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

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Big-Fish (Frog)-in-Little-Pond Effect (BFLPE)

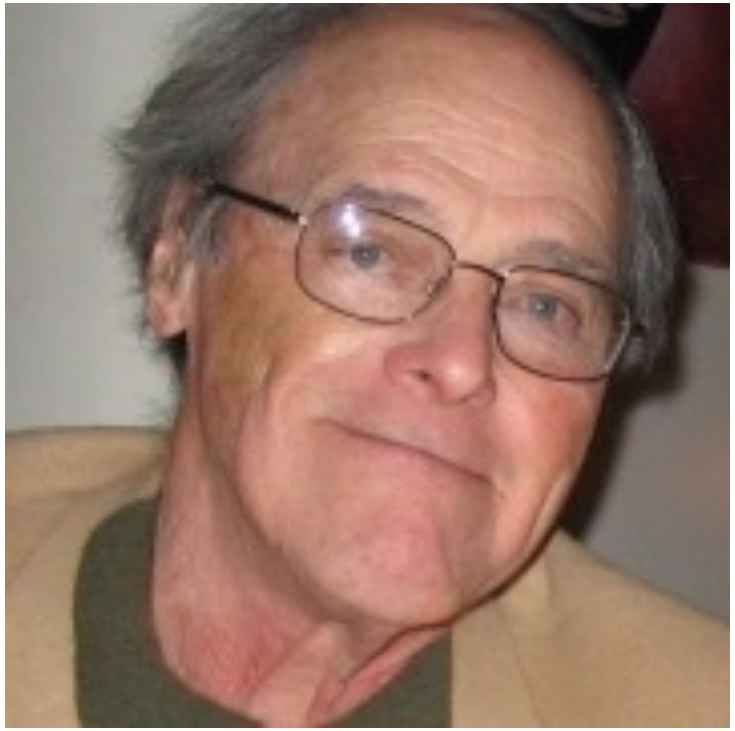
Big-Fish-Little-Pond Effect (BFLPE) – the negative effect of class or school average achievement on student' **academic self-concept** (knowledge and perception about own academic ability).

BFLPE is theoretically important because academic self-concept is positively associated with a number of educational outcomes including

- academic achievement (Marsh, 1990; Marsh & Yeung, 1998; Marsh et al., 2005; Green et al., 2006),
- intrinsic motivation to learn subject (Valas & Sovik, 1993),
- attitudes toward school (Valas & Sovik, 1993; Green et al., 2012), and
- course selection (Marsh & Yeung, 1997),
- entry into more elite educational tracks (Byrne, 1990).

James Davis, 1966

James A. Davis examined the career decisions of college-age men. He found that on a given campus, students who had higher grade point averages (GPAs) were more likely to opt for elite careers. However, when students' scholastic aptitude was controlled and school quality varied, a given student was less likely to select a high-performance career field the more competitive his college academic environment was. Davis cautioned parents who were sending their sons to college: "It is better to be a big frog in a small pond than a small frog in a big pond" (Davis, 1966)



How does BFLPE work?
Social comparison theory

To explain BFLPE, Marsh (1984a, 1984b; Marsh & Parker, 1984) proposed a frame of reference model based on social comparison theory .

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).

Other words…

- Students with relative high performance in class, compare themselves to less academically talented classmates and form high positive academic self-concept.
- Students downgrade their belief in their own ability in a particular subject when they perceive other students are more likely to excel in that subject (Huguet et al., 2009).

Internal & external frames of reference

Students compare their academic ability using two different, but connected, frames of reference:

- Within the internal frame of reference students compare their own attainments in a particular academic domain with that in another domain.
- External frame is a comparison of own achievements to results of other students (Marsh, 1986; Möller et al., 2009; Chiu, 2008, 2012; Hung, Y.-C., &Liou, P.-Y., 2013).

Does BFLPE exist for self-concept only?

Although academic self-concept is the main aim of BFLPE studies there are some evidences that BFLPE also exists for

- educational and professional aspiration (Marsh, 1991; Nagengast & Marsh, 2012),
- course selection (Marsh, 1991) and
- test anxiety (Zeidner & Schleyer, 1999; Goetz et al., 2008).

