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INEQUALITY OF OPPORTUNITY IN EDUCATION IN THE ARAB REGION

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Abstract

Inequality of opportunity (IOp) in education concerns the influence of circumstances that children were born into on their educational achievement. Earlier literature has shown that IOp in the Arab region for the most part is considerably high (Salehi-Isfahani et al., 2014). This paper updates the literature by using the latest student test scores in math and science reported by the Trends in Mathematics and Science Study and student test scores in reading reported by the Programme for International Students Assessment. We compare the inequality of opportunity for achievement in math, science, and reading for eleven Arab countries (Bahrain, Jordan, Lebanon, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Syria, Tunisia, and United Arab Emirates [UAE]) between 1999 and 2012. Our results confirm the earlier finding in the literature (Salehi 2012) that inequality of opportunity in most Arab states is high and more or less in line with other developing regions and, in many countries, it has been worsening for years. Although there has been evidence of improvement in recent years in few cases, for many others high IOp remains a challenging issue in the region.

1. Introduction

Social and political upheavals in the Arab world have raised questions about the sources of public dissatisfaction with social justice, given the overall low level of income inequality comparing to other developing regions (Ncube et. al. 2013). It has been suggested that high inequality of opportunity (IOp) could offer insights into a better understanding of public discontent with the status quo (Salehi-Isfahani et al., 2014). Some studies have measured IOp in education and its trend over time in the Arab region (Ersado and Gignoux, 2014; Salehi-Isfahani et al., 2014). This paper updates the literature by using more recent data. We use math and science test scores of fourth- and eighth-grade students reported by the international consortium, Trends in Mathematics and Science Study (TIMSS), in 1999, 2003, 2007, and 2011, and test scores in reading reported by the Programme for International Student Assessment (PISA) in 2000, 2003, 2006, 2009, and 2012. This paper focuses in particular on the eleven Arab countries in the fifth round of TIMSS in 2011 and the four countries in PISA in 2012.

We analyze the latest patterns in national averages of fourth- and eighth-grade test scores in math, science and reading and in various subpopulations. Using a method proposed by Roemer (1998), we estimate the inequality of opportunity in education as the share of inequality in educational outcome accounted for by factors beyond student's control (i.e., circumstances). We also compare the findings across countries and over time. Our results confirm the earlier finding in the literature (Salehi 2012) that inequality of opportunity in most Arab states is high comparing to other regions and has been worsening for years. Although there has been evidence of improvement in recent years in few cases (Jordan, Lebanon) but for the most part high IOp remains a challenging issue for the policy makers of the region. For a complementary

methodology using non-parametric methods, we refer to an ESCWA companion paper by Peragine et al. (2015).

This paper is organized as follows. Section 2 describes the data reported by two international surveys. Section 3 discusses the patterns in math, science, and reading average scores in the Arab countries participating in the latest rounds of TIMSS and PISA. Section 4 discusses the methodology for measuring IOp. Section 5 presents the comparative results. Section 6 concludes and provides recommendations.

2. Data

We use data from four rounds of TIMSS (1999, 2003, 2007, and 2011) and five rounds of PISA (2000, 2003, 2006, 2009, and 2012), the two international surveys providing comparable data on educational achievement in more than 60 developed and developing countries. TIMSS measures trends in mathematics and science achievement at fourth- and eighth-grade levels and PISA assesses mathematics, science, and reading skills of 15-year- old students (in 34 OECD countries and 31 partner countries). Both surveys provide rich data on student, home, teacher, school, and educational system. Table 1 shows the list of Arab and non-Arab developing countries in TIMSS 2011 and PISA 2012 and their sample sizes.

Table 1. List of Arab and non-Arab developing countries in TIMSS 2011, PISA 2012

	TIMSS 2011		PISA 2012
	Grade 4	Grade 8	
<i>Arab countries</i>			
Bahrain		9,280	
Jordan		15,388	7,038
Lebanon		16,508	
Morocco	14,318	26,958	
Oman	16,577	19,084	
Palestine		15,624	
Qatar	7,839	8,844	10,966
Saudi Arabia	9,000	8,688	
Syria		13,358	
Tunisia		10,256	4,407
United Arab Emirates (UAE)	27,462	31,655	11,500
<i>non-Arab countries</i>			
TIMSS 2011, 4th grade: Botswana, Chinese Taipei, Georgia, Honduras, Iran;			
TIMSS 2011, 8th grade: Armenia, Botswana, Chinese Taipei, Georgia, Honduras, Iran, Kazakhstan,			
Korea, Macedonia, South Africa, Thailand, Turkey			
PISA 2012: Albania, Bulgaria, Chinese Taipei, Colombia, Costa Rica, Indonesia, Kazakhstan, Korea,			
Malaysia, Mexico, Montenegro, Peru, Serbia, Viet Nam, Thailand, Turkey			

TIMSS uses nationally representative samples of students in grades 4 and 8 in each participating country to evaluate cognitive skills in math and science. It also provides information on family background (student's and parent's birth country, parents' education, wealth, number of books at home, owning a computer), school quality (teacher shortage, class size, public or private school), teacher characteristics (age, gender, education), and community (population size, rural or urban). Figure 4 through Figure 23 in the Appendix take a closer look at the distribution of Math and Science scores at 8th and 4th grade by gender and by location. Table 2 reports the relative size of the expatriate population in each country in our sample and the average test scores in the expatriate and native subpopulations. The relative size of the expatriate population in the eleven Arab countries in our sample is almost four times the size in the non-Arab countries. In cases with unusually large expatriate populations such as Qatar and UAE, the average performance of expatriate students differs significantly from the native students. To avoid potential bias, we focus on the native population. A first finding is that in Arab countries, expat students tend to perform slightly better than Arab residents while in non-Arab countries it seems to be the other way around.

Table 2. Average scores in native and expatriate populations

	%Expatriate	Math		Science		Reading	
		Native	Expatriate	Native	Expatriate	Native	Expatriate
Bahrain	29%	394.1	449.3	440.0	486.7		
Jordan	28%	405.8	412.8	450.8	453.2	399.4	425.1
Lebanon	11%	448.9	452.3	405.2	414.2		
Morocco	4%	374.2	327.6	379.6	322.1		
Oman	17%	359.7	409.2	416.8	448.9		
Palestine	15%	403.7	410.7	420.9	422.9		
Qatar	57%	357.5	451.7	361.1	465.1	341.2	427.6
Saudi Arabia	15%	387.7	430.5	432.5	460.1		
Syria	6%	382.3	359.0	429.2	399.2		
Tunisia	5%	426.9	388.2	440.6	404.8	405.2	397.3
UAE	64%	413.6	480.7	417.4	492.5	406.0	466.2
Arab countries	0.23	395.9	415.6	417.7	433.6	388.0	429.1
non-Arab countries	0.06	452.6	435.6	450.9	432.5	438.3	414.7

Note: Statistically significant (at 95% level) differences in mean scores are in boldface. Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

3. Patterns in average test scores

We use TIMSS 2011 and PISA 2012 to look at the patterns in the national average of test scores and the average score in various subpopulations for the two grades. Table 3 shows the national

averages of test scores in math, science, and reading. Overall, the performance of Arab countries in all subjects for the two grades is lower than in non-Arab developing countries, although the only significant difference between the two groups is in 8th grade Math scores. Judging by TIMSS's international achievement benchmarks (Low 400, Intermediate 475, High 550, and Advanced 625), the performance of Arab countries is considered low at best and in a few cases such as Morocco (both grades), Oman (grade 4), and Qatar (grade 8), the national averages even fall below TIMSS's international benchmarks.

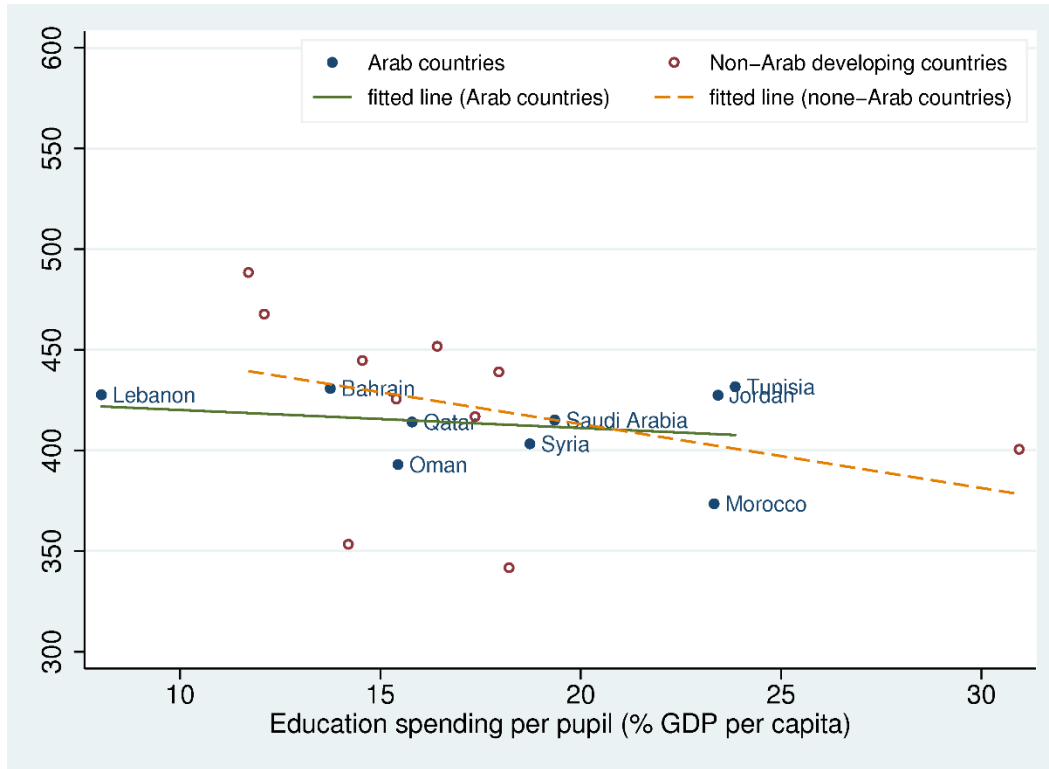
Table 3. Average scores, GDP per capita, and public educational spending per pupil

	Grade 4		Grade 8			GDP per capital (PPP)	Public Educational spending per pupil (% GDP per capita)
	Math	Science	Math	Science	Reading		
Bahrain			394.1	440.0		40,083.38	13.8
Jordan			405.8	450.8	399.4	11,292.20	-
Lebanon			448.9	405.2		16,431.15	5.9
Morocco	334.6	263.7	374.2	379.6		6,697.60	23.3
Oman	384.9	377.0	359.7	416.8		46,131.85	15.4
Palestine			403.7	420.9		-	-
Qatar	412.9	394.2	357.5	361.1	341.2	133,733.87	15.8
Saudi Arabia	410.2	429.4	387.7	432.5		49,229.77	19.4
Syria			382.3	429.2		-	18.7
Tunisia			426.9	440.6	405.2	10,235.03	23.9
UAE	434.4	427.8	413.6	417.4	406.0	56,376.77	-
Arab countries	395.4	378.4	395.9	417.7	388.0	41,134.60	17.0
non-Arab	457.6	451.8	452.6	450.9	438.3	13,992.70	17.8

Note: GDP per capita and Public educational spending per pupil are obtained from UNESCO Institute for Statistics (UIS).
Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

In Table 3, the two columns on the right listing countries' income (GDP per capita in PPP dollars) and public educational spending per pupil (as % GDP per capita), show no clear relationship between a country's education spending and its average test scores. For instance, while Qatar ranks first in education spending, its national average scores in math, science, and reading are the lowest in the sample, whereas Lebanon spends about half as much on public education as the other ten Arab countries but has the highest national average score in math. Lack of relationship between Arab countries educational outcomes and their education spending is also shown in Figure 1 which shows the average math and science scores by education spending per pupil.

Figure 1. Average score by education spending



Average scores by gender

Table 4 reports the average scores by gender for math, science, and reading. In almost all Arab countries, grade 4 girls outperform boys in math and science. The exceptions are Saudi Arabia and UAE where boys and girls perform similarly in math. In almost all Arab countries, grade 8 girls slightly outperform boys in math and science. The exceptions are Lebanon and Tunisia where boys perform significantly better in math and science. In all Arab countries, girls' average scores in reading are significantly higher than boys. One may wonder if there is a potential selection bias of girls into grade 8. However, since both grade 4 and grade 8 are part of the compulsory education in these countries and overall enrollment rates are high among both male and female students throughout the region, this potential bias does not seem to be an issue in our estimation.

Table 4. Average scores by gender

(a). Grade 4

Math		Science	
Girl	Boy	Girl	Boy

Morocco	338.1	331.4	268.2	259.5
Oman	398.2	372.0	394.2	360.3
Qatar	419.9	406.6	408.1	381.6
Saudi Arabia	417.8	402.1	452.5	404.6
UAE	438.3	430.4	437.1	418.6
Arab countries	402.5	388.5	392.0	364.9
non-Arab	459.0	456.1	452.4	451.1

(b). Grade 8

	Math		Science		Reading	
	Girl	Boy	Girl	Boy	Girl	Boy
Bahrain	418.0	371.2	473.6	407.9		
Jordan	418.3	393.7	470.6	431.7	432.6	363.8
Lebanon	443.0	456.5	402.3	408.9		
Morocco	373.4	374.8	380.5	378.8		
Oman	392.0	324.9	456.2	374.4		
Palestine	415.1	391.8	433.9	407.3		
Qatar	366.6	348.3	375.1	346.8	383.6	299.6
Saudi Arabia	395.4	380.4	446.0	419.7		
Syria	377.2	387.5	425.9	432.6		
Tunisia	419.1	435.4	432.8	449.2	418.8	389.4
UAE	430.7	398.0	438.9	397.8	437.0	374.2
Arab countries	404.4	387.5	430.5	405.0	418.0	356.8
non-Arab	453.2	452.2	453.7	448.4	453.7	422.4

Note: Statistically significant (at 95% level) differences in mean scores are in boldface. Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Average scores by community type

Table 5 shows the average scores by community type. In most Arab countries, urban and rural areas show similar performances. The exceptions are Morocco and UAE where the average test scores in urban areas are higher than those in rural areas. In addition to Morocco and UAE, grade 8 urban students in Jordan, Qatar (only in math), and Tunisia perform better than rural students. The exception is Bahrain where rural areas perform significantly better than the urban areas. In the rest of countries the overall performance of students in rural areas is not statistically different than that in urban areas. The same pattern exists in reading skills. In all Arab countries urban and rural students show similar levels of reading skills. Comparing the Arab countries and non-Arab

developing countries in the last two rows of this table shows that the rural-urban gap in average scores is much larger in non-Arab countries than in Arab countries.

Table 5. Average scores by community type

(a). Grade 4

	Math		Science	
	Rural	Urban	Rural	Urban
Morocco	320.8	344.8	246.2	275.5
Oman	380.0	378.8	374.9	368.6
Qatar	419.9	413.1	402.3	395.4
Saudi Arabia	406.0	411.0	423.2	430.3
UAE	411.6	434.7	407.5	428.0
Arab countries	387.7	<i>396.5</i>	370.8	<i>379.6</i>
non-Arab	434.3	<i>475.4</i>	425.4	<i>474.2</i>

(b). Grade 8

	Math		Science		Reading	
	Rural	Urban	Rural	Urban	Rural	Urban
Bahrain	414.6	387.1	465.3	431.4		
Jordan	387.5	414.4	434.1	458.6	384.6	401.6
Lebanon	435.6	452.7	384.3	410.4		
Morocco	351.3	381.3	359.8	385.6		
Oman	359.7	360.7	415.3	418.7		
Palestine	406.6	402.2	422.0	420.3		
Qatar	331.7	361.0	356.4	361.6	337.2	341.9
Saudi Arabia	371.8	389.6	415.0	435.2		
Syria	380.7	384.1	428.3	430.2		
Tunisia	404.2	436.2	424.7	447.0	408.6	405.1
UAE	401.0	417.8	408.7	420.7	417.2	405.1
Arab countries	385.9	<i>398.8</i>	410.4	<i>420.0</i>	386.9	388.4
non-Arab	428.7	<i>468.3</i>	428.9	<i>468.0</i>	407.3	446.1

Note: Statistically significant (at 95% level) differences in mean scores are in boldface. Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Average scores by school type

Table 6 shows the average scores in public and private schools in the eleven Arab countries. Although TIMSS does not directly provide information on school type, the data can be inferred from the stratification variable for countries where the sample is stratified based on school type.

In all Arab countries at the fourth grade and most Arab countries at the eighth grade, private school students outperform public school students in math and science. The exceptions are Palestine, Saudi Arabia, Tunisia, and UAE, but the differences between school types is not statistically significant. The same pattern exists in reading skills. The exception is Tunisia where public schools perform better than the private schools. Similar patterns can also be observed in non-Arab countries.

