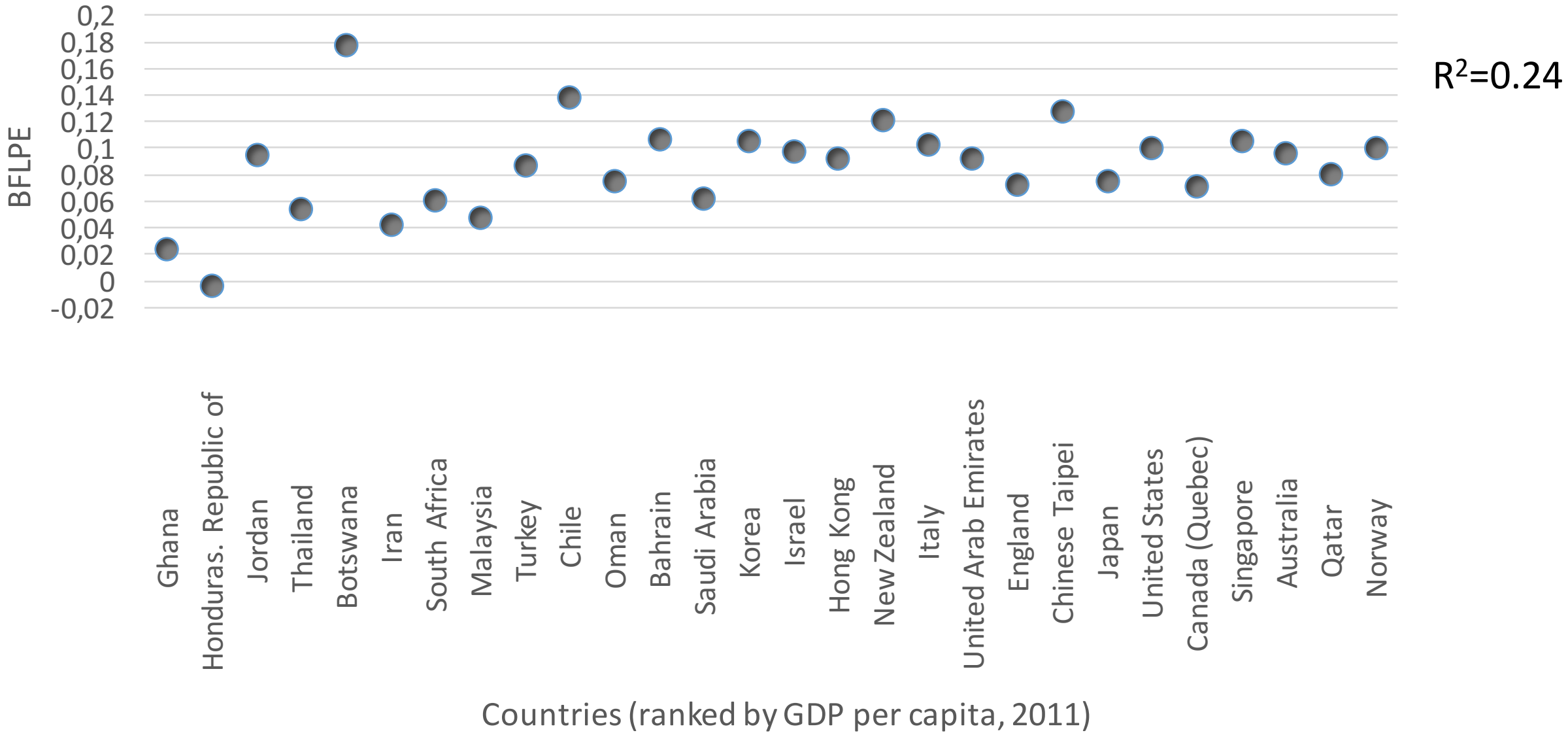
Big-Fish-Little-Pond Effect for Russian Sample (Cross-Grade Fixed Effect Analysis Results, Math)

	BFLPE = Class Averaged Scores				BFLPE = Class Rank			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	Boys	Girls	Interaction	All	Boys	Girls	Interaction
Individual test scores (std)	0.16***	0.18***	0.14***	0.16***	0.12**	0.16*	0.08	0.12**
	(0.03)	(0.04)	(0.04)	(0.03)	(0.06)	(0.09)	(0.05)	(0.06)
BFLPE	-0.05	-0.01	-0.09	0.01	0.02	0.01	0.03**	0.02
	(0.08)	(0.10)	(0.09)	(0.10)	(0.02)	(0.02)	(0.01)	(0.02)
Female*BFLPE				-0.10				0.001
				(0.11)				(0.01)
Constant	0.01	0.07	-0.05	0.01	-0.08	0.01	-0.18***	-0.08
	(0.02)	(0.03)	(0.03)	(0.02)	(0.08)	(0.11)	(0.07)	(0.08)
Observations	5776	2872	2904	5776	5776	2872	2904	5776
Number of students	2,888	1,436	1,452	2,888	2,888	1,436	1,452	2,888
R-squared	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.03

Why Magnitude/ Patterns of Results Differ across Countries?