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 across a large number of countries (Marsh & Hau, 2003; Chiu, 2012; Seaton, Marsh, & Craven, 2009, 2010; Nagengast & Marsh, 2012
- for students with different characteristics of academic self-regulation (extrinsic and intrinsic motivation, strategies of memorization and cooperation) (Seaton et al., 2010)

Gender differences in BFLPE

- Existence and size of BFLPE may vary by gender:
  - In formulating her self-concept, a girl may be more sensitive to the importance that parents, teachers and peers place on an individual's relative standing in a class or school (Lent, Lopez et al., 1996; Pomerantz et al., 2002).
  - In general girls are more susceptible to reference group effects than boys (Catsambis, 1994; Catsambis, Mulkey, & Crain, 2001; Huguet & Monteil, 1995; Steinberg & Monahan, 2007).
- Gender differences in BFLPE may be particularly large in STEM subjects.
  - Girls already tend to have lower levels of self-concept in STEM subjects than boys (e.g. Marsh & Yeung, 1998; Preckel, Goetz, Pekrun, & Kleine, 2008; Sullivan, 2009).
  - Girls take even greater account of the judgments of others when formulating their self-concept in STEM subjects (Usher & Pajares, 2006; Zeldin & Pajares, 2000; Zeldin, Britner, & Pajares, 2008).
- Whether there are consistent gender differences in the BFLPE, however, is unclear from the existing literature

BFLPE in cross-national studies

Previous cross-countries studies of BFLPE showed that BFLPE generalized across different countries (Marsh & Hau, 2003; Chiu, 2012; Seaton et al., 2010; Nagengast & Marsh, 2012).

- There was little variability in the country-specific BFLPE (Nagengast & Marsh, 2012).
- Cross-country differences in BLPE are not related to differences in economic development (Seaton, Marsh, & Craven, 2009).
- A range of cultural characteristics such as collectivism, uncertainty avoidance, and a long-term orientation have little relation to the BFLPE (Nagengast & Marsh, 2012).

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 Aims

- To estimate if BFLPE exists in causal sense
- To test robustness of estimations of BFLPE using different indicators (class rank and average class achievements) and different methods
- To estimate variability of “true” estimations of BFLPE across country and gender
- To estimate country specific characteristics as possible moderators of BFLPE

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.
- To facilitate cross-national comparisons across the largest number of countries and regions possible, we limited our sample to the 33 countries/regions that took the general science test. In addition to 28 countries, three regions in Canada (Alberta, Ontario and Quebec) and two regions (cities) in the UAE (Abu Dhabi and Dubai) participated in the TIMSS 2011.
- Number of students within each country range from 3,842 to 14,089, mean age within each country range from 13.7 to 16.0 years, proportion of girls range from .46 to .55.

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.

How to measure BFLPE?
Average achievement vs class rank

- The usual way to estimate BFLPE is multilevel regression where students' self-concept and achievements are variables on individual level and class (school) average achievement is the variable on class (school) level
- Class rank may better catch the core mechanism of BFLPE. There is evidence that students' perception of their own achievements compared to class, plays a major role in the BFLPE (Huguet et al., 2009).
- There are no studies of BFLPE where real class rank was used instead class average scores.
  - We've found one study where class rank was used as a predictor for probability of admission to elite university at the USA and it had positive effect on admission (Espenshade, Hale & Chung, 2005).

Estimation Strategy

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

Replicating Previous Studies - OLS

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

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

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.