Table 6. Average score by school type

(a). Grade 4

	Math		Science	
	Private	Public	Private	Public
Morocco	435.1	324.3	382.9	251.4
Oman	423.3	378.4	411.6	371.2
Qatar	469.8	393.2	442.5	377.4
Saudi Arabia	426.4	408.3	457.2	428.1
UAE	447.2	383.2	439.0	379.2
Arab countries	440.4	377.5	426.6	361.5
non-Arab	499.2	418.1	519.4	439.2

(b). Grade 8

	Math		Science		Reading	
	Private	Public	Private	Public	Private	Public
Bahrain	471.0	384.5	488.2	434.0		
Lebanon	468.8	414.9	432.1	359.2		
Morocco	505.6	366.1	486.7	373.0		
Oman	416.1	358.5	434.8	416.5		
Palestine	411.3	399.4	425.0	418.6		
Qatar	422.7	349.3	418.8	353.8	380.1	335.7
Saudi Arabia	411.3	386.2	449.8	431.4		
Syria	447.6	382.0	476.5	428.7		
Tunisia	396.5	427.2	412.3	440.9	286.1	406.4
UAE	425.7	411.4	421.2	418.8	405.7	406.8
Arab countries	437.7	387.9	444.5	407.5	379.0	385.4
non-Arab	-	-	-	-	435.3	439.2

Note: Statistically significant (at 95% level) differences in mean scores are in boldface. Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Average scores by parent's education

Table 7 and Table 8 report the average test scores by father's and mother's education categorized by Primary or less, Secondary, and Tertiary or more. As expected, both tables show a strong and significant relationship between parent's education and child's educational outcome. In all Arab and non-Arab countries, children in more educated households perform significantly better than those with illiterate or less-educated parents. It is interesting to observe that the average differences between Arabs and non-Arabs tend to increase with the parents' levels of education, particularly for Grade 8.

Table 7. Average scores by father's education

(a). Grade 4

	Math			Science		
	Primary or less	Secondary	Tertiary or more	Primary or less	Secondary	Tertiary or more
Morocco	329.4	349.1	398.5	252.9	283.8	341.7
Oman	359.5	386.1	436.7	348.7	379.4	436.7
Qatar	338.9	397.0	455.2	311.3	378.9	445.6
Saudi Arabia	382.1	411.0	436.2	392.7	431.3	462.4
UAE	374.7	403.1	470.8	363.1	396.1	468.3
Arab countries	356.9	389.3	439.5	333.8	373.9	430.9
non-Arab	420.3	467.3	516.9	412.4	465.9	521.2

(b). Grade 8

	Math			Science			Reading		
	Primary or less	Secondary	Tertiary or more	Primary or less	Secondary	Tertiary or more	Primary or less	Secondary	Tertiary or more
Bahrain	352.9	386.1	439.5	389.9	438.4	476.7			
Jordan	372.5	400.3	444.0	418.8	451.3	483.3	370.6	394.9	415.7
Lebanon	426.1	452.6	486.7	380.3	411.0	455.9			
Morocco	360.6	374.8	424.0	370.4	380.9	421.0			
Oman	342.2	374.8	400.2	398.0	436.8	458.7			
Palestine	388.8	408.6	439.4	401.6	427.1	457.0			
Qatar	309.5	332.4	394.1	324.6	336.2	397.4	327.5	337.3	347.9

Saudi Arabia	365.5	385.2	416.7	409.2	430.3	458.6			
Syria	375.6	383.0	407.5	419.9	430.5	450.9			
Tunisia	414.7	417.0	469.5	432.2	434.0	472.1	383.1	406.9	433.5
UAE	381.4	411.8	434.8	388.2	415.1	440.0	389.7	403.4	414.5
Arab countries	371.8	<i>393.3</i>	<i>432.4</i>	393.9	417.4	<i>452.0</i>	367.7	385.6	402.9
non-Arab	413.0	<i>448.2</i>	<i>498.9</i>	409.1	447.6	<i>494.8</i>	412.5	439.5	469.3

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Table 8. Average scores by mother's education

(a). Grade 4

	Math			Science		
	Primary or less	Secondary	Tertiary or more	Primary or less	Secondary	Tertiary or more
Morocco	333.5	361.9	393.1	260.9	300.7	329.4
Oman	362.6	393.3	457.4	351.2	387.2	458.5
Qatar	350.7	406.1	456.6	329.2	390.4	444.0
Saudi Arabia	390.3	415.3	437.8	402.6	436.4	466.1
UAE	380.7	411.1	474.0	367.2	404.1	472.6
Arab countries	363.6	397.6	443.8	342.2	383.8	434.1
non-Arab	423.7	467.6	520.5	417.0	465.4	524.5

(b). Grade 8

	Math			Science			Reading		
	Primary or less	Secondary	Tertiary or more	Primary or less	Secondary	Tertiary or more	Primary or less	Secondary	Tertiary or more
Bahrain	374.8	388.8	431.3	415.4	440.4	472.8			
Jordan	358.5	408.3	441.3	410.9	455.6	484.5	370.0	397.7	414.4
Lebanon	416.9	456.8	487.4	371.7	413.9	456.8			
Morocco	366.3	385.6	438.2	375.5	388.7	435.6			
Oman	358.0	375.9	393.5	415.0	438.0	452.1			
Palestine	386.5	410.8	443.5	406.8	426.5	463.4			
Qatar	317.2	334.8	392.9	319.2	339.4	397.2	325.4	344.0	346.4
Saudi Arabia	383.7	388.5	421.5	427.4	433.2	464.3			
Syria	377.5	388.0	401.3	422.7	435.0	447.3			
Tunisia	411.6	424.6	481.8	432.6	438.3	480.1	390.6	414.5	434.4
UAE	390.2	417.8	436.9	397.5	421.5	441.8	402.2	402.0	415.9

Arab countries	376.5	398.2	433.6	399.5	421.0	454.2	372.1	389.6	402.8
non-Arab	416.1	452.3	503.3	409.6	451.6	500.0	417.0	442.6	468.7

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Average scores by number of books at home

Number of books in a student's home likely indicates a suitable environment for home education. Table 9 shows a direct relationship between the availability of books at home and child's performance in math, science, and reading. For both Arab and non-Arab countries children in households having many books significantly outperform children in households having few or no books. The exceptions are Qatar (grade 4) and Syria (grade 8) where there is an insignificant difference. Also here, the average differences between Arabs and non-Arabs tend to increase with the number of books.

Table 9. Average scores by number of books in home

(a). Grade 4

	Math			Science		
	<25	25-100	>100	<25	25-100	>100
Morocco	336.0	364.8	355.2	263.8	310.7	287.1
Oman	373.9	406.1	396.3	364.3	403.0	389.4
Qatar	410.4	438.5	411.4	391.8	425.3	391.6
Saudi Arabia	402.9	422.8	422.6	418.2	450.2	446.1
UAE	423.7	450.8	445.2	415.7	450.0	437.2
Arab countries	389.4	416.6	406.1	370.8	407.9	390.3
non-Arab	442.8	482.9	479.2	435.8	482.9	478.2

(b). Grade 8

	Math			Science			Reading		
	<25	25-100	>100	<25	25-100	>100	<25	25-100	>100
Bahrain	371.6	416.6	421.8	417.8	463.2	468.2			
Jordan	393.4	421.2	432.1	439.6	467.6	473.6	395.8	413.4	416.0
Lebanon	433.7	469.4	478.8	383.6	434.3	447.5			
Morocco	367.2	401.0	406.2	375.5	397.9	404.8			
Oman	332.5	388.1	394.5	390.2	445.7	451.6			
Palestine	390.7	426.9	430.1	406.7	447.2	448.3			
Qatar	334.4	374.4	393.7	337.4	382.1	394.5	326.4	355.9	360.8
Saudi Arabia	375.9	410.1	410.5	421.3	453.3	455.8			
Syria	379.1	400.1	384.4	427.0	444.7	429.0			

Tunisia	414.7	451.9	469.8	431.6	458.7	476.7	397.7	432.0	441.7
UAE	401.2	430.6	428.6	403.1	435.7	436.0	395.6	415.3	421.5
Arab countries	381.3	<i>417.3</i>	422.8	403.1	439.1	444.2	378.9	404.2	410.0
non-Arab	427.3	<i>470.6</i>	492	427.8	469.8	489.8	417.0	454.9	490.1

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Average scores by wealth

Although TIMSS does not provide a measure of family income or wealth, we created a proxy by combining a series of TIMSS's asset ownership indicators (computer, internet, own room, etc.) using Principle Component Analysis. The distribution of the resulting proxy then were divided into three equal divisions (tertiles) indicating low, medium, and high level of wealth. Table 10 reports the average math and science score by tertiles of the newly defined asset ownership index. In most Arab and non-Arab countries, children in affluent families perform better in math and science than children in disadvantaged families.

Table 10. Average scores by wealth

	Math			Science		
	Low asset own.	Medium asset own.	High asset own.	Low asset own.	Medium asset own.	High asset own.
Bahrain	388.3	397.2	408.6	436.1	447.1	449.5
Jordan	399.4	411.3	420.8	449.7	456.8	463.1
Lebanon	429.1	453.6	474.5	380.3	409.8	439.5
Morocco	358.6	378.5	397.9	369.6	383.9	398.3
Oman	351.1	368.1	371.7	407.8	425.8	429.7
Palestine	389.0	416.0	414.3	401.1	432.6	438.2
Qatar	343.8	359.6	380.4	344.0	366.3	384.4
Saudi Arabia	384.8	393.6	393.7	428.3	437.9	438.5
Syria	369.1	395.8	388.7	417.0	440.4	437.5
Tunisia	408.1	427.8	450.4	427.9	442.8	456.2
UAE	411.5	419.0	414.1	419.2	421.3	415.7
Arab countries	384.8	<i>401.9</i>	410.5	407.4	424.1	431.9
non-Arab	432.0	<i>456.8</i>	<i>476.6</i>	430.6	455.8	<i>477.0</i>

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

3.1 Inequality in test scores

Table 11 reports the Gini coefficients of the test scores in math, science, and reading by community type. Comparing inequality of scores in rural and urban areas does not reveal a particular pattern. For most Arab countries, the inequality in grade 4 scores is higher than for non-Arab countries. Morocco (grade 4) and Qatar and Oman (grade 8) which all show higher inequality in math and science scores, and Tunisia shows the lowest inequality in math and science.

Table 11. Inequality in test scores by community type

(a). Grade 4

	Math			Science		
	Rural	Urban	Total	Rural	Urban	Total
Morocco	0.166	0.147	0.158	0.264	0.226	0.246
Oman	0.147	0.145	0.144	0.181	0.178	0.176
Qatar	0.119	0.142	0.139	0.151	0.178	0.175
Saudi Arabia	0.134	0.126	0.128	0.141	0.130	0.132
UAE	0.112	0.124	0.123	0.129	0.142	0.141
Arab countries	0.141	<i>0.134</i>	0.137	0.183	<i>0.165</i>	0.171
non-Arab	0.107	<i>0.089</i>	0.099	0.139	<i>0.094</i>	0.114

(b). Grade 8

	Math			Science			Reading		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Bahrain	0.108	0.132	0.127	0.102	0.125	0.120			
Jordan	0.140	0.125	0.130	0.128	0.114	0.119	0.113	0.111	0.111
Lebanon	0.094	0.088	0.090	0.130	0.127	0.129			
Morocco	0.110	0.119	0.118	0.113	0.116	0.116			
Oman	0.157	0.151	0.154	0.143	0.137	0.140			
Palestine	0.134	0.132	0.133	0.132	0.133	0.133			
Qatar	0.138	0.143	0.143	0.153	0.163	0.162	0.124	0.153	0.149
Saudi Arabia	0.126	0.122	0.124	0.102	0.096	0.098			
Syria	0.134	0.131	0.133	0.102	0.100	0.101			
Tunisia	0.088	0.092	0.093	0.076	0.078	0.078	0.093	0.115	0.114
UAE	0.101	0.099	0.100	0.109	0.108	0.109	0.110	0.111	0.112
Arab countries	0.122	0.119	0.121	0.118	0.116	0.118	0.113	0.122	0.121
non-Arab	0.109	0.109	0.113	0.120	0.106	0.116	0.103	0.100	0.103

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Error! Not a valid bookmark self-reference. reports the inequality of scores by gender. Overall, the inequality of grade 4 and grade 8 scores in math, science, and reading is higher among boys than girls. The exceptions are Qatar and Tunisia (grade 8). Interestingly, inequality scores tend to be higher in grade 4 than in grade 8. Here there might be a self-selection dynamics after grade 4 where girls might be particularly affected.

Table 12. Inequality in scores by gender

(a). Grade 4

	Math		Science	
	Girl	Boy	Girl	Boy
Morocco	0.153	0.162	0.239	0.253
Oman	0.130	0.156	0.157	0.193
Qatar	0.129	0.147	0.159	0.188
Saudi Arabia	0.104	0.151	0.105	0.154
UAE	0.111	0.134	0.126	0.155
Arab countries	0.124	0.148	0.154	0.186
non-Arab	0.096	0.102	0.110	0.118

(b). Grade 8

	Math		Science		Reading	
	Girl	Boy	Girl	Boy	Girl	Boy
Bahrain	0.104	0.140	0.093	0.133		
Jordan	0.114	0.145	0.097	0.136	0.083	0.120
Lebanon	0.088	0.090	0.126	0.132		
Morocco	0.120	0.116	0.115	0.117		
Oman	0.125	0.168	0.106	0.156		
Palestine	0.121	0.143	0.119	0.145		
Qatar	0.145	0.140	0.163	0.157	0.106	0.158
Saudi Arabia	0.106	0.140	0.083	0.111		
Syria	0.133	0.132	0.101	0.102		
Tunisia	0.094	0.091	0.079	0.077	0.104	0.122
UAE	0.085	0.109	0.089	0.120	0.087	0.120
Arab countries	0.112	0.126	0.106	0.124	0.095	0.130
non-Arab	0.109	0.116	0.11	0.121	0.093	0.109

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in

italic.

3.2 School quality

TIMSS provides several indicators of school quality. Schools have reported the extent of teacher absenteeism, teacher shortage, and other issues. Table 13 shows teacher absenteeism by school type and community type. The difference between Arab and non-Arab countries is striking. For instance, in Arab countries teacher absenteeism by ratio of students is 4 to 6 times higher than in non-Arab countries. Morocco, Oman, Jordan, and Syria show the highest rates of absenteeism. For most Arab and non-Arab countries, the rate of teacher absenteeism is similar in all-boys and all-girls schools. The exceptions are Qatar and UAE, where teacher absenteeism in all-girls schools is twice that in all-boys schools. In most countries except Bahrain, Morocco, and Saudi Arabia, teacher absenteeism is higher in public schools than in private schools. Jordan, Lebanon, and Tunisia show higher teacher absenteeism in rural schools than in urban schools.

Table 13. Teacher absenteeism by gender, community type, and school type

(a). Grade 4

	Gender		Community		School type	
	Girl	Boy	Rural	Urban	Private	Public
Morocco	0.51	0.51	0.60	0.47	0.59	0.50
Oman	0.39	0.39	0.41	0.38	0.27	0.40
Qatar	0.11	0.07	0.01	0.11	0.04	0.11
Saudi Arabia	0.36	0.26	0.43	0.28	0.29	0.31
UAE	0.13	0.14	0.15	0.12	0.14	0.19
Arab countries	<i>0.30</i>	<i>0.28</i>	<i>0.32</i>	<i>0.27</i>	0.26	0.30
non-Arab	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	0.06	0.07

(b). Grade 8

	Gender		Community type		School type	
	Girl	Boy	Rural	Urban	Private	Public
Bahrain	0.03	0.05	0.03	0.05	0.08	0.04
Jordan	0.28	0.32	0.41	0.25	-	-
Lebanon	0.08	0.11	0.14	0.09	0.08	0.12
Morocco	0.39	0.38	0.33	0.40	0.51	0.38
Oman	0.26	0.27	0.31	0.25	0.19	0.27
Palestine	0.17	0.21	0.19	0.18	0.18	0.20
Qatar	0.14	0.06	0.12	0.10	0.06	0.11

Saudi Arabia	0.30	0.25	0.30	0.27	0.38	0.27
Syria	0.57	0.54	0.56	0.56	0.41	0.57
Tunisia	0.33	0.34	0.41	0.29	0.19	0.34
UAE	0.22	0.11	0.16	0.15	0.08	0.21
Arab countries	<i>0.25</i>	<i>0.24</i>	<i>0.27</i>	<i>0.24</i>	0.22	0.25
non-Arab	<i>0.05</i>	<i>0.05</i>	<i>0.05</i>	<i>0.06</i>	-	-

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

Table 14 shows teacher shortage by school type and community type. Teacher shortage at the 8th grade seems to be a serious issue in Arab countries. The shortage rate at 8th grade is noticeably higher than that at the 4th grade. Also it is much higher in Arab countries comparing to non-Arab developing countries. In almost all Arab countries more than half of 8th grade students experienced teacher shortage in math or science. Teacher shortage in Tunisia was highest in our sample with the shortage rate of more than 60%. Lebanon on the other hand had the lowest shortage rate among all the Arab countries.