- BFLPE and GDP
- BFLPE and Individualism
- BFLPE and Country Average TIMSS Score

GDP and BFLPE

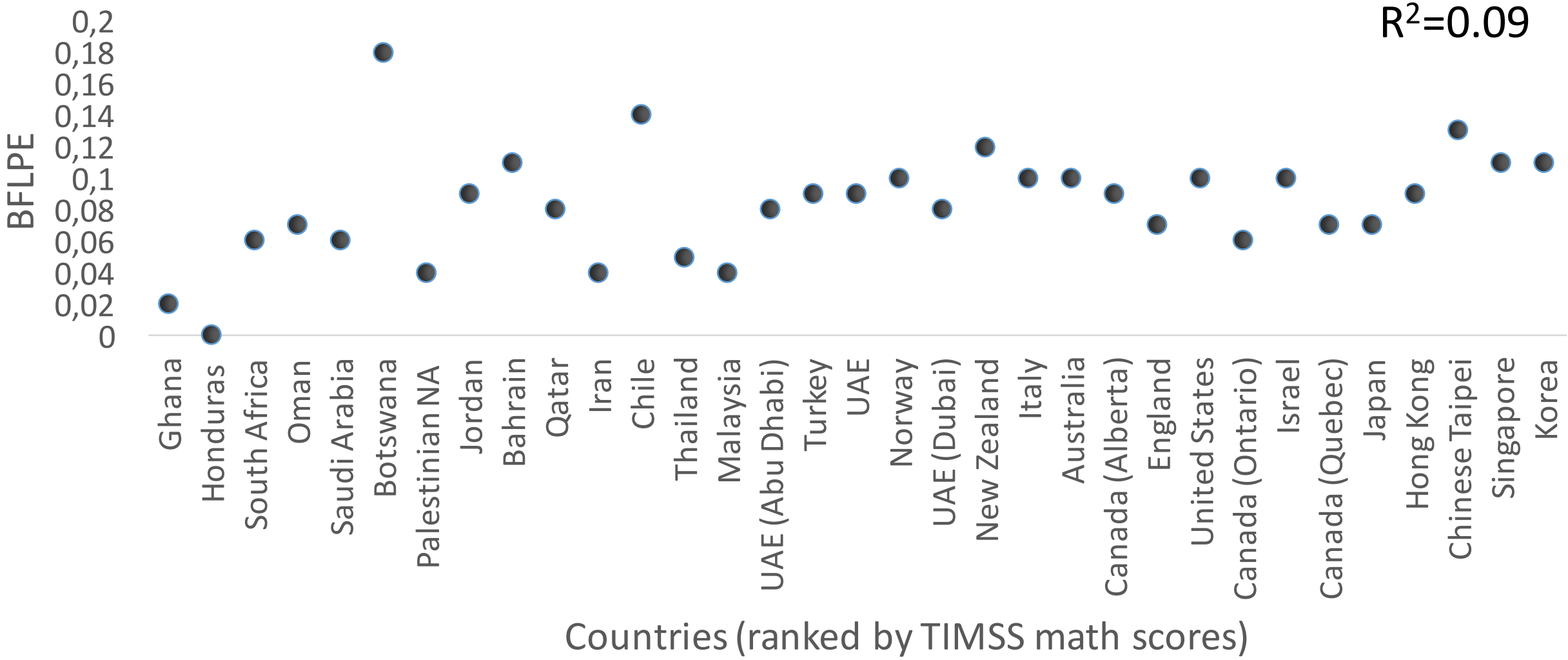


R^2=0.24

BFLPE and Prevalence of Individualism in a Culture (Hofstede)

We test relationship of BFLPE with prevalence of individualism vs collectivism as an important characteristic of national cultures. For this purpose, we use Hofstede's individualism scale of cultural dimension**.** Higher scores on this scale mean preference for a loosely-knit social framework in a country

BFLPE and Country Average TIMSS Score



For a Discussion

Our analyses reveal a set of findings.

- We find consistent evidence for existence of BFLPE identified with student rank in classroom. Class average test score shows significant relationship with student self-concept only in regular OLS models.
- Cross-grades fixed effects analysis done on Russian longitudinal study data shows existence of BFLPE mainly for girls.
- Student fixed effects analysis shows that BFLPE exists across most countries and is largely similar across genders.
- BFLPE size might be related to countries GDP and average TIMSS scores

Our results provide the strongest evidence to date that a sizeable BFLPE exists in STEM subjects.

Relation to policy

Tracking and non-random assignment of students to classes based on students SES and abilities is widely spread in schools in many countries.

If peer-effects and BFLPE exist is students' assignment to classes a good policy?