Cross-national comparison

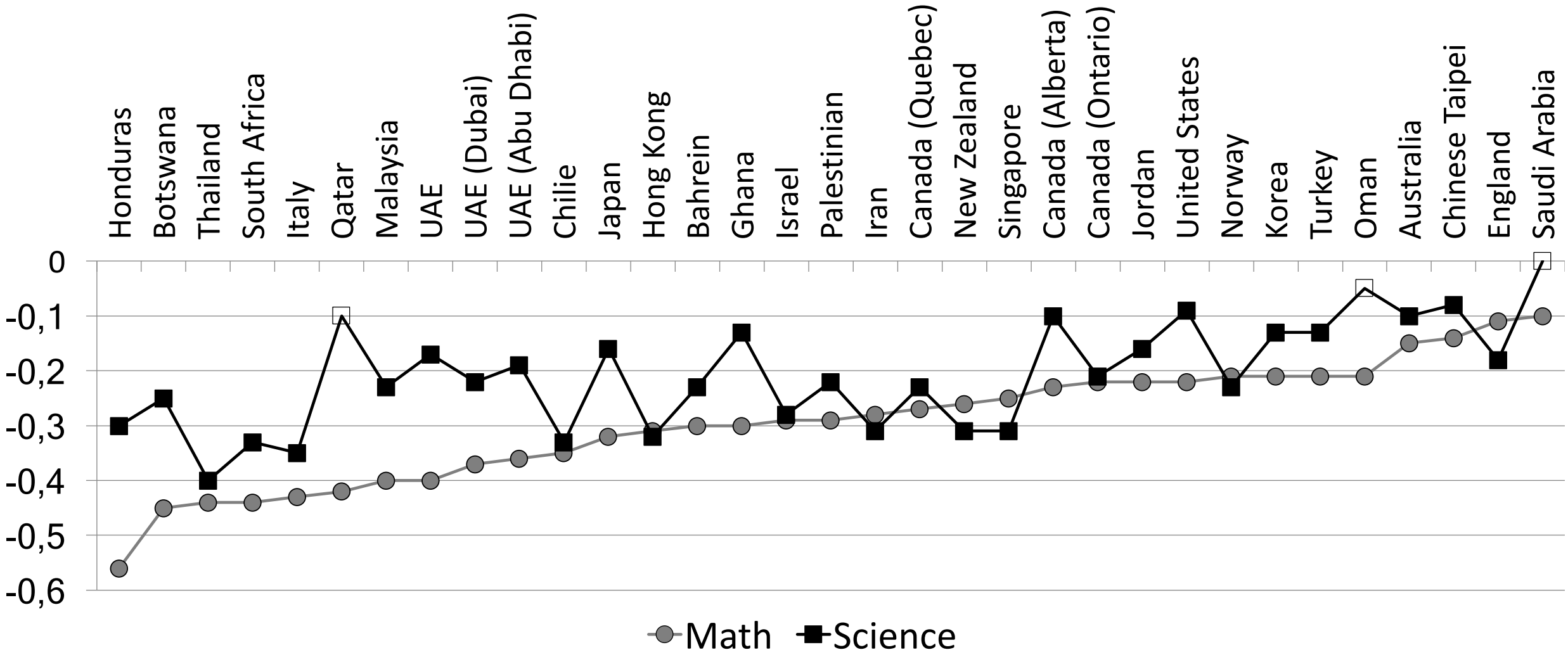
- We do heterogeneous analysis to see whether BFLPE varies across countries. We include interaction of BFLPE variable with dummies that identify countries.
- To investigate whether BFLPE works differently for boys and girls we use a three-way interaction of BFLPE, country id and student sex
- We use descriptive analysis of country average BFLPE and socio-economic characteristics

Results

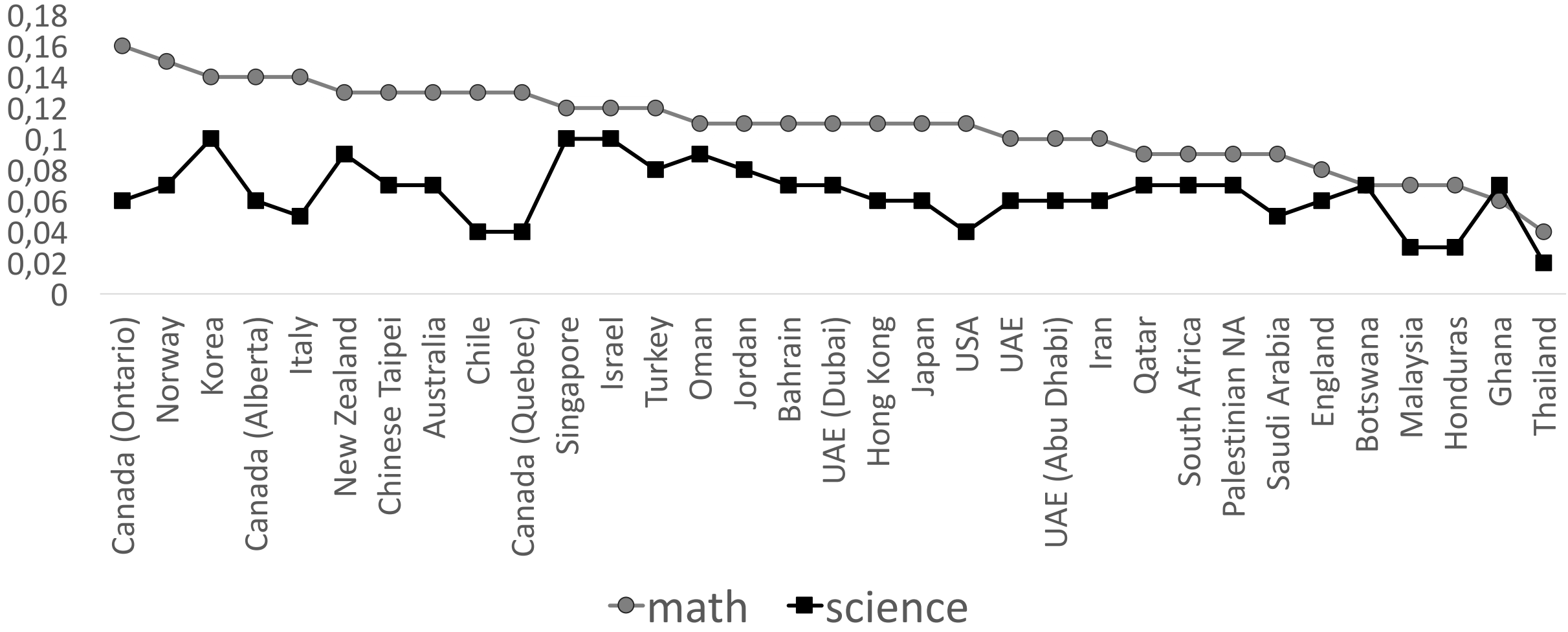
- How large is BFLPE? Cross-countries comparison
- Are there gender differences? Cross-countries comparison
- Why magnitude (patterns) of results differs across countries? Descriptive Analysis