Table 14. Ratio of students in schools with teacher shortages in math and science

	Math		Science	
	Grade 4	Grade 8	Grade 4	Grade 8
Bahrain		0.44		0.52
Jordan		0.50		0.49
Lebanon		0.28		0.29
Morocco	0.14	0.52	0.15	0.51
Oman	0.58	0.58	0.52	0.58
Palestine		0.51		0.55
Qatar	0.35	0.53	0.39	0.55
Saudi Arabia	0.38	0.48	0.36	0.50
Syria		0.55		0.42
Tunisia		0.62		0.65
UAE	0.34	0.54	0.34	0.54
Arab countries	0.36	<i>0.50</i>	0.35	<i>0.51</i>
non-Arab	0.23	<i>0.26</i>	0.26	<i>0.25</i>

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

TIMSS also provides data on the use of memorization. Table 15 presents the ratio of students whose teachers encourage memorization of rules in every class in the two grades. For most countries, the extent of memorization is higher in grade 4. In Arab countries and non-Arab

countries the average ratio in math classes is about the same, whereas in Arab countries there is more emphasis on memorization in science classes. The finding that memorization is encouraged more in science than in math classes is not surprising considering the different nature of the classes. Memorization ratios show considerable variation, however, across all countries in the sample. For instance, in UAE 36% of grade 8 students in math and science classes, and in Lebanon more than 70% of grade 8 students in math classes and 60% of grade 8 students in science classes report severe memorization.

Table 15. Ratio of students reporting severe memorization

	Math		Science	
	Grade 4	Grade 8	Grade 4	Grade 8
Bahrain		0.70		0.59
Jordan		0.52		0.78
Lebanon		0.71		0.64
Morocco	0.73	0.54	0.52	0.62
Oman	0.59	0.67	0.68	0.61
Palestine		0.60		0.83
Qatar	0.57	0.37	0.49	0.52
Saudi Arabia	0.55	0.42	0.55	0.66
Syria		0.60		0.81
Tunisia		0.49		0.66
UAE	0.47	0.36	0.52	0.36
Arab countries	0.58	0.54	0.55	<i>0.64</i>
non-Arab	0.56	0.56	0.44	<i>0.46</i>

Note: Statistically significant difference between Arab and non-Arab countries subsamples are in italic.

4. Methodology

As mentioned, we use a method proposed by Roemer (1998) and widely used in the literature (de Barros et al., 2009; Ersado and Gignoux, 2014; Francisco H. G. Ferreira and Gignoux, 2011). We first identify a set of factors beyond students' control ("circumstances") and then define opportunity-equal situation as a situation in which students' outcomes (y) are independent of the circumstances into which they are born (C) as

$$f(y|C) = f(y)$$

We use the math and science scores of grade 8 and grade 4 (only in 2011) students from TIMSS and the reading scores of 15-year-old students from PISA as the educational outcomes. The set of circumstances available for all countries and in all years include gender, family background

(i.e. father's education, mother's education, number of books at home, computer at home, ethnicity indicated by how often the language of the test is used at home), and community characteristics (community size, average characteristics of community teachers including age, gender, years of experience, education; average characteristics of community schools including class size, an indicator of teacher shortage, the percentages of students coming from economically disadvantaged families, and an indicator of school climate)

Using a parametric approach to estimate IOp, we describe the relationship between student i 's educational outcome and the set of circumstances she faces (C_i) as

$$y_i = C_i\beta + \epsilon_i, \quad (1)^\dagger$$

where ϵ_i represents unobserved factors which determine the outcome such as individual's efforts and luck. To measure the inequality of opportunity we compare the inequality in the observed distribution of outcome (y_i) with the inequality in the synthetic distribution of outcome (\tilde{y}_i) which is the predicted outcome when circumstances are assumed fixed for everyone. Since the impact of circumstances is removed, the inequality in the synthetic distribution can be only attributed to luck and effort. We calculate \tilde{y}_i as

$$\tilde{y}_i = \bar{C}\hat{\beta} + \hat{\epsilon}_i, \quad (2)$$

where \bar{C} represents a vector of circumstances fixed for everyone (at their mean values), and $\hat{\beta}$ and $\hat{\epsilon}_i$ are the estimated coefficients and residuals from the original equation. Now we can write the measure of inequality of opportunity as

$$\theta = 1 - \frac{I(\tilde{y}_i)}{I(y_i)}, \quad (3)$$

where $I(\tilde{y}_i)$ and $I(y_i)$ show the inequality in the synthetic and original distribution of outcomes, respectively. As an appropriate index I(), literature recommends using the General Entropy (GE) class due its desirable properties (Ferreira and Gignoux, 2011). Within GE class, only GE(2) is considered appropriate to be used with TIMSS data because of the way TIMSS scores are standardized (Salehi-Isfahani et al., 2014). In this paper we use GE(2) to measure inequality in both distributions.

[†] Actually, this equation represents a sort of reduced form relation, rather than the structural one. That is, circumstances and effort could be related, implying that estimates of beta via OLS are potentially biased. One can't vary C independently of the error term to recover the structural relation between circumstances and outcomes. Rather, what we are doing here is to project outcomes in the space of circumstances, so that the estimated beta captures both the impact of circumstances on outcomes, and the impact of the correlation between effort and circumstances on outcomes. As a result, estimates of the residual term of (1) are orthogonal to C by construction. This is close to the idea in Roemer, who suggests that the correlation between effort and circumstances is a circumstance in its own and deserve compensation, i.e. should be accounted for in determining the extent of IOp. Hence, one should interpret the residual of an OLS regression of (1) as part of the effort and a residual component, and not directly the disturbance term in (1).

5. Results

This section discusses the results of the measures of Inequality of Opportunity as explained in Section 4 for the Arab countries in our dataset. This section also compares the IOp across countries and discusses its trend over time. The shares of each single circumstance as well as the share of main groups of circumstances (family background, community characteristics) in IOp of achievement are also reported in this section.

Table 16 shows the estimates of inequality of opportunity for achievement in math and science scores (Grade 8) over time. These numbers are the share of inequality in math and science scores that are accounted for by circumstances. In most countries, IOp is larger in science than in math. Overall, Morocco is the most opportunity-equal Arab country followed by Saudi Arabia, Syria, and Tunisia. In 2011, 20.4% (16.4%) of Morocco's inequality in math (science) scores can be attributed to circumstances, whereas Lebanon and Qatar (with more than 30% of inequality in math and science scores attributed to circumstances) lie at the other extreme.

Over time, Morocco, Oman, Qatar, Saudi Arabia, and Tunisia have become more opportunity-unequal whereas IOp decreases in Syria. It is not clear whether the decline in Egypt from 2003 to 2007 reflects a lasting trend or is a one-time change since it did not participate in 2011 survey. In case of Syria, the decline in IOp only occurs for achievement in math. In most of the countries where IOp worsens (the exception is Qatar), the increase in IOp occurs along with the increase in the share of family background. In Lebanon and Jordan, IOp declines in 2011 after a period of initial increase. In Bahrain, IOp decreases from 0.234 to 0.184 between 2003–2007 and then rises to 0.302 in 2011. In Palestine, IOp remains about the same over time. In all countries the temporal change in IOp is similar for math and science for the most part. The exception is Qatar where the IOp in math increases and the IOp in science drops. Overall, in almost all Arab countries IOp does not consistently decrease over time and it has worsened in all Gulf Cooperation Council (GCC) countries (Saudi Arabia, Kuwait, UAE, Qatar, Oman, and Bahrain) in recent years.

Figure 2 shows the average estimates of IOp in math and science for grade 8 education spending. The graph reveals that spending more on education does not necessarily lead to lower IOp as countries such as Jordan or Tunisia with highest education spending per pupil also have higher IOp than many other Arab countries with much lower education spending. Figure 3 shows the average IOp in math and science by the average Gini coefficient in math and science. In both Arab and non-Arab countries, IOp increases with the overall inequality in scores. In the Arab region, the pattern seems to be influenced by the effect of some GCC countries.

Figure 2. Average IOP by education spending

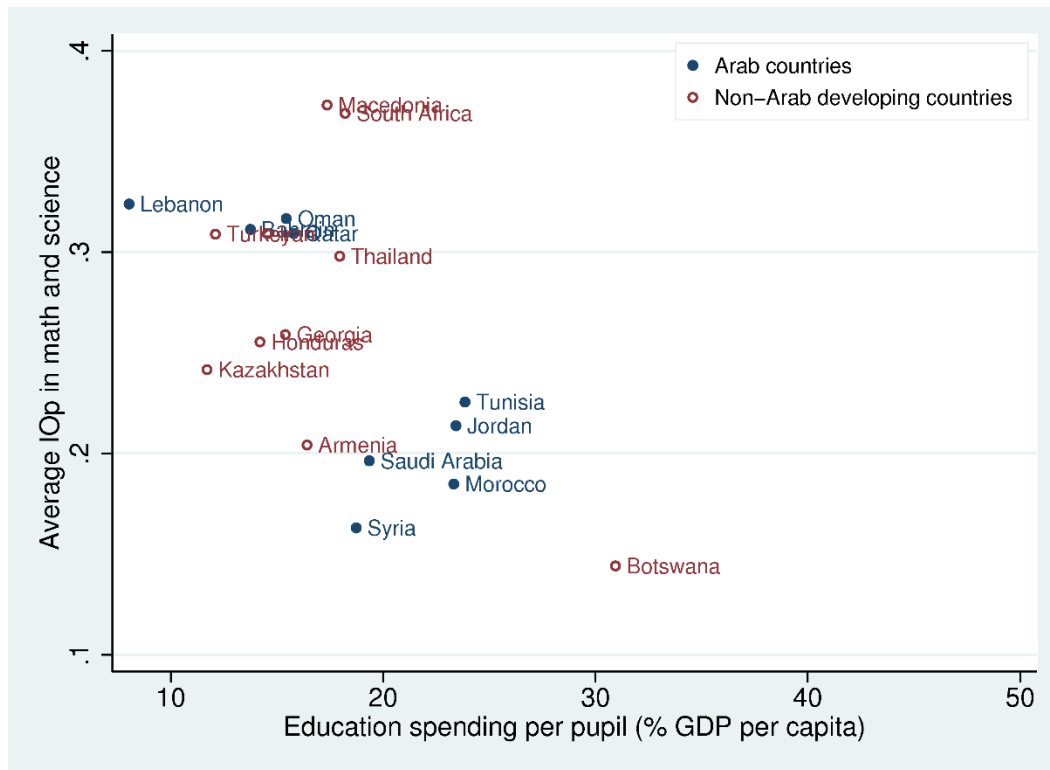
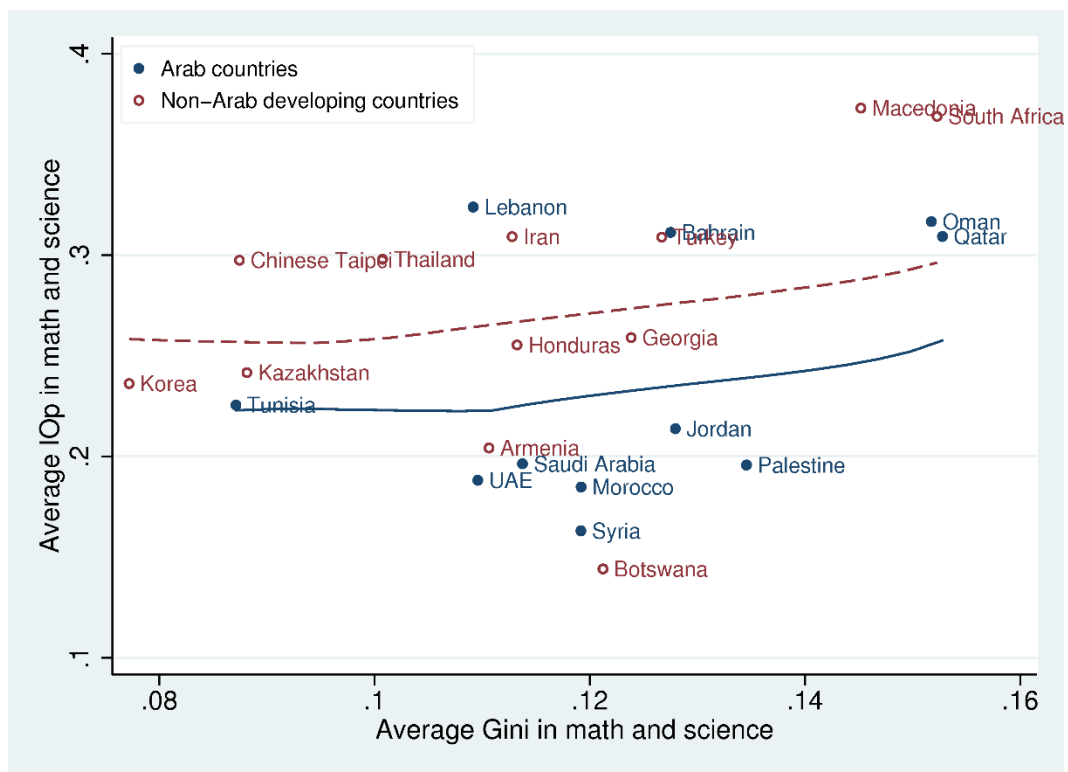


Figure 3. Average IOP by Gini



This approach also allows us to estimate the partial impact of individual circumstances or groups of circumstances on educational outcomes by fixing the value of the particular circumstance or group at its mean. We distinguish between circumstances related to family background and those related to community characteristics. Table 17 through Table 19 show the estimates of IOp using TIMSS 2011 (grades 4 and 8) along with the contribution of family background, community characteristics, gender, mother's education, father's education, number of books in the home, community location, and access to computer at home to IOp for achievement in math and science over time. In almost all countries the contribution of family background is larger than the share of community characteristics. Also in almost all countries the share of gender is relatively small, and in high IOp countries such as Qatar and Saudi Arabia, it is statistically insignificant. In Oman, Bahrain, and UAE, however, the share of gender is relatively high, possibly due to the fact that in the three countries girls perform better than boys.

In most countries father's education account for larger share of IOp than mother's education. In Syria, the share of father's education in IOp in math is four times the share of mother's education. Lebanon is the only country in which the partial impact of mother's education is larger than that of father's education in both math and science achievements. In all countries, the contribution of number of books at home and access to computer at home (the two variables which reflect the quality of home environment) in overall IOp appear significant. In Bahrain, Oman, Tunisia, and UAE, the partial impact of number of books is quite large (twice that of father's education). In most countries the share of access to computer at home is relatively small. In all countries partial impact of community size is relatively small and insignificant in Oman and Palestine.

Table 19 shows the estimates of IOp for achievement in math and science at grade 4. For almost all countries participating at both grades, IOp at grade 4 is comparable with that at grade 8. The exception is Oman where the education system is significantly less opportunity-equal at 4th grade. The partial impacts of single and grouped circumstances follow the same pattern described for IOp estimates at grade 8. For instance, as before, in almost all countries the share of family background is larger than community characteristics, the share of gender appears to be relatively small, and the share of father's education is relatively larger than mother's education.

Table 20 shows the IOp in educational achievement in reading over time. Again, Qatar is among the most unequal opportunity countries in our sample. While IOp in Jordan increases, Tunisia and UAE become less opportunity-unequal in reading. In most countries contribution of family background is larger than that of community characteristics. Also in most countries the partial impact of gender in IOp for achievement in reading is much larger than that in math and science. For instance, in 2012 the share of gender in Jordan, Qatar, and UAE is more than 50% of total IOp. On the other hand, the share of parent's education in IOp for achievement in reading is lower than that in math or science. The partial impact of circumstances related to the quality of home environment appears to be relatively large. In 2012, the share of number of books of total inequality of opportunity varies from 15% to 30%. The contribution of access to computer at

home in IOp in reading score is much smaller compared to the number of books at home. Same as in math and science, the partial impact of community location in IOp for achievement in reading is small in all countries.