How large is BFLPE?
Replicating Previous Studies

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



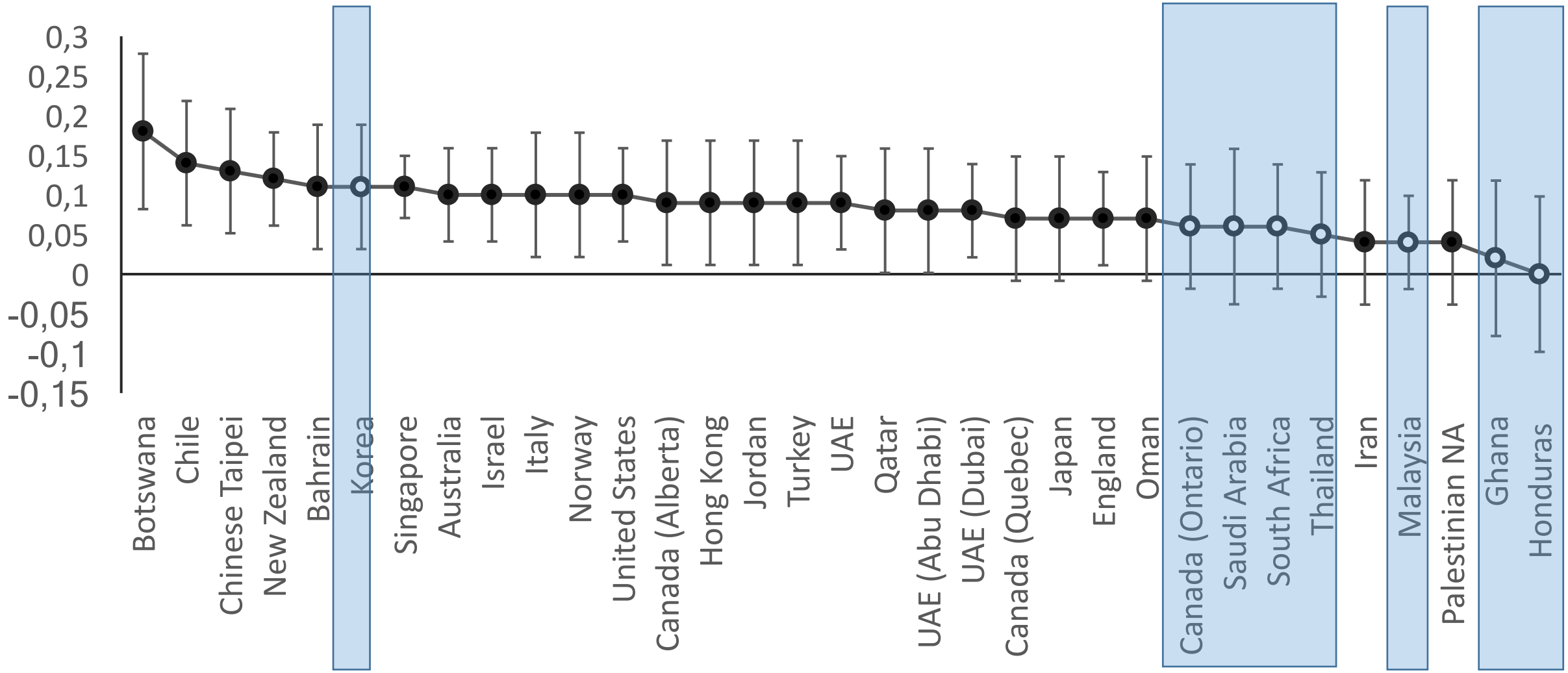
Cross-Countries Estimates of BFLPE from OLS Model with Student's Rank in a Class (Math and Science)



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)



Are There Gender Differences?

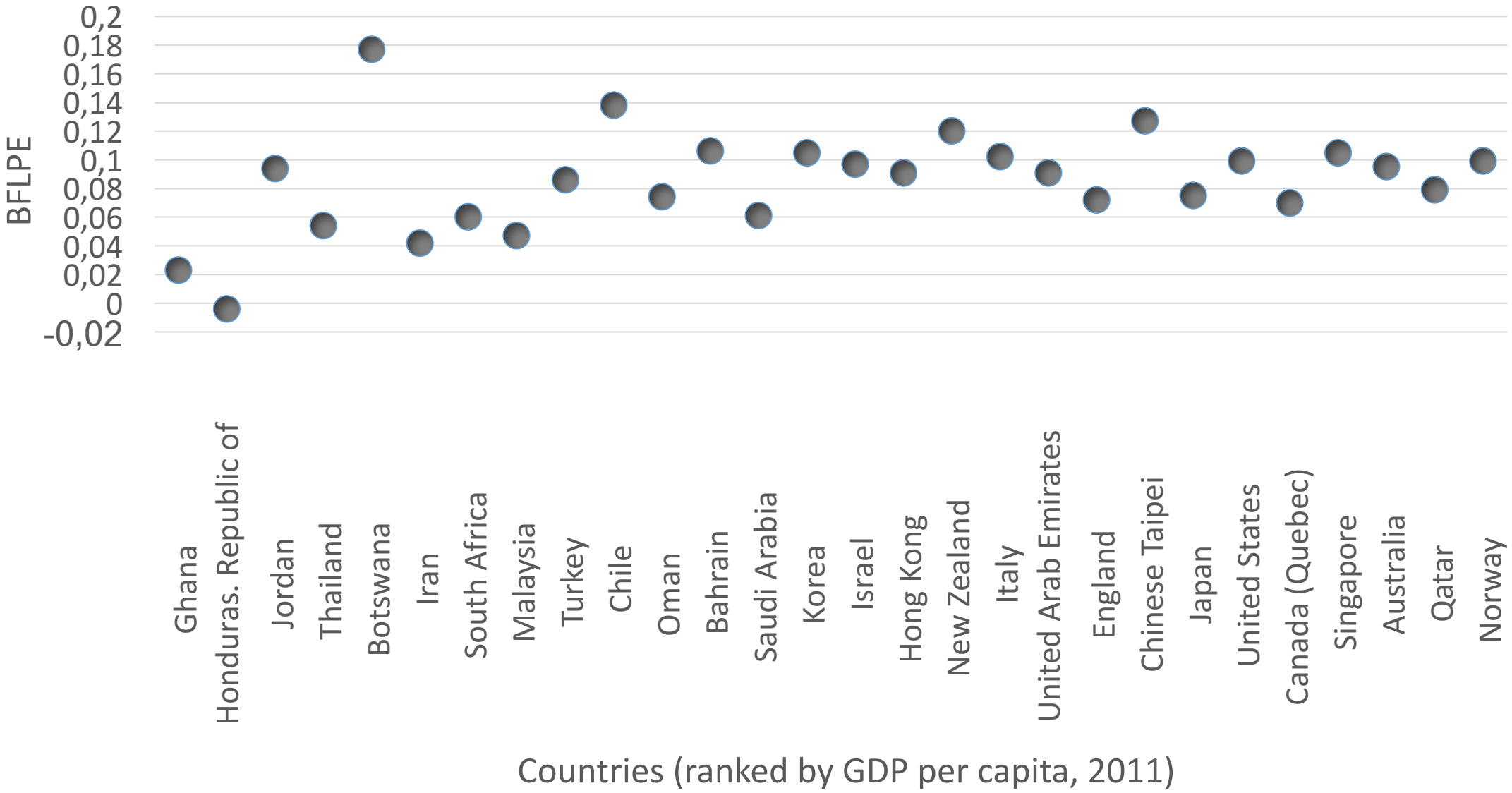
Gender Differences. Cross-Countries Estimates of BFLPE from Cross-Subject Students Fixed Effect Model (Class Rank)

	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)

Why Magnitude/ Patterns of Results Differ across Countries?