Table 16. Estimates of IOp for achievement in math and science, 1999–2011, Grade 8

	Math				Science			
	1999	2003	2007	2011	1999	2003	2007	2011
Bahrain		0.234 (0.012)	0.184 (0.013)	0.302 (0.014)		0.181 (0.015)	0.272 (0.015)	0.321 (0.016)
Egypt		0.243 (0.011)	0.142 (0.012)			0.223 (0.011)	0.130 (0.01)	
Jordan	0.186 (0.014)	0.250 (0.017)	0.240 (0.015)	0.202 (0.012)	0.197 (0.013)	0.239 (0.014)	0.265 (0.013)	0.225 (0.013)
Kuwait			0.146 (0.012)				0.199 (0.013)	
Lebanon		0.302 (0.014)	0.384 (0.016)	0.304 (0.015)		0.305 (0.01)	0.425 (0.01)	0.343 (0.008)
Morocco	0.102 (0.01)	0.101 (0.015)	0.201 (0.018)	0.204 (0.008)	0.112 (0.007)	0.173 (0.019)	0.161 (0.011)	0.165 (0.006)
Oman			0.229 (0.013)	0.300 (0.009)			0.267 (0.013)	0.333 (0.011)
Palestine		0.196 (0.011)	0.199 (0.012)	0.188 (0.01)		0.194 (0.013)	0.212 (0.012)	0.203 (0.013)
Qatar			0.286 (0.011)	0.336 (0.021)			0.416 (0.014)	0.282 (0.019)
Saudi Arabia		0.154 (0.016)	0.176 (0.013)	0.189 (0.014)		0.146 (0.015)	0.224 (0.013)	0.203 (0.014)
Syria		0.205 (0.016)	0.177 (0.01)	0.163 (0.009)		0.170 (0.01)	0.175 (0.009)	0.163 (0.007)
Tunisia	0.158 (0.011)	0.229 (0.013)	0.237 (0.013)	0.250 (0.011)	0.148 (0.011)	0.187 (0.011)	0.179 (0.01)	0.201 (0.013)

UAE	0.181 (0.01)	0.195 (0.01)
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Note: Bootstrapped standard error is in parentheses.

Table 17. Inequality of opportunity shares for achievement in math, 2011, Grade 8

	Bahrain	Jordan	Lebanon	Morocco	Oman	Palestine	Qatar	Saudi	Syria	Tunisia	UAE
All	0.302 (0.014)	0.202 (0.012)	0.304 (0.015)	0.204 (0.008)	0.300 (0.009)	0.188 (0.01)	0.336 (0.021)	0.189 (0.014)	0.163 (0.009)	0.250 (0.011)	0.181 (0.01)
Family background	0.178 (0.017)	0.177 (0.012)	0.197 (0.016)	0.163 (0.009)	0.277 (0.01)	0.121 (0.01)	0.241 (0.022)	0.128 (0.03)	0.077 (0.008)	0.206 (0.011)	0.162 (0.01)
Community characteristics	0.161 (0.012)	0.029 (0.01)	0.183 (0.012)	0.069 (0.006)	0.057 (0.008)	0.069 (0.008)	0.079 (0.029)	0.067 (0.028)	0.084 (0.009)	0.079 (0.009)	0.028 (0.007)
Gender	0.046 (0.013)	0.016 (0.005)	0.005 (0.003)	0.0002 (0.008)	0.109 (0.008)	0.015 (0.004)	0.001 (0.009)	0.004 (0.03)	0.003 (0.002)	0.013 (0.004)	0.049 (0.007)
Mother's education	0.016 (0.007)	0.056 (0.009)	0.076 (0.012)	0.047 (0.009)	0.022 (0.005)	0.035 (0.007)	0.058 (0.016)	0.022 (0.008)	0.010 (0.006)	0.040 (0.01)	0.034 (0.006)
Father's education	0.040 (0.008)	0.062 (0.01)	0.047 (0.011)	0.063 (0.007)	0.039 (0.006)	0.043 (0.006)	0.078 (0.014)	0.041 (0.009)	0.039 (0.005)	0.039 (0.01)	0.028 (0.006)
Number of books	0.091 (0.012)	0.045 (0.008)	0.067 (0.011)	0.034 (0.006)	0.108 (0.008)	0.043 (0.007)	0.073 (0.014)	0.043 (0.008)	0.019 (0.005)	0.073 (0.008)	0.062 (0.008)
Community location	-0.010 (0.007)	0.010 (0.004)	0.019 (0.008)	0.013 (0.004)	0.005 (0.003)	-0.003 (0.003)	0.077 (0.017)	0.022 (0.009)	0.010 (0.004)	0.024 (0.005)	0.007 (0.003)
Computer at home	0.021 (0.007)	0.033 (0.006)	0.028 (0.009)	0.058 (0.006)	0.063 (0.006)	0.028 (0.005)	0.002 (0.004)	0.016 (0.005)	0.011 (0.004)	0.074 (0.008)	0.012 (0.004)

Table 18. Inequality of opportunity shares for achievement in science, 2011, Grade 8

	Bahrain	Jordan	Lebanon	Morocco	Oman	Palestine	Qatar	Arabia	Syria	Tunisia	UAE
All	0.321 (0.016)	0.225 (0.013)	0.343 (0.008)	0.165 (0.006)	0.333 (0.011)	0.203 (0.013)	0.282 (0.019)	0.203 (0.014)	0.163 (0.007)	0.201 (0.013)	0.195 (0.01)
Family background	0.168 (0.021)	0.192 (0.013)	0.222 (0.009)	0.131 (0.006)	0.317 (0.011)	0.134 (0.01)	0.221 (0.022)	0.172 (0.021)	0.072 (0.008)	0.167 (0.014)	0.169 (0.009)
Community characteristics	0.197 (0.017)	0.042 (0.014)	0.192 (0.008)	0.056 (0.004)	0.042 (0.012)	0.083 (0.012)	0.064 (0.028)	0.015 (0.04)	0.072 (0.006)	0.057 (0.008)	0.031 (0.007)
Gender	0.056 (0.017)	0.041 (0.007)	-0.002 (0.001)	-0.0005 (0.0002)	0.154 (0.01)	0.016 (0.005)	0.015 (0.011)	0.028 (0.015)	0.002 (0.001)	0.018 (0.004)	0.066 (0.007)
Mother's education	0.013 (0.006)	0.052 (0.011)	0.065 (0.007)	0.048 (0.005)	0.035 (0.006)	0.032 (0.006)	0.062 (0.012)	0.022 (0.007)	0.013 (0.004)	0.023 (0.008)	0.028 (0.005)
Father's education	0.024 (0.007)	0.058 (0.01)	0.052 (0.006)	0.045 (0.004)	0.048 (0.006)	0.043 (0.006)	0.055 (0.012)	0.042 (0.007)	0.039 (0.005)	0.030 (0.008)	0.024 (0.006)
Number of books	0.099 (0.01)	0.043 (0.007)	0.088 (0.007)	0.025 (0.003)	0.097 (0.008)	0.051 (0.007)	0.065 (0.012)	0.051 (0.009)	0.019 (0.003)	0.069 (0.008)	0.065 (0.008)
Community location	-0.021 (0.008)	0.010 (0.003)	0.040 (0.005)	0.013 (0.003)	-0.001 (0.003)	0.000 (0.003)	0.074 (0.015)	0.017 (0.008)	0.007 (0.002)	0.022 (0.006)	0.003 (0.003)
Computer at home	0.021 (0.007)	0.025 (0.007)	0.019 (0.003)	0.035 (0.003)	0.057 (0.006)	0.028 (0.006)	0.001 (0.004)	0.037 (0.007)	0.014 (0.003)	0.032 (0.007)	0.009 (0.003)

Table 19. Inequality of opportunity shares for achievement in math and science, 2011 (Grade 4)

	Math				Science			
	Morocco	Oman	Qatar	UAE	Morocco	Oman	Qatar	UAE
All	0.214 (0.013)	0.161 (0.008)	0.387 (0.012)	0.202 (0.008)	0.216 (0.011)	0.159 (0.009)	0.393 (0.015)	0.173 (0.008)
Family background	0.091 (0.01)	0.117 (0.007)	0.287 (0.013)	0.14 (0.007)	0.101 (0.01)	0.12 (0.008)	0.32 (0.014)	0.137 (0.007)
Community characteristics	0.152 (0.012)	0.056 (0.005)	0.201 (0.014)	0.053 (0.005)	0.129 (0.011)	0.051 (0.006)	0.151 (0.013)	0.036 (0.004)
Gender	0.000 (0.001)	0.018 (0.003)	0.002 (0.002)	0.002 (0.001)	0.001 (0.001)	0.02 (0.003)	0.006 (0.002)	0.006 (0.002)
Mother's education	0.016 (0.004)	0.006 (0.002)	0.016 (0.005)	0.032 (0.005)	0.017 (0.005)	0.006 (0.002)	0.01 (0.004)	0.035 (0.005)
Father's education	0.01 (0.003)	0.011 (0.003)	0.06 (0.006)	0.065 (0.006)	0.014 (0.004)	0.011 (0.003)	0.044 (0.007)	0.059 (0.006)
Number of books	0.028 (0.007)	0.046 (0.005)	0.069 (0.007)	0.029 (0.004)	0.05 (0.007)	0.048 (0.006)	0.078 (0.007)	0.032 (0.004)
Community location	0.041 (0.008)	0.015 (0.004)	0.099 (0.01)	0.041 (0.004)	0.037 (0.006)	0.017 (0.003)	0.097 (0.011)	0.03 (0.004)
Computer at home	0.001 (0.002)	0.034 (0.003)	0.025 (0.006)	0.0001 (0.0002)	0.003 (0.003)	0.03 (0.004)	0.025 (0.005)	0.002 (0.001)

Table 20. Inequality of opportunity shares for achievement in reading (15 year olds), 2006–2012

	2006			2009				2012			
	Jordan	Qatar	Tunisia	Jordan	Qatar	Tunisia	UAE	Jordan	Qatar	Tunisia	UAE
All	0.302 (0.015)	0.367 (0.014)	0.441 (0.011)	0.301 (0.014)	0.446 (0.008)	0.274 (0.009)	0.332 (0.009)	0.346 (0.011)	0.379 (0.012)	0.19 (0.011)	0.279 (0.014)
Family background	0.297 (0.014)	0.217 (0.03)	0.145 (0.013)	0.295 (0.013)	0.264 (0.01)	0.182 (0.01)	0.315 (0.009)	0.346 (0.011)	0.347 (0.012)	0.176 (0.011)	0.219 (0.015)
Gender	0.102 (0.01)	0.132 (0.034)	0.039 (0.005)	0.104 (0.009)	0.037 (0.005)	0.035 (0.005)	0.084 (0.006)	0.19 (0.01)	0.219 (0.01)	0.032 (0.006)	0.155 (0.012)
Mother's education	0.072 (0.01)	-0.001 (0.002)	0.007 (0.012)	0.058 (0.009)	0.023 (0.004)	0.014 (0.006)	0.09 (0.006)	0.038 (0.008)	0.006 (0.003)	0.027 (0.008)	0.01 (0.004)
Father's education	0.057 (0.011)	0.004 (0.002)	0.001 (0.012)	0.064 (0.008)	0.026 (0.004)	0.009 (0.005)	0.079 (0.007)	0.035 (0.007)	0.001 (0.003)	0.032 (0.008)	0.014 (0.005)
Number of books	0.053 (0.008)	0.031 (0.008)	0.063 (0.01)	0.091 (0.01)	0.041 (0.005)	0.065 (0.008)	0.063 (0.007)	0.072 (0.012)	0.055 (0.008)	0.056 (0.007)	0.053 (0.008)
Community location	0.039 (0.007)	0.04 (0.01)	0.066 (0.018)	0.024 (0.005)	0.131 (0.008)	0.076 (0.007)	0.06 (0.006)	0.036 (0.005)	0.015 (0.005)	0.03 (0.006)	-0.001 (0.003)
Computer at home	0.046 (0.007)	0.006 (0.004)	0.035 (0.006)	0.035 (0.006)	0.017 (0.003)	0.03 (0.006)	0.029 (0.004)	0.042 (0.005)	0.031 (0.005)	0.051 (0.009)	0.019 (0.005)

The estimates of IOp in previous rounds of TIMSS (1999, 2003, and 2007) are reported in the Appendix (Table 21 through Table 25).³ Table 26 in the Appendix reports the OLS estimates of the partial effects of circumstances on Math and Science scores. The results show large differentials associated with parent's education, number of books at home, whether language of test spoken at home, computer ownership, and community size. There are also some differentials associated with teacher and school characteristics.

6. Conclusion

Throughout the Arab world, child's education is seen as a critical path to social mobility. State-dominated education systems in these countries have long sought to provide more quantity of education in terms of years of schooling. The emphasis on *quantity*, however, has not coincided with improving the *quality* of education. The harsh reality is that in few Arab countries average test scores in international tests such as TIMSS have fallen below the international benchmarks. This seems to be partly confirmed by the WEF Global Competitiveness Report, which ranks most Arab countries – with the notable exception of Jordan, Lebanon, KSA, Qatar, and UAE – around the middle or in the bottom half of the global ranking as far as education-related indicators are concerned (WEF, 2015).

Also, the emphasis on *quantity* does not guarantee equal-opportunity in an education system. Ensuring equal opportunity is a key determinant of the success of an education system, since it guarantees a level playing field for students from diverse backgrounds and provides incentives to students to stay in school beyond compulsory schooling. The impact of equal opportunity extends beyond a country's education system by influencing the opportunity and quality of jobs when graduates enter the job market.

The evidence based on the most recent data presented in this paper shows that inequality of opportunity in Arab countries is relatively high already at early stages of education (grade 4) and continues along a student's educational experience (grade 8 and beyond). This is due particularly to the effect of Lebanon and some GCC countries on the regional sample. Our results show that in 2011 the share of inequality in achievement in mathematics accounted for by circumstance ranges from 16 percent in Syria to 33 percent in Qatar; in science ranges from 16 percent in Syria

³ Comparing our IOp estimates with those reported in Salehi-Isfani et al. (2012), we notice some discrepancies particularly as far as Egypt, Kuwait, KSA, and Morocco are concerned. The reason for discrepancies between our results and theirs is that we are not using the same samples. While our sample is limited to those whose parents (both father and mother) are natives, they only focus on those whose father is native (they drop those with foreign-born fathers and use mother's place of birth as one of the circumstances). Another potential reason is that they do not regroup levels of circumstances to fewer levels (for instance, we regrouped father's education to primary or less, secondary, tertiary). Making the above changes in our sample, we get similar estimates.

and Morocco and 34 percent in Lebanon, and in reading (in 2012) ranges from 19 percent in Tunisia to 37 percent in Qatar. These figures are in line and, in some cases, higher than the reported range of 12%-27% for Latin America and OECD (De Barros et al. 2009), 10%-35% for a sample of 57 countries investigated by Ferreira and Gignoux, 2011), or that for India (Asadullah and Yalonetsky, 2010). Our results also reveal that IOp in most of Arab world has worsened over time. In Morocco, Tunisia, and all GCC countries in our sample the inequality of opportunity has increased from since 2007.

The underlying causes of IOp patterns in the Arab region are not firmly established. Salehi-Isfahani (2015) cites several possible characteristics of education systems which we suggest also apply to the eleven countries in our sample. Salehi-Isfahani (2015) argues that in the region low public spending on education has actually increased private spending in the form of increased private school enrollment and private tutoring. The author also cites the misallocation of education budgets. The combination of under-spending on primary and secondary education and over-spending on tertiary education puts students from lower social and economic strata in a disadvantaged position. Salehi-Isfahani (2015) also argues that focusing on a narrow set of skills (memorization, test taking, etc.) in the national exams in the MENA region rather than investing in the so-called soft skills (teamwork, creativity, writing, etc.) prevents students with those skills to succeed and worsens IOp. Finally, the author notes that compulsory tracking in education systems can contribute to higher IOp since it often selects poorer children for vocational training which has very low returns.

IOp is a major challenge for education systems in the Arab region. Our results confirm and expand the earlier findings by Assaad et al. (2012) and Salehi-Isfahani et al. (2014) on the role of family background and community characteristics in high IOp in this region.

Moreover, Arab countries recording low average IOp levels, such as Syria, do not necessarily point at a relatively better situation compared to their regional comparators. This is because while in these countries more equity in education achievements seems to be at play, it may also be the case that there are limited incentives to apply efforts in achieving higher education scores due to potential labor market distortions that may not necessarily reward the best students. In the latter case, equity can be attained by lower scores at the top of the students' population rather than higher scores at the bottom.

Clearly, there is an important role for governments in all this. Family background (parents' education, number of books, etc.) can be influenced by public policy. First Improving education will eventually improve parental education, leading to a virtuous circle. Parental education could also be used to teach parents to improve their understanding of what they can do to help their kids, what the opportunities brought about by schooling are, etc. Government policies can also target community characteristics in order to achieve more equal opportunity education systems. Indeed, public policy can also focus on providing public libraries, access to computers to compensate inequality due to geographical disparities. Moreover, education policies that aim to

reallocate spending from tertiary education to primary and secondary education, reform the technical and vocational track, and invest in broader set of skills seem also to be potential solutions. Finally, country governance systems in the field of education need to be improved as shown by relatively higher rates of teachers' absenteeism in the region.