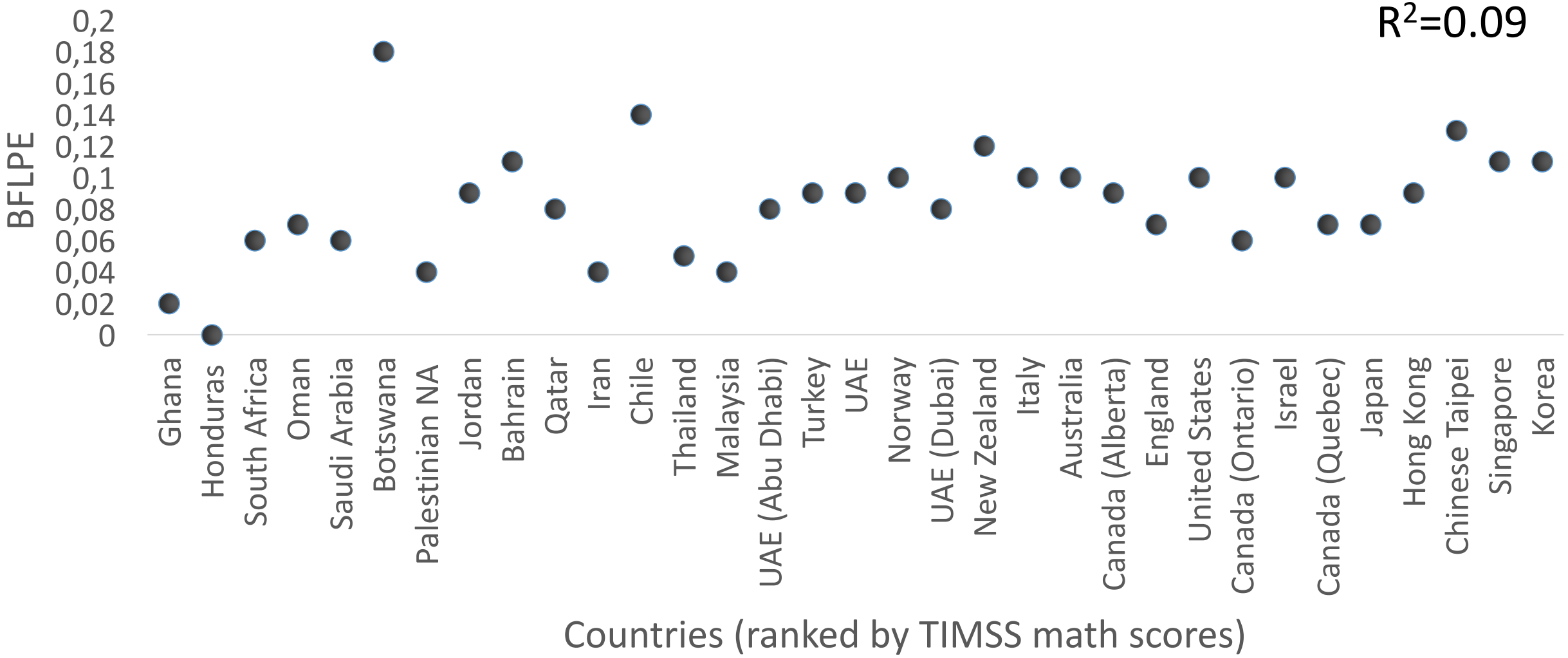
- BFLPE and GDP
- BFLPE and Individualism
- BFLPE and Country Average TIMSS Score

GDP and BFLPE



BFLPE and Prevalence of Individualism in a Culture (Hofstede)