Appendix

Table 21. Inequality of opportunity shares for achievement in math, 2007, Grade 8

	Bahrain	Egypt	Jordan	Kuwait	Lebanon	Morocco	Oman	Palestine	Qatar	KSA	Syria	Tunisia
All	0.184 (0.013)	0.142 (0.012)	0.240 (0.015)	0.146 (0.012)	0.384 (0.016)	0.201 (0.018)	0.229 (0.013)	0.199 (0.012)	0.286 (0.011)	0.176 (0.013)	0.177 (0.01)	0.237 (0.013)
Family background	0.137 (0.01)	0.087 (0.009)	0.173 (0.013)	0.089 (0.011)	0.150 (0.017)	0.105 (0.015)	0.188 (0.017)	0.148 (0.013)	0.260 (0.01)	0.127 (0.014)	0.072 (0.008)	0.200 (0.013)
Community characteristics	0.061 (0.013)	0.072 (0.01)	0.073 (0.014)	0.077 (0.01)	0.319 (0.017)	0.123 (0.017)	0.079 (0.02)	0.065 (0.013)	0.053 (0.009)	-0.003 (0.022)	0.119 (0.01)	0.070 (0.01)
Gender	0.041 (0.008)	0.001 (0.001)	0.014 (0.005)	0.013 (0.004)	0.013 (0.005)	0.007 (0.004)	0.076 (0.016)	0.018 (0.01)	0.049 (0.008)	0.020 (0.008)	0.016 (0.005)	0.034 (0.007)
Mother's education	0.032 (0.008)	0.015 (0.007)	0.047 (0.012)	0.023 (0.006)	0.041 (0.012)	0.042 (0.011)	0.019 (0.006)	0.051 (0.008)	0.045 (0.007)	0.013 (0.008)	0.017 (0.004)	0.025 (0.009)
Father's education	0.013 (0.006)	0.042 (0.008)	0.047 (0.01)	0.023 (0.007)	0.041 (0.011)	0.019 (0.011)	0.015 (0.005)	0.043 (0.007)	0.029 (0.007)	0.043 (0.005)	0.034 (0.006)	0.041 (0.01)
Number of books	0.071 (0.008)	0.028 (0.006)	0.054 (0.01)	0.020 (0.006)	0.031 (0.009)	0.026 (0.01)	0.066 (0.009)	0.043 (0.008)	0.048 (0.007)	0.067 (0.014)	0.012 (0.005)	0.098 (0.012)
Community location	-0.009 (0.005)	0.013 (0.005)	0.023 (0.008)	0.003 (0.004)	0.030 (0.009)	0.013 (0.006)	0.016 (0.005)	0.015 (0.004)	0.100 (0.014)	0.018 (0.006)	0.002 (0.003)	0.015 (0.005)
Computer	0.001	-0.001	0.038	0.018	0.011	0.013	0.029	0.017	0.028	0.006	-0.002	0.023

at home	(0.001)	(0.002)	(0.008)	(0.005)	(0.007)	(0.01)	(0.006)	(0.005)	(0.005)	(0.005)	(0.001)	(0.007)
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Table 22. Inequality of opportunity shares for achievement in science, 2007, Grade 8

	Bahrain	Egypt	Jordan	Kuwait	Lebanon	Morocco	Oman	Palestine	Qatar	KSA	Syria	Tunisia
All	0.272 (0.015)	0.130 (0.01)	0.265 (0.013)	0.199 (0.013)	0.425 (0.01)	0.161 (0.011)	0.267 (0.013)	0.212 (0.012)	0.416 (0.014)	0.224 (0.013)	0.175 (0.009)	0.179 (0.01)
Family background	0.235 (0.017)	0.085 (0.008)	0.191 (0.011)	0.129 (0.014)	0.221 (0.012)	0.064 (0.009)	0.214 (0.015)	0.128 (0.017)	0.377 (0.015)	0.151 (0.019)	0.063 (0.008)	0.155 (0.009)
Community characteristics	0.083 (0.016)	0.054 (0.008)	0.079 (0.019)	0.113 (0.014)	0.308 (0.01)	0.108 (0.012)	0.094 (0.017)	0.072 (0.009)	0.073 (0.008)	-0.099 (0.025)	0.093 (0.007)	0.039 (0.005)
Gender	0.146 (0.014)	0.003 (0.002)	0.035 (0.007)	0.061 (0.01)	0.005 (0.002)	-0.0001 (0.0004)	0.086 (0.015)	-0.002 (0.012)	0.068 (0.009)	0.061 (0.013)	0.009 (0.003)	0.039 (0.01)
Mother's education	0.040 (0.008)	0.018 (0.006)	0.057 (0.01)	0.012 (0.005)	0.073 (0.009)	0.026 (0.007)	0.029 (0.007)	0.057 (0.008)	0.018 (0.005)	0.021 (0.008)	0.016 (0.005)	0.018 (0.008)
Father's education	0.005 (0.006)	0.034 (0.006)	0.050 (0.01)	0.014 (0.005)	0.064 (0.008)	0.022 (0.006)	0.014 (0.004)	0.039 (0.008)	0.012 (0.004)	0.025 (0.008)	0.033 (0.005)	0.030 (0.008)
Number of books	0.060 (0.008)	0.028 (0.005)	0.058 (0.011)	0.037 (0.007)	0.055 (0.008)	0.015 (0.005)	0.071 (0.01)	0.051 (0.008)	0.031 (0.005)	0.074 (0.01)	0.018 (0.004)	0.066 (0.008)
Community location	0.002 (0.006)	0.015 (0.004)	0.012 (0.006)	0.005 (0.006)	0.037 (0.005)	0.003 (0.004)	0.022 (0.005)	0.008 (0.004)	0.162 (0.013)	0.015 (0.007)	-0.010 (0.004)	0.012 (0.002)

Computer	-0.00001	-0.001	0.036	0.011	0.017	0.006	0.032	0.008	0.012	0.001	-0.002	-0.008
at home	(0.0004)	(0.002)	(0.009)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.003)	(0.005)	(0.001)	(0.004)

Table 23. Inequality of opportunity shares for achievement in math, 2003, Grade 8

	Bahrain	Egypt	Jordan	Lebanon	Morocco	Palestine	KSA	Syria	Tunisia
All	0.234 (0.012)	0.243 (0.011)	0.250 (0.017)	0.302 (0.014)	0.101 (0.015)	0.196 (0.011)	0.154 (0.016)	0.205 (0.016)	0.229 (0.013)
Family background	0.171 (0.017)	0.210 (0.011)	0.180 (0.014)	0.176 (0.015)	0.061 (0.013)	0.164 (0.01)	0.106 (0.014)	0.142 (0.015)	0.170 (0.012)
Community characteristics	0.005 (0.034)	0.057 (0.008)	0.073 (0.027)	0.185 (0.013)	0.045 (0.012)	0.038 (0.006)	0.042 (0.015)	0.063 (0.01)	0.077 (0.009)
Gender	0.047 (0.013)	0.000 (0.0002)	0.031 (0.009)	0.006 (0.003)	0.014 (0.006)	0.000 (0.002)	0.004 (0.009)	0.000 (0.002)	0.049 (0.006)
Mother's education	0.041 (0.009)	0.094 (0.012)	0.050 (0.011)	0.051 (0.011)	0.007 (0.006)	0.069 (0.009)	0.035 (0.009)	0.057 (0.009)	0.015 (0.008)
Father's education	0.046 (0.01)	0.125 (0.011)	0.055 (0.012)	0.033 (0.01)	0.015 (0.007)	0.074 (0.009)	0.041 (0.011)	0.073 (0.013)	0.055 (0.008)
Number of books	0.060 (0.009)	0.031 (0.007)	0.061 (0.01)	0.093 (0.01)	0.005 (0.003)	0.042 (0.007)	0.043 (0.009)	0.033 (0.008)	0.049 (0.007)
Community location	0.004 (0.007)	0.022 (0.004)	0.004 (0.006)	0.025 (0.007)	0.016 (0.007)	0.014 (0.005)	0.022 (0.008)	0.022 (0.007)	0.022 (0.006)
Computer at home	0.023 (0.005)	-0.001 (0.004)	0.031 (0.009)	0.002 (0.005)	-0.002 (0.002)	0.015 (0.005)	0.004 (0.006)	0.001 (0.004)	0.016 (0.005)

Table 24. Inequality of opportunity shares for achievement in science, 2003, Grade 8

	Bahrain	Egypt	Jordan	Lebanon	Morocco	Palestine	KSA	Syria	Tunisia
All	0.181 (0.015)	0.223 (0.011)	0.239 (0.014)	0.305 (0.01)	0.173 (0.019)	0.194 (0.013)	0.146 (0.015)	0.170 (0.01)	0.187 (0.011)
Family background	0.156 (0.015)	0.199 (0.011)	0.183 (0.017)	0.189 (0.011)	0.071 (0.011)	0.161 (0.012)	0.074 (0.021)	0.125 (0.009)	0.138 (0.011)
Community characteristics	0.024 (0.025)	0.040 (0.006)	0.066 (0.024)	0.187 (0.009)	0.088 (0.016)	0.034 (0.008)	-0.026 (0.032)	0.059 (0.008)	0.063 (0.007)
Gender	0.044 (0.009)	-0.00003 (0.0003)	0.024 (0.01)	0.00008 (0.0003)	0.008 (0.005)	0.002 (0.003)	-0.023 (0.023)	0.008 (0.002)	0.051 (0.006)
Mother's education	0.053 (0.009)	0.090 (0.013)	0.052 (0.01)	0.066 (0.009)	0.005 (0.005)	0.077 (0.009)	0.025 (0.009)	0.040 (0.007)	0.006 (0.007)
Father's education	0.049 (0.01)	0.106 (0.012)	0.062 (0.01)	0.024 (0.009)	0.022 (0.007)	0.059 (0.009)	0.030 (0.009)	0.066 (0.006)	0.045 (0.007)
Number of books	0.046 (0.007)	0.035 (0.007)	0.072 (0.013)	0.108 (0.009)	0.011 (0.006)	0.038 (0.006)	0.046 (0.008)	0.025 (0.005)	0.043 (0.006)
Community location	0.004 (0.005)	0.018 (0.004)	0.001 (0.006)	0.017 (0.005)	0.031 (0.008)	0.014 (0.004)	0.010 (0.006)	0.020 (0.005)	0.014 (0.004)
Computer at home	0.012 (0.004)	-0.002 (0.004)	0.023 (0.008)	0.009 (0.005)	-0.002 (0.001)	0.017 (0.005)	0.006 (0.005)	-0.007 (0.001)	-0.004 (0.004)

Table 25. Inequality of opportunity shares for achievement in math and science, 1999

	Math			Science		
	Jordan	Morocco	Tunisia	Jordan	Morocco	Tunisia
All	0.186 (0.014)	0.102 (0.01)	0.158 (0.011)	0.197 (0.013)	0.112 (0.007)	0.148 (0.011)
Family background	0.166 (0.015)	0.089 (0.009)	0.130 (0.01)	0.178 (0.015)	0.103 (0.007)	0.116 (0.01)
Community characteristics	0.030 (0.007)	0.016 (0.006)	0.041 (0.006)	0.030 (0.007)	0.012 (0.003)	0.046 (0.005)
Gender	-0.001 (0.002)	0.016 (0.004)	0.045 (0.005)	0.006 (0.007)	0.014 (0.003)	0.053 (0.007)
Mother's education	0.063 (0.011)	0.025 (0.006)	0.031 (0.006)	0.060 (0.009)	0.024 (0.004)	0.030 (0.007)
Father's education	0.061 (0.012)	0.009 (0.005)	0.033 (0.006)	0.048 (0.012)	0.008 (0.004)	0.023 (0.006)
Number of books	0.079 (0.011)	0.030 (0.005)	0.042 (0.007)	0.095 (0.012)	0.041 (0.005)	0.022 (0.004)
Computer at home	-0.003 (0.001)	0.001 (0.001)	0.006 (0.004)	-0.001 (0.001)	0.003 (0.001)	-0.007 (0.002)

Table 26. OLS Regressions of Math and Science scores on circumstances

	Math				Science			
	1999	2003	2007	2011	1999	2003	2007	2011
girl	-19.68*** (3.037)	0.965 (2.835)	-2.247 (2.362)	-1.922 (1.356)	-23.55*** (2.817)	-3.206 (2.761)	2.099 (2.116)	2.598* (1.209)
<i>Father's education (reference: primary or less)</i>								
secondary	13.77*** (2.276)	8.050*** (1.786)	12.07*** (1.907)	-1.090 (1.483)	10.17*** (1.869)	7.939*** (1.777)	8.471*** (1.744)	0.601 (1.369)
tertiary	23.86*** (3.507)	32.12*** (2.815)	30.90*** (2.919)	17.53*** (1.947)	20.07*** (2.922)	31.91*** (2.844)	26.74*** (2.642)	17.05*** (1.809)
<i>Mother's education (reference: primary or less)</i>								
secondary	18.46*** (2.673)	13.99*** (2.056)	13.70*** (1.827)	-0.661 (1.521)	21.76*** (2.497)	11.59*** (1.921)	8.660*** (1.564)	-8.058*** (1.391)
tertiary	15.97** (6.160)	30.42*** (3.331)	20.01*** (3.561)	15.22*** (2.144)	25.74*** (4.934)	29.56*** (3.268)	14.17*** (3.098)	5.640** (1.949)
<i>Number of books at home (reference: less than 10 books)</i>								
books at home: 11-25	13.48*** (1.933)	4.415** (1.469)	14.50*** (1.778)	13.07*** (1.126)	10.20*** (1.931)	3.161* (1.599)	13.04*** (1.571)	14.62*** (1.134)
books at home: 26-100	28.31*** (2.291)	13.15*** (1.919)	32.87*** (2.050)	40.29*** (1.417)	24.40*** (2.368)	8.914*** (1.983)	29.12*** (1.853)	35.75*** (1.308)
books at home: 101-200	35.20*** (3.207)	18.94*** (3.093)	42.40*** (3.227)	67.24*** (1.986)	34.75*** (3.119)	10.58** (3.409)	36.68*** (2.920)	53.63*** (1.760)
books at home: >200	35.62*** (3.933)	18.74*** (3.323)	26.12*** (3.430)	76.37*** (2.416)	30.19*** (3.728)	15.41*** (3.193)	25.51*** (3.073)	59.14*** (2.094)
<i>How often language of test spoken at home (reference: always)</i>								
sometimes	-24.09*** (3.076)	4.527* (2.011)	-7.530*** (2.160)	-32.31*** (2.167)	-32.28*** (3.221)	-0.672 (2.105)	-11.63*** (1.930)	-44.68*** (2.026)
never	-20.64*** (3.792)	3.616 (3.512)	-13.86*** (3.377)	-38.30*** (2.871)	-30.34*** (4.221)	-1.258 (3.290)	-12.00*** (2.843)	-46.20*** (2.785)

	Math				Science			
	1999	2003	2007	2011	1999	2003	2007	2011
<i>Community size (reference: less than 3000)</i>								
3,000-15,000		9.597 (5.452)	6.370 (4.666)	11.99** (4.545)		1.014 (5.515)	2.672 (4.141)	13.13** (4.982)
15,000-50,000		10.97 (6.441)	15.57** (5.675)	18.01*** (4.599)		4.339 (6.292)	9.655 (5.031)	16.58*** (4.667)
50,000-100,000		22.02** (6.890)	23.77*** (6.522)	21.56*** (4.837)		16.27* (6.808)	16.84** (5.879)	24.05*** (4.933)
100,000-500,000		25.89*** (6.831)	29.63*** (5.980)	38.41*** (4.524)		22.18*** (6.431)	22.61*** (4.770)	35.10*** (4.441)
more than 500,000		20.29*** (6.077)	29.80*** (5.090)	26.84*** (4.251)		17.75** (5.930)	25.48*** (4.391)	26.87*** (4.204)
computer owned	4.265 (2.398)	-2.984 (1.928)	8.918*** (1.728)	27.25*** (1.382)	2.652 (2.810)	-2.079 (1.854)	8.887*** (1.589)	23.24*** (1.274)
<i>Class size (reference: less than 25 students)</i>								
25-33	31.01** (10.56)	24.41** (7.704)	-6.848 (6.072)	-19.32*** (5.520)	31.50** (12.11)	11.01 (6.646)	-7.628 (5.168)	-12.68* (5.030)
33-40	22.32* (11.02)	17.36* (7.097)	-9.505 (6.344)	20.38*** (4.992)	21.68 (11.80)	-5.233 (6.332)	-20.84*** (5.238)	-6.202 (4.661)
>40	14.59 (12.64)	14.13 (8.244)	-3.999 (7.533)	-24.37*** (5.557)	14.96 (13.60)	-7.125 (7.326)	-25.17*** (6.421)	-47.69*** (5.582)
<i>Teacher's gender (reference: male)</i>								
female	3.614 (6.136)	-6.357 (5.028)	0.754 (4.123)	3.682 (3.461)	1.638 (6.050)	2.894 (4.655)	7.492* (3.562)	3.412 (3.294)
<i>Teacher's education (reference: secondary or less)</i>								
tertiary & above	16.10** (5.001)	-6.401 (3.923)	23.46*** (4.411)	56.33*** (4.259)	0.507 (5.096)	-14.38*** (3.443)	19.52*** (3.960)	48.04*** (3.805)
<i>Teacher's age (reference: less than 30)</i>								
30-50	3.903 (10.05)	12.20 (8.684)	13.46 (7.888)	31.04*** (6.538)	-12.46 (10.67)	5.382 (6.555)	9.572 (6.744)	4.770 (5.914)