BFLPE and Country Average TIMSS Score



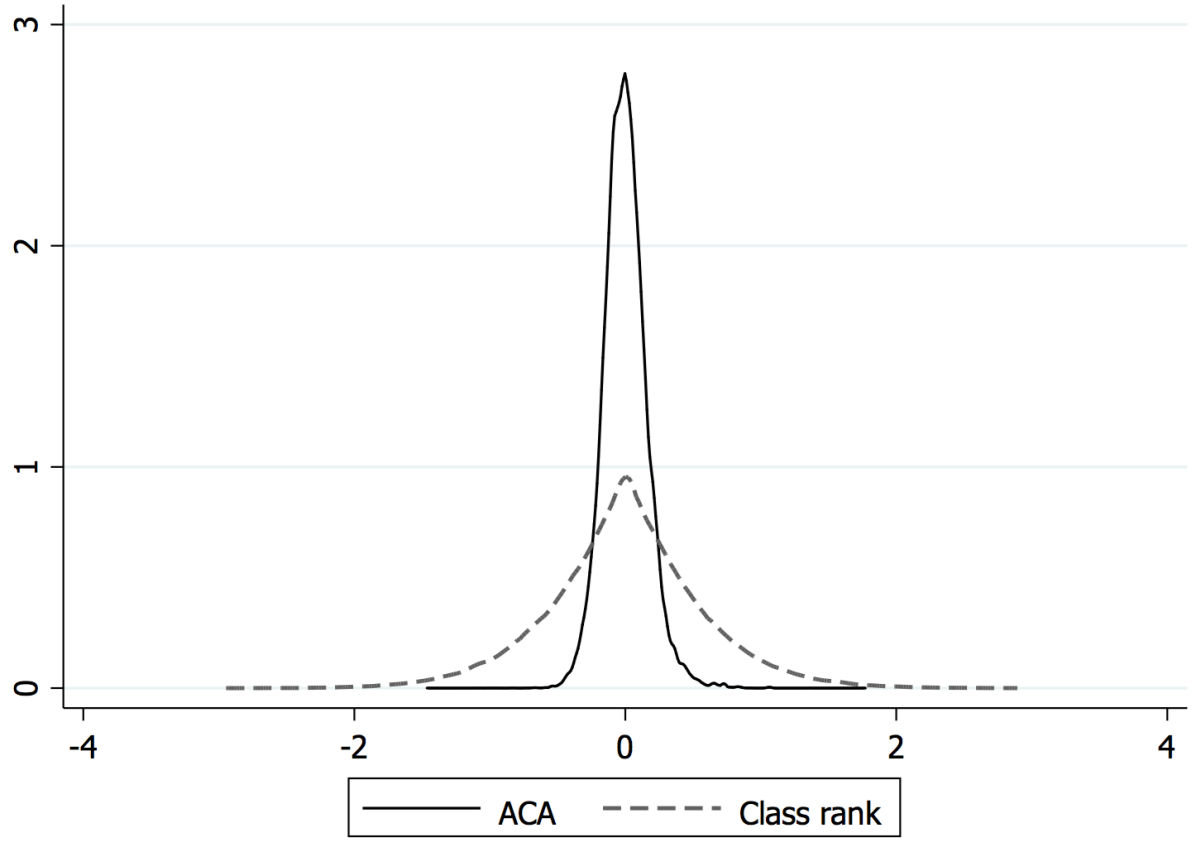
For a discussion

Main findings

- To the best of our knowledge, our study is the first to use representative, cross-national data in combination with a quasi-experimental research design to provide cross-national causal estimates of the BFLPE.
- Our findings not only confirm that the BFLPE exists, but that it is similar across countries and genders. Our findings thus provide strong support for the notion that the BFLPE is a pan-human phenomenon.