	Math				Science			
	1999	2003	2007	2011	1999	2003	2007	2011
>50	-1.874 (16.45)	10.69 (11.96)	17.52 (10.26)	21.35* (9.145)	-9.605 (18.44)	3.954 (9.795)	5.466 (8.437)	-13.21 (8.938)
<i>Teacher's experience (reference: less than 5 years)</i>								
5-10	5.000 (8.827)	7.088 (8.345)	1.742 (8.083)	-24.66*** (6.577)	21.45* (9.411)	11.16 (7.258)	8.786 (6.622)	-18.77** (6.274)
10-20	-15.47 (11.22)	15.85 (9.514)	-13.82 (9.076)	3.262 (7.445)	-16.64 (12.11)	9.430 (7.656)	-0.0757 (7.807)	-5.190 (7.207)
>20	10.45 (11.89)	19.52 (10.20)	10.05 (8.748)	16.23 (8.836)	13.03 (13.16)	11.39 (9.258)	11.68 (7.368)	-3.609 (8.408)
<i>Teacher shortage in school</i>								
a little		-6.424 (6.112)	-8.340 (6.926)	-42.15*** (6.535)		-4.987 (5.735)	-10.87 (5.966)	-22.33*** (6.187)
some		-2.705 (6.572)	6.205 (6.941)	-63.84*** (5.698)		1.679 (6.414)	8.761 (6.123)	-34.55*** (5.442)
a lot		-16.89** (6.087)	17.02** (5.529)	-49.24*** (4.420)		-11.61* (5.108)	13.88** (4.602)	-6.741 (3.769)
<i>% students with disadvantaged economic background (reference: less than 10%)</i>								
11-25%		-13.20 (8.720)	19.07 (10.55)	-7.254 (5.861)		-9.786 (7.724)	11.93 (8.554)	0.448 (4.695)
26-50%		-23.48** (8.009)	15.22 (9.455)	-31.53*** (5.756)		-20.27** (7.412)	3.696 (8.012)	-11.46* (4.980)
>50%		-15.79* (7.214)	11.20 (8.752)	-41.30*** (4.938)		-16.92* (6.886)	-6.698 (7.599)	-30.61*** (4.205)
<i>School emphasis on academic success (reference: medium)</i>								
high		3.916 (4.590)	10.66* (5.371)	15.93*** (3.996)		13.09** (4.210)	11.38* (4.427)	23.82*** (3.731)
very high		22.55** (7.438)	19.10* (8.218)	33.88*** (8.377)		20.70** (7.059)	15.71* (7.246)	38.22*** (6.763)

	Math				Science			
	1999	2003	2007	2011	1999	2003	2007	2011
Constant	382.9*** (10.86)	356.9*** (12.21)	306.4*** (12.85)	375.7*** (10.85)	421.5*** (12.07)	422.4*** (10.68)	373.7*** (11.35)	407.3*** (9.984)
Observations	24686	38512	51727	118228	24686	38512	51727	118228

Figure 4. Mean and standard deviation of Math scores, TIMSS 2011 (8th grade)

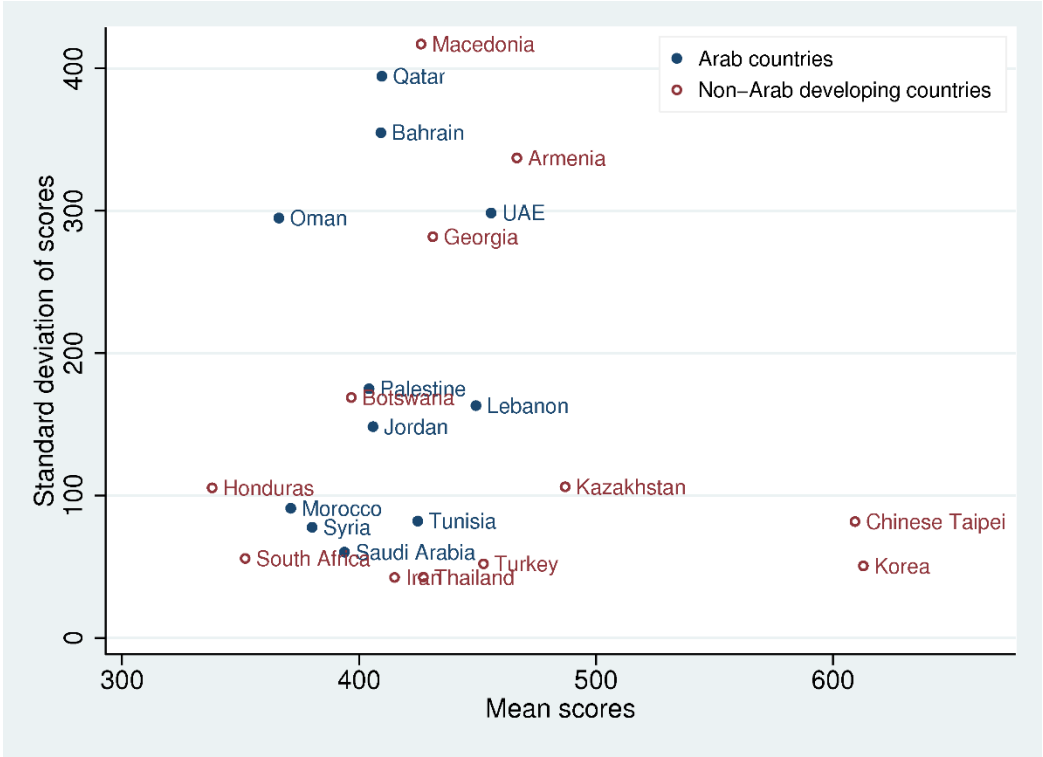


Figure 5. Mean and standard deviation of Science scores, TIMSS 2011 (8th grade)

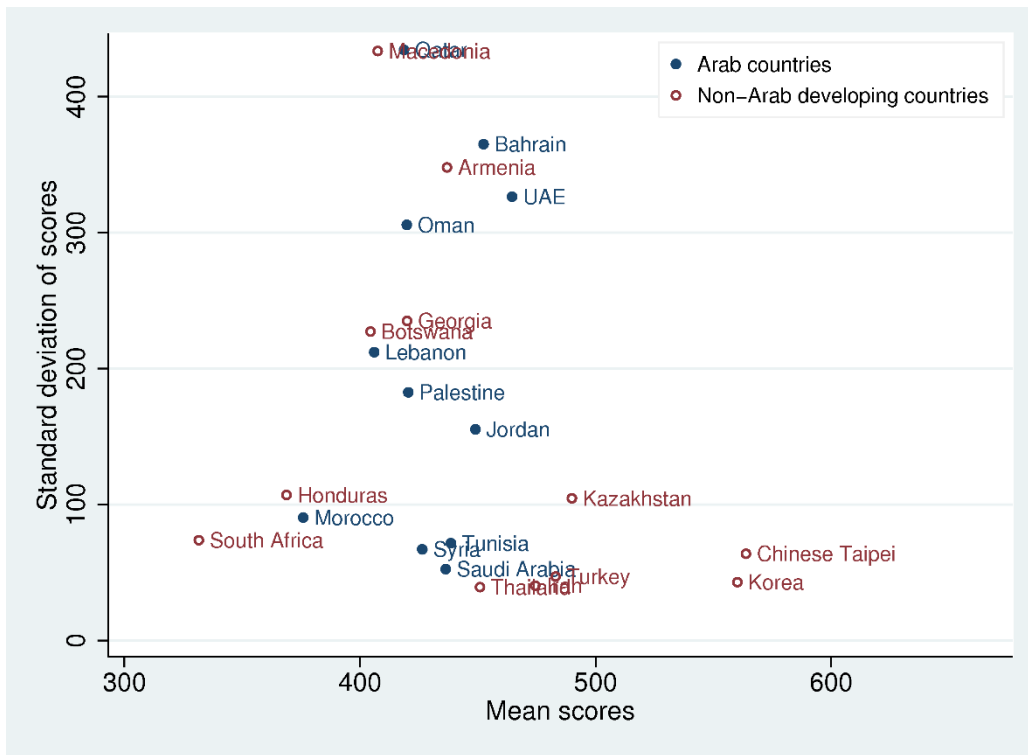


Figure 6. Mean and standard deviation of Math scores, TIMSS 2011 (4th grade)

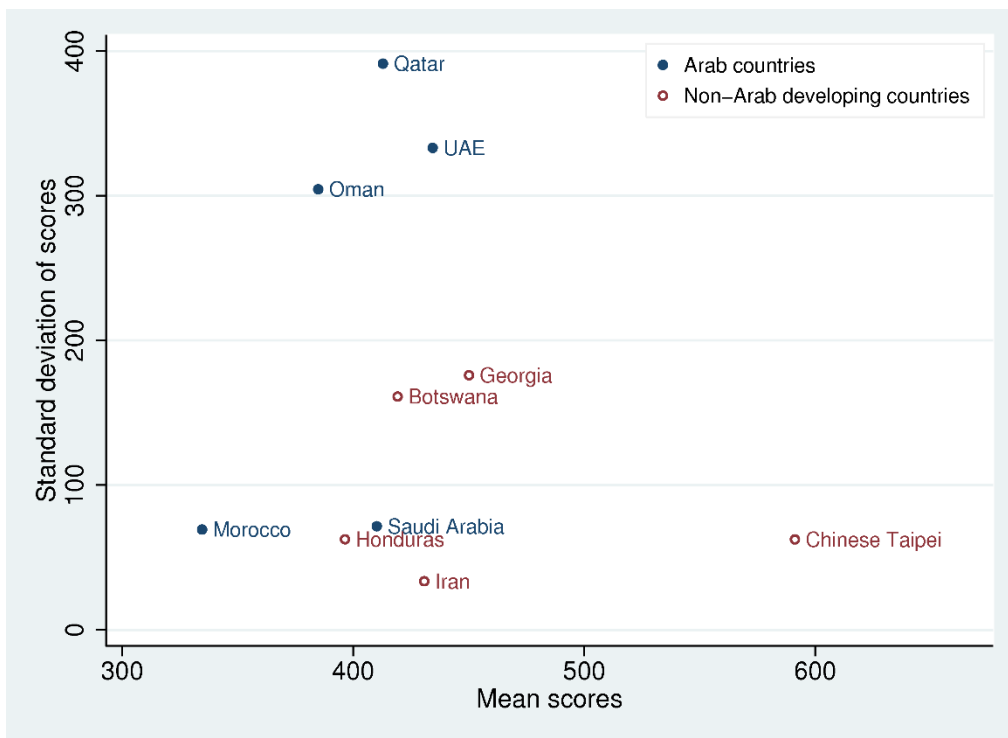


Figure 7. Mean and standard deviation of Science scores, TIMSS 2011 (4th grade)

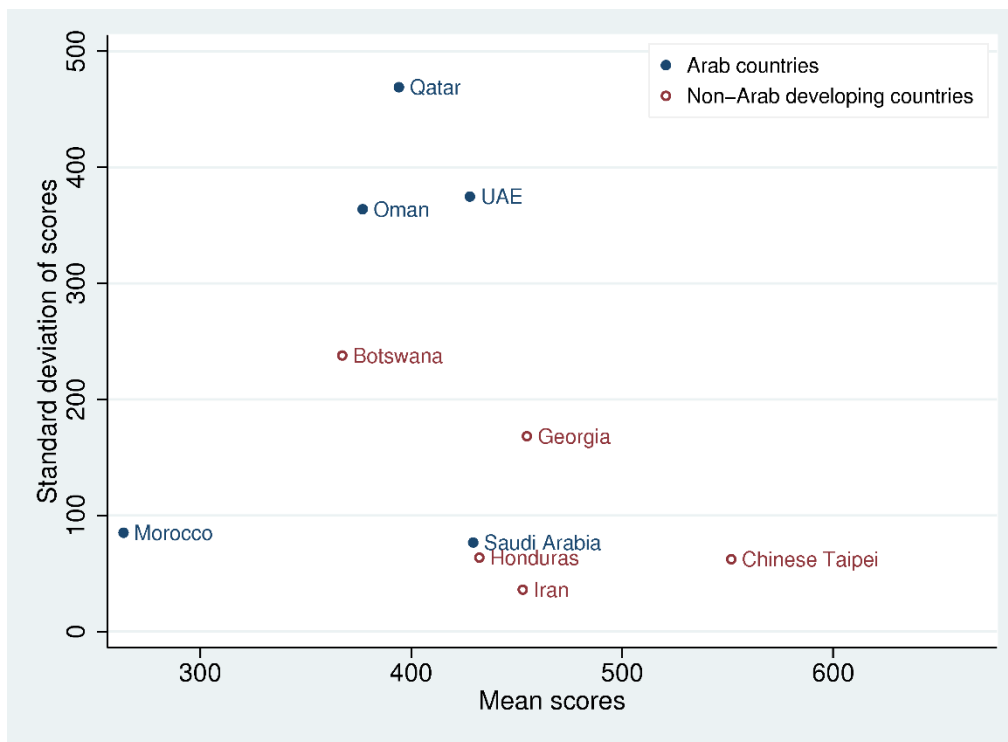


Figure 8. Distribution of Math scores by gender, TIMSS 2011 (8th grade)

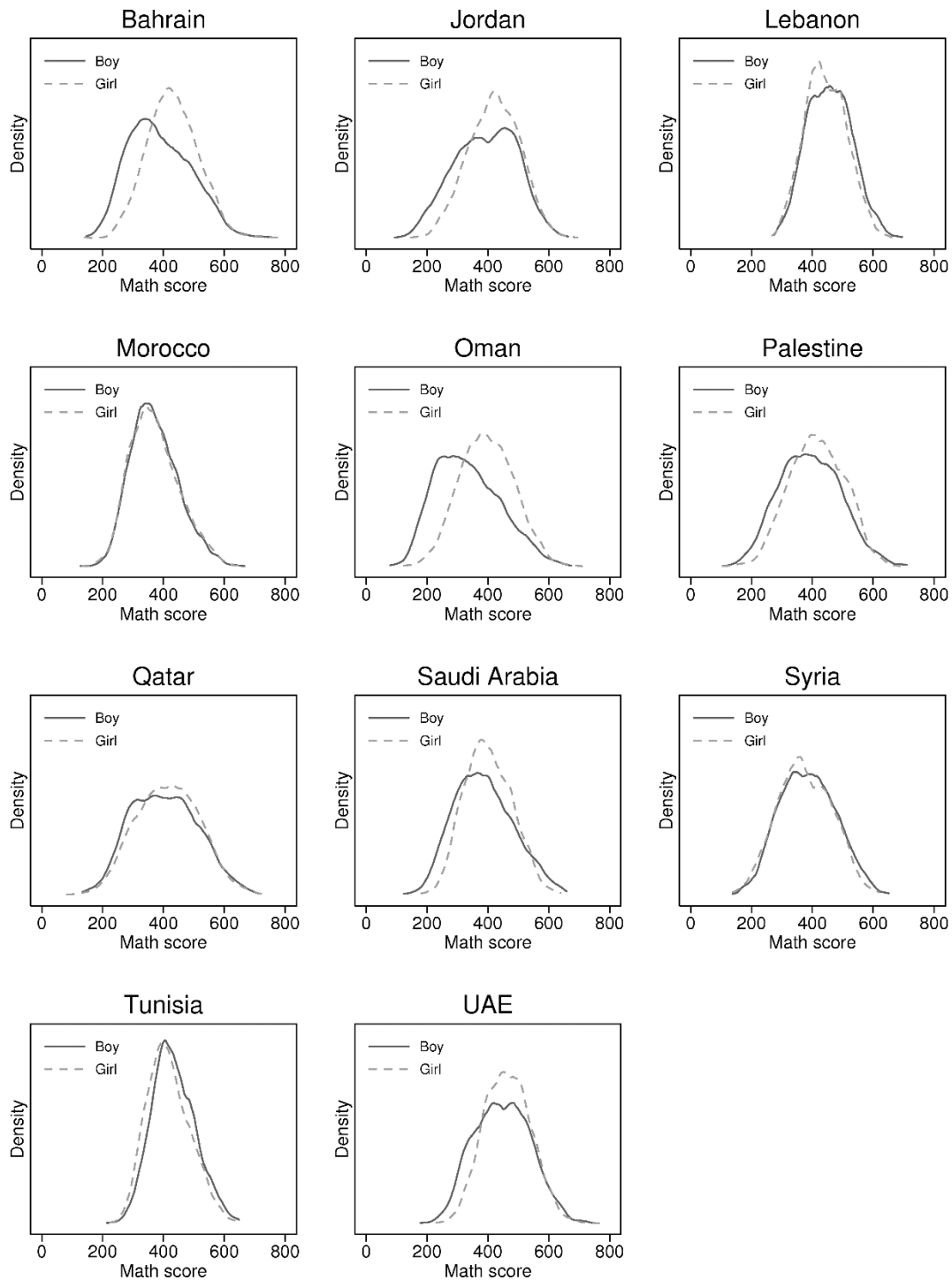


Figure 9. Distribution of Science scores by gender, TIMSS 2011 (8th grade)

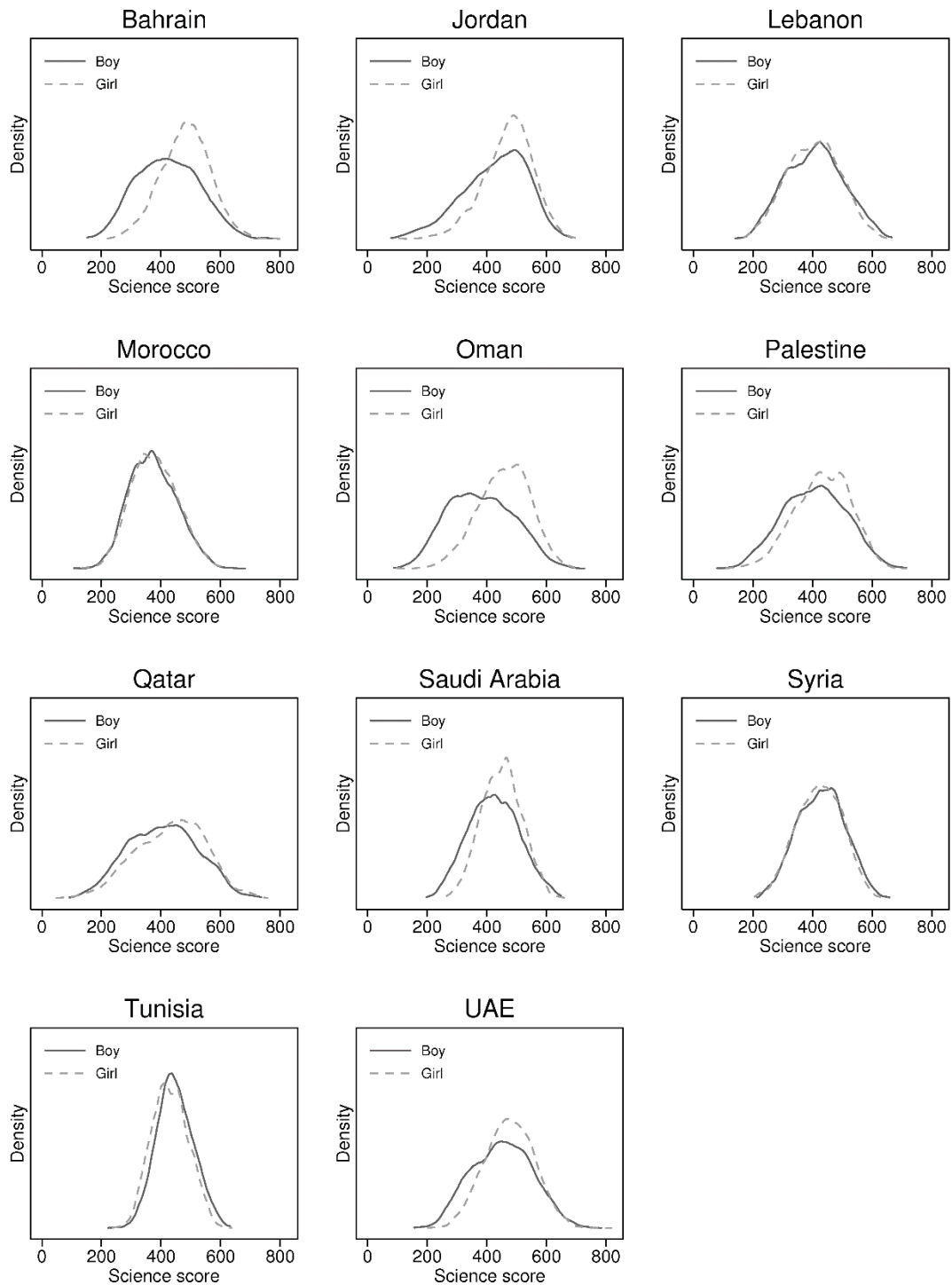


Figure 10. Distribution of Math scores by gender, TIMSS 2011 (4th grade)

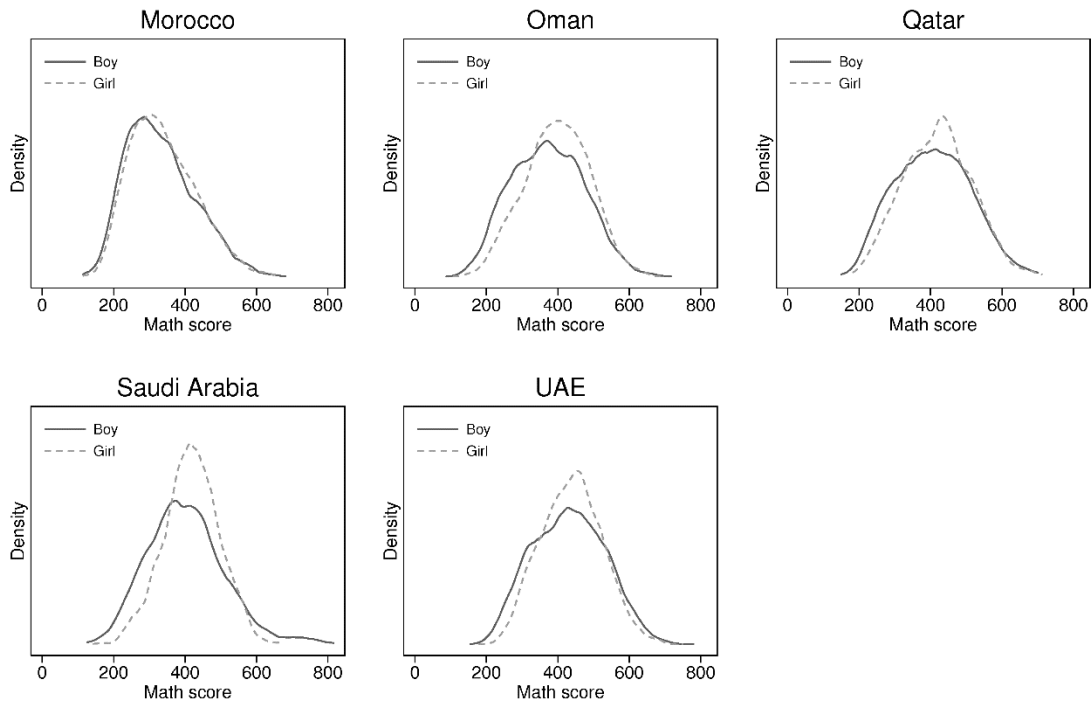


Figure 11. Distribution of Science scores by gender, TIMSS 2011 (4th grade)

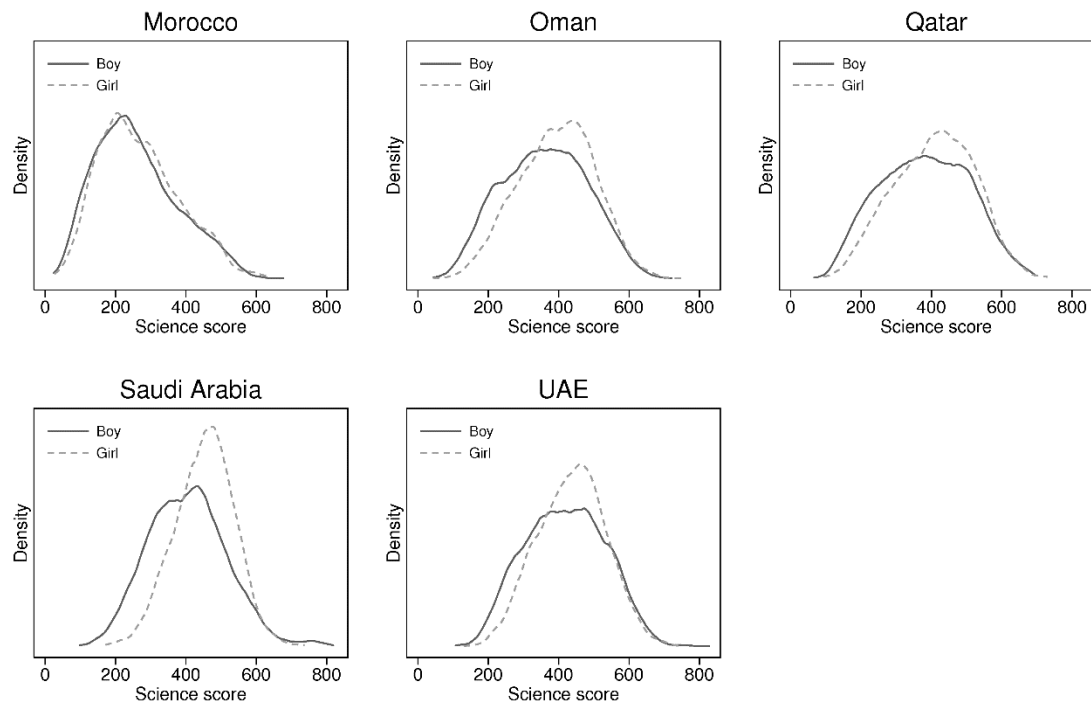


Figure 12. Gender gap in Math scores, TIMSS 2011 (8th grade)

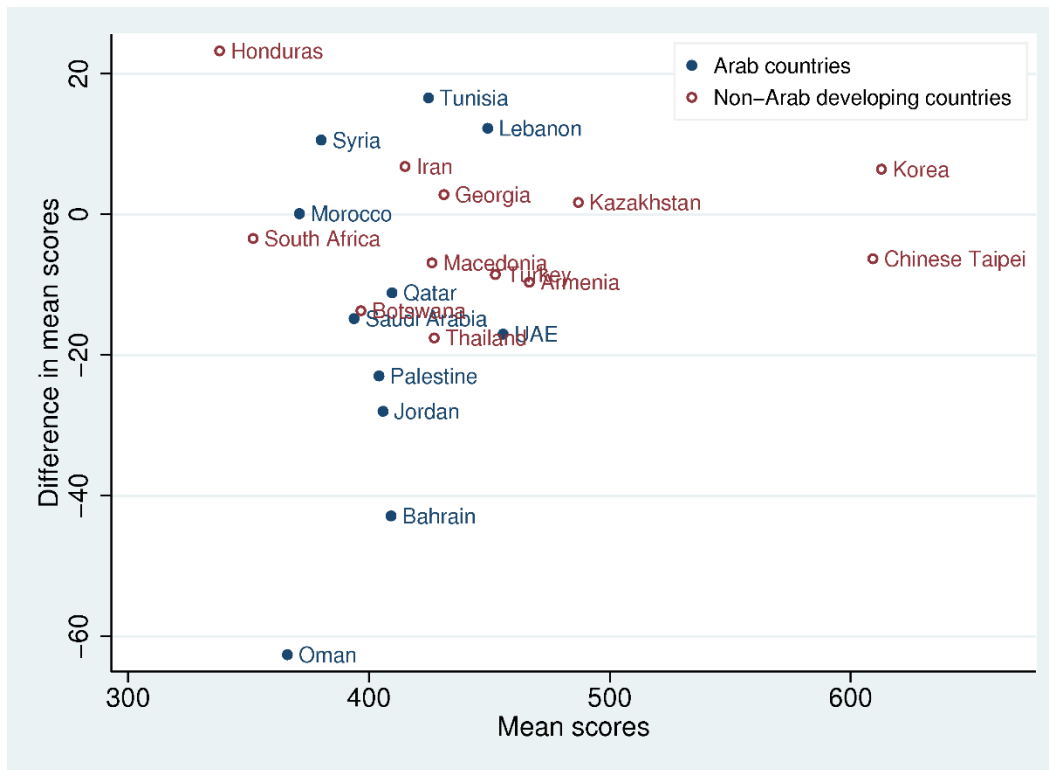


Figure 13. Gender gap in Science scores, TIMSS 2011 (8th grade)

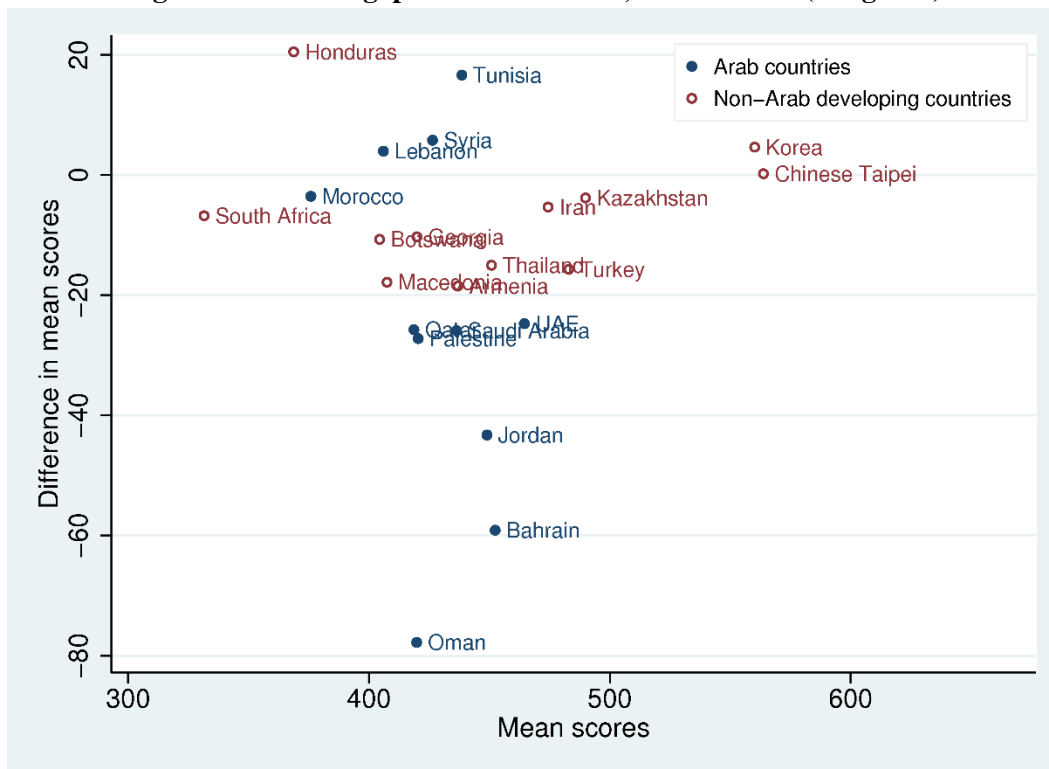


Figure 14. Gender gap in Math scores, TIMSS 2011 (4th grade)

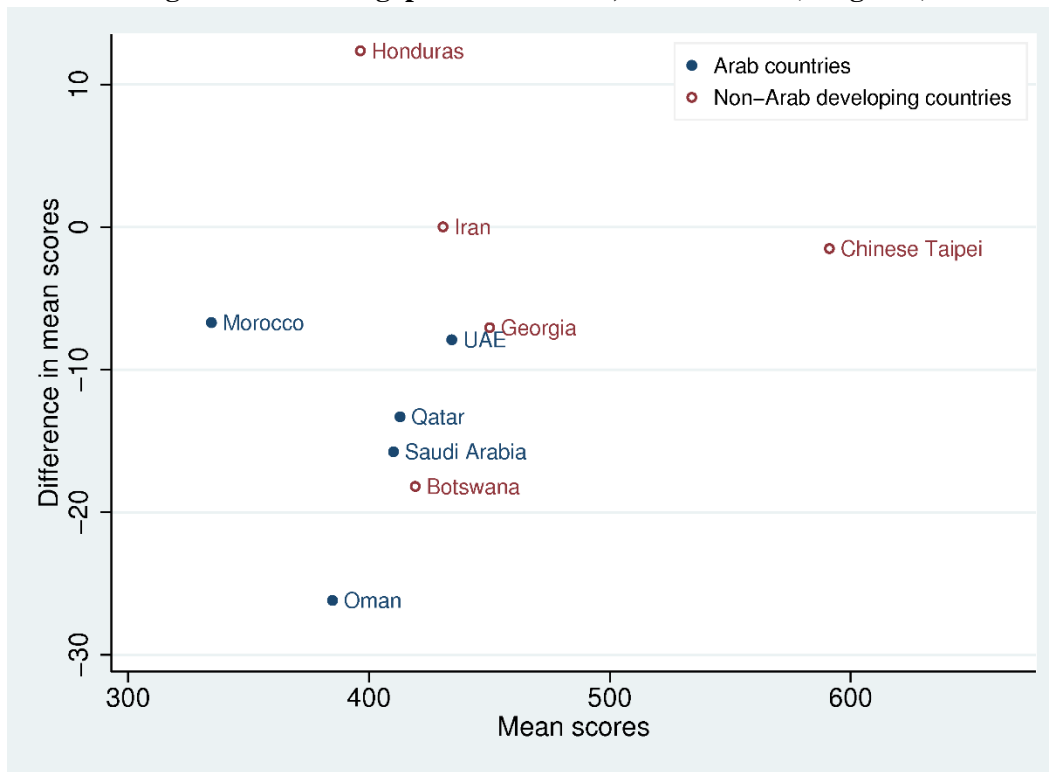


Figure 15. Gender gap in Science scores, TIMSS 2011 (4th grade)