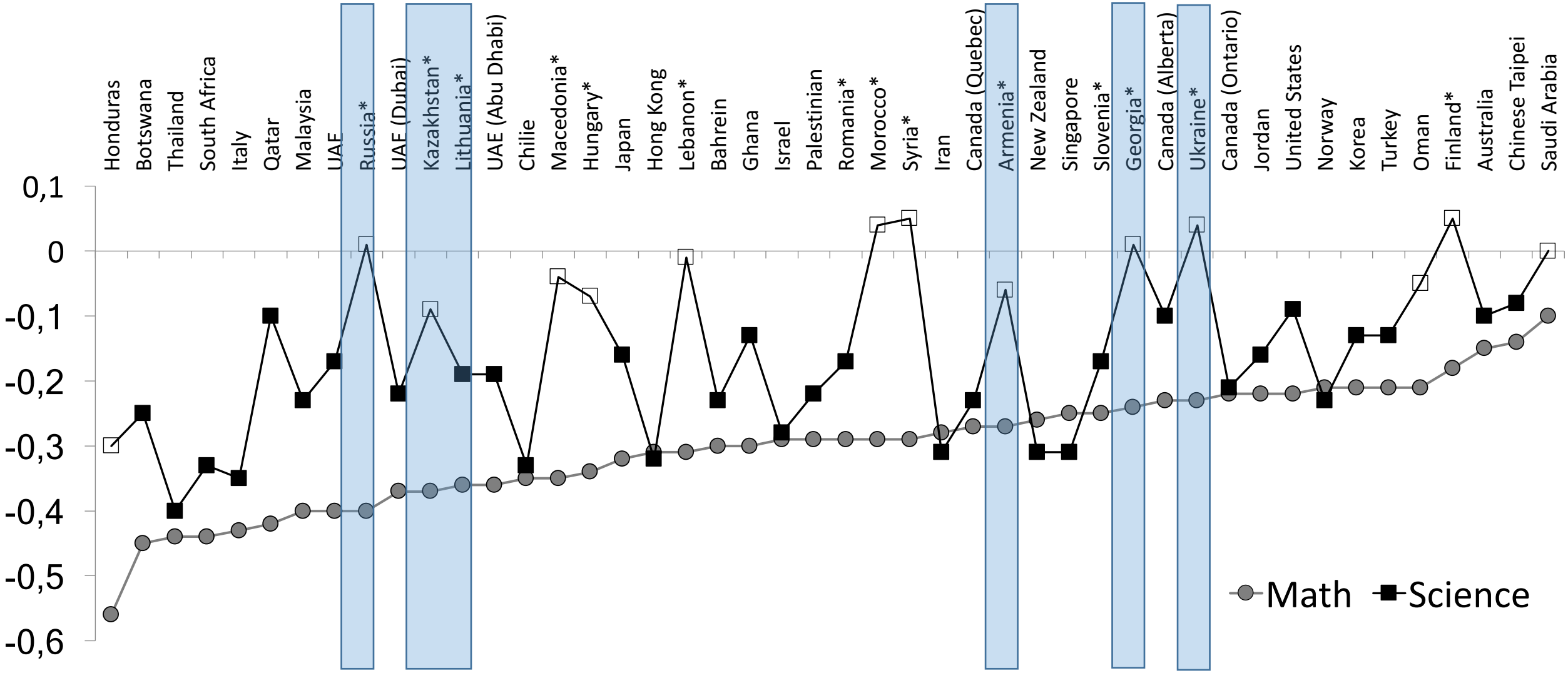
Methodological contributions

- We illustrate how it is possible to estimate the BFLPE using a combination of a cross-subjects within student fixed effects model and cross-sectional data
- We show that it is often desirable to use class rank instead of average class achievement to estimate the BFLPE.
  - Students may conceptualize their relative standing in terms of class rank rather than average class achievement (both conditional on individual student achievement),
  - Class rank allows us to utilize greater variation within the classroom

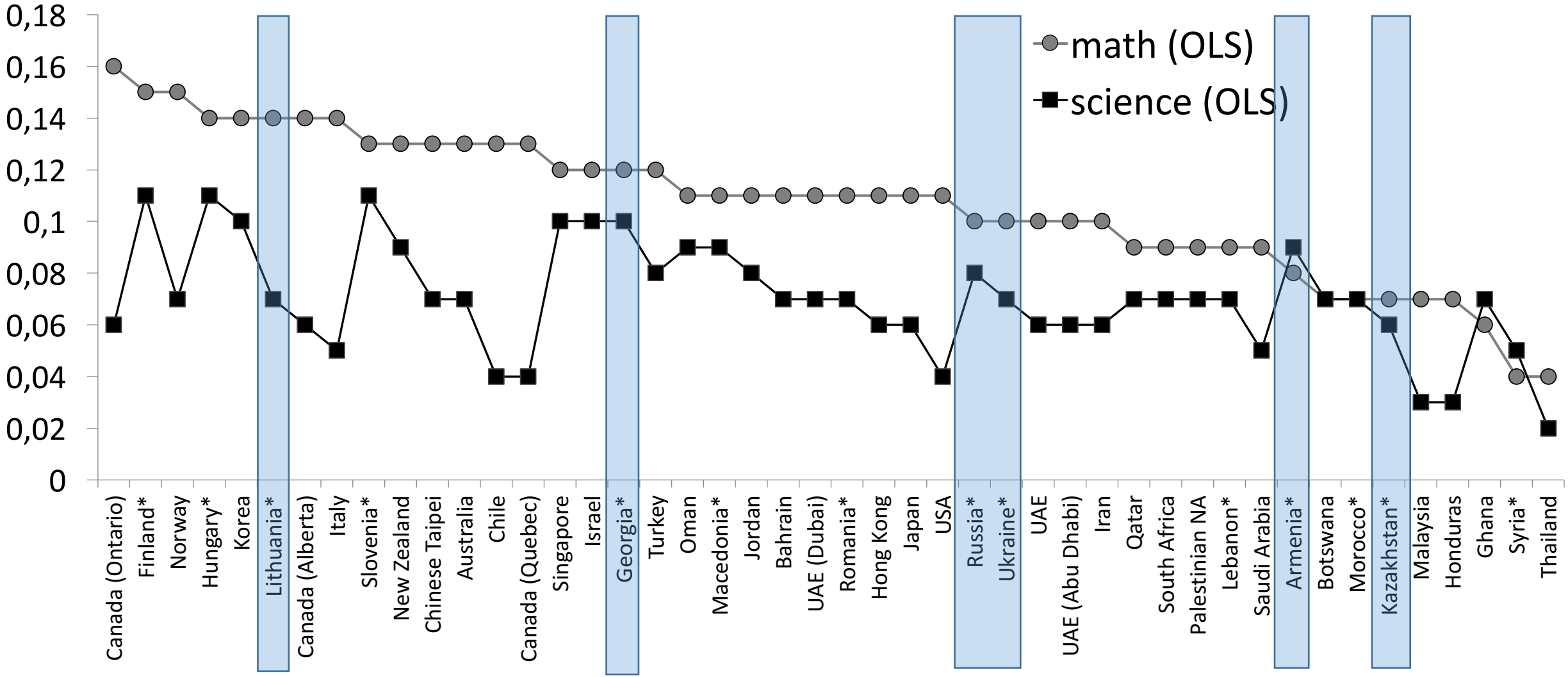


Appendix

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



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



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