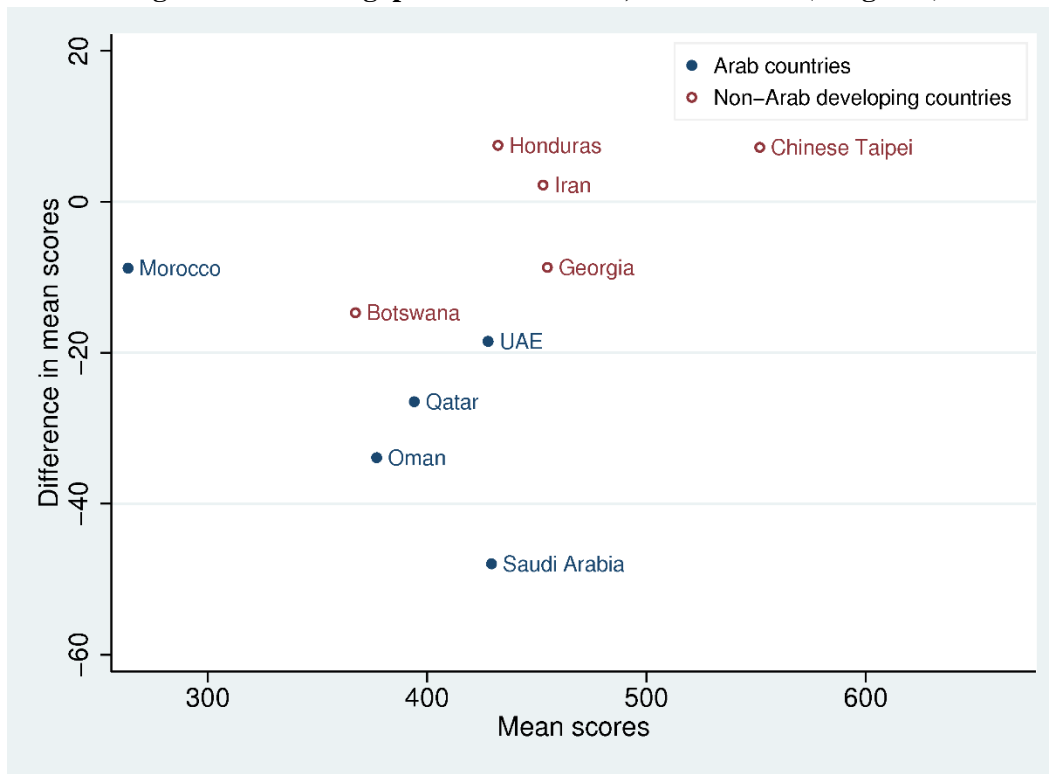


Figure 16. Distribution of Math scores by location, TIMSS 2011 (8th grade)

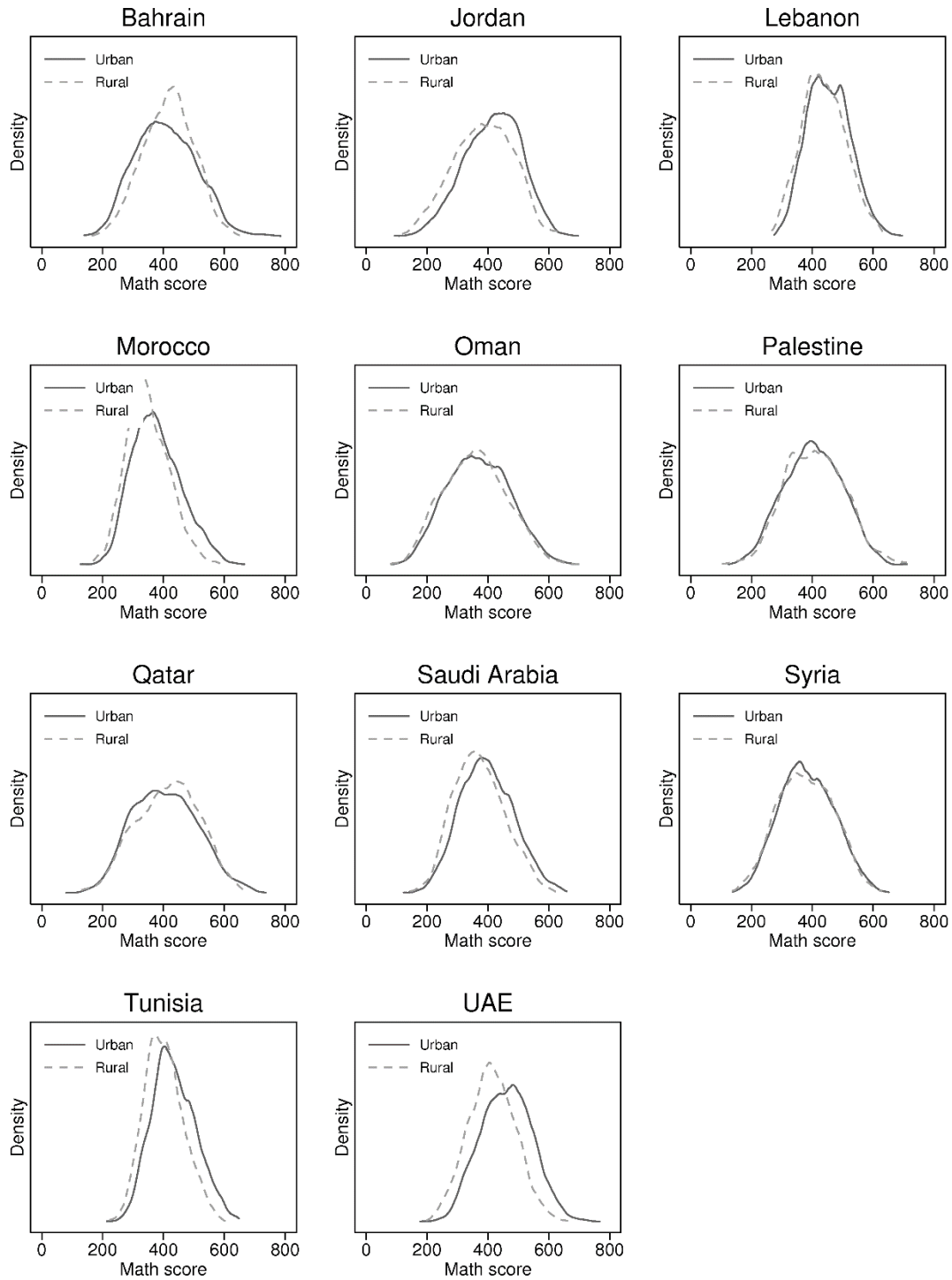


Figure 17. Distribution of Science scores by location, TIMSS 2011 (8th grade)

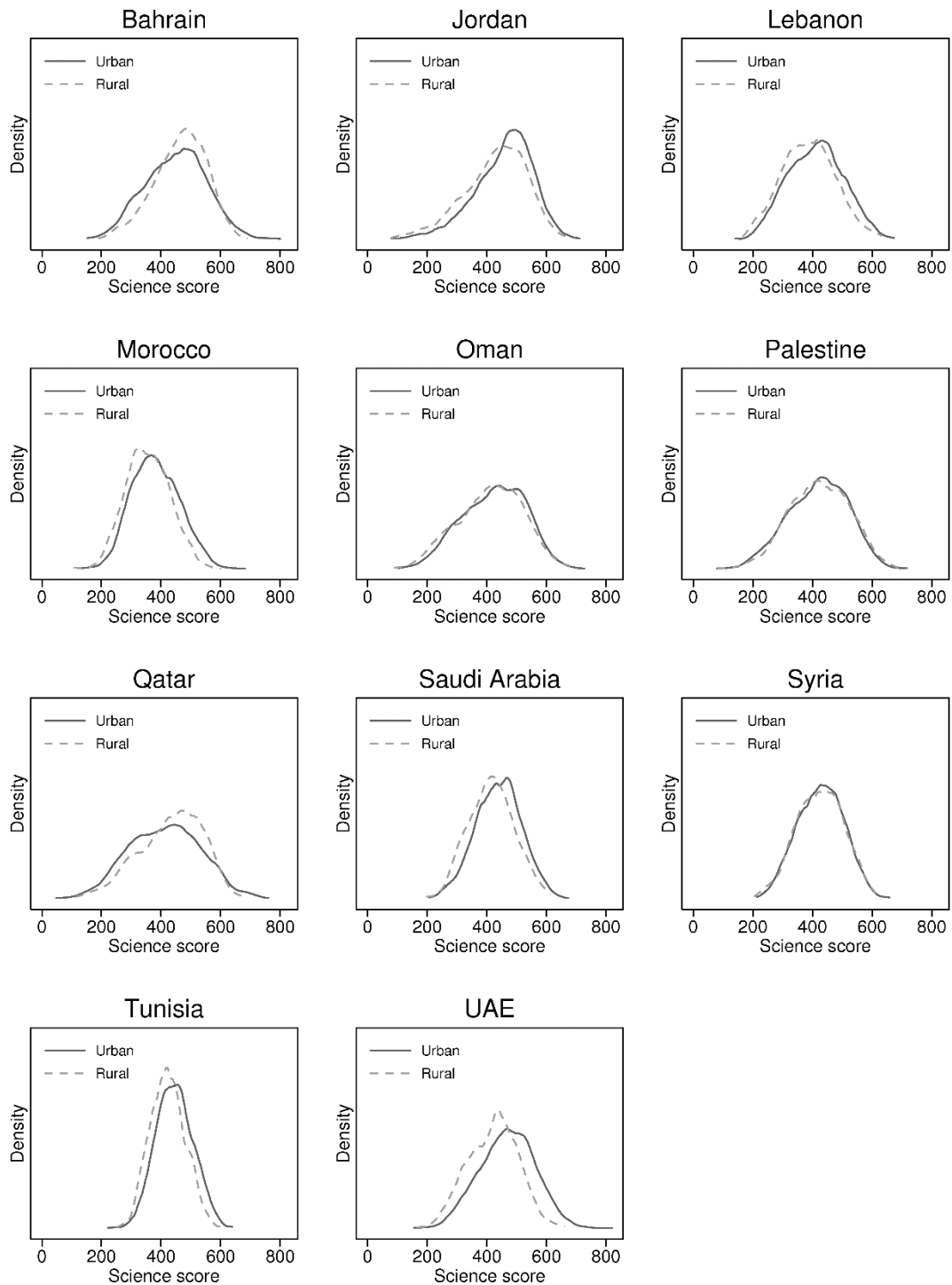


Figure 18. Distribution of Math scores by location, TIMSS 2011 (4th grade)

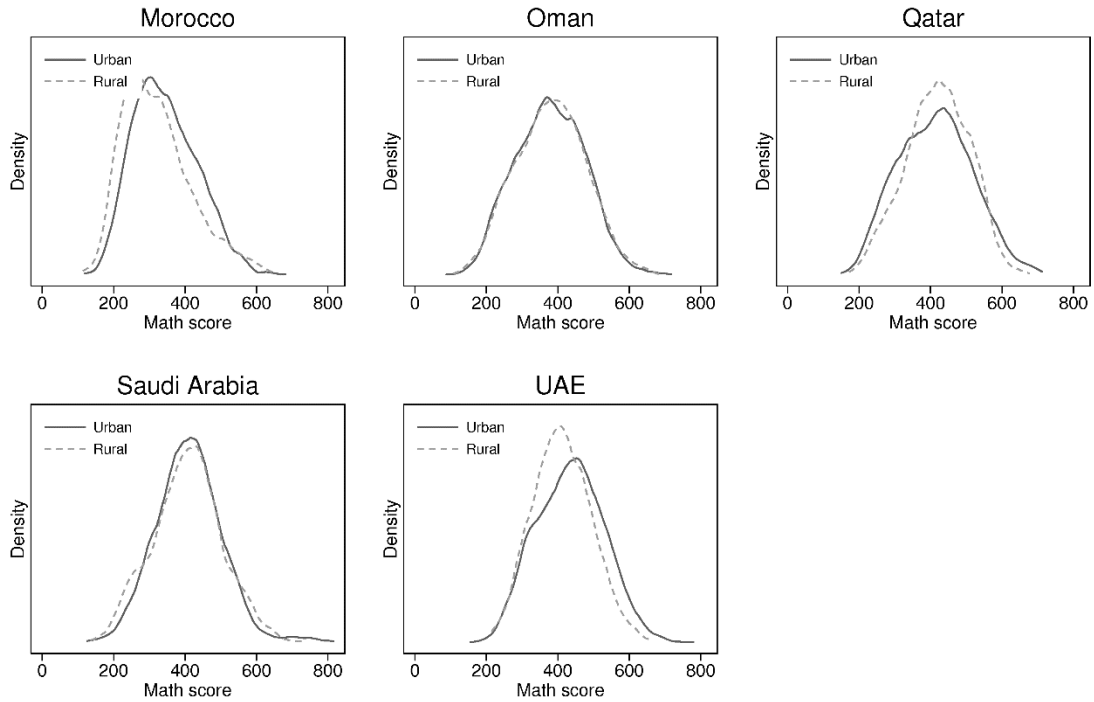


Figure 19. Distribution of Science scores by location, TIMSS 2011 (4th grade)

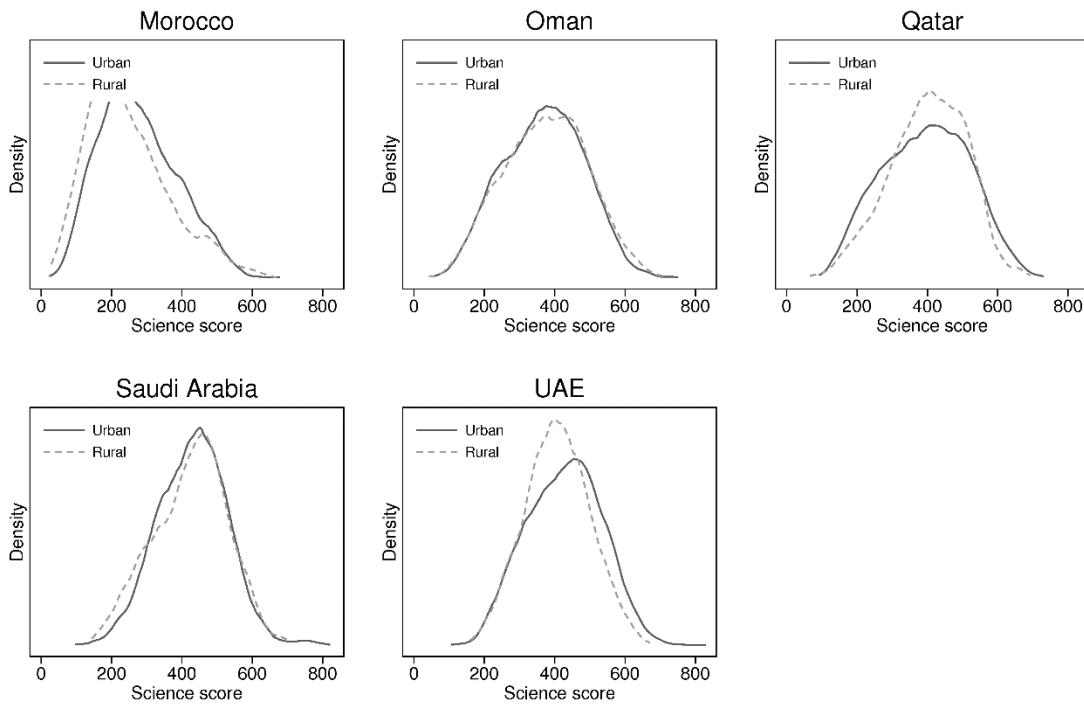


Figure 20. Rural/Urban gap in Math scores, TIMSS 2011 (8th grade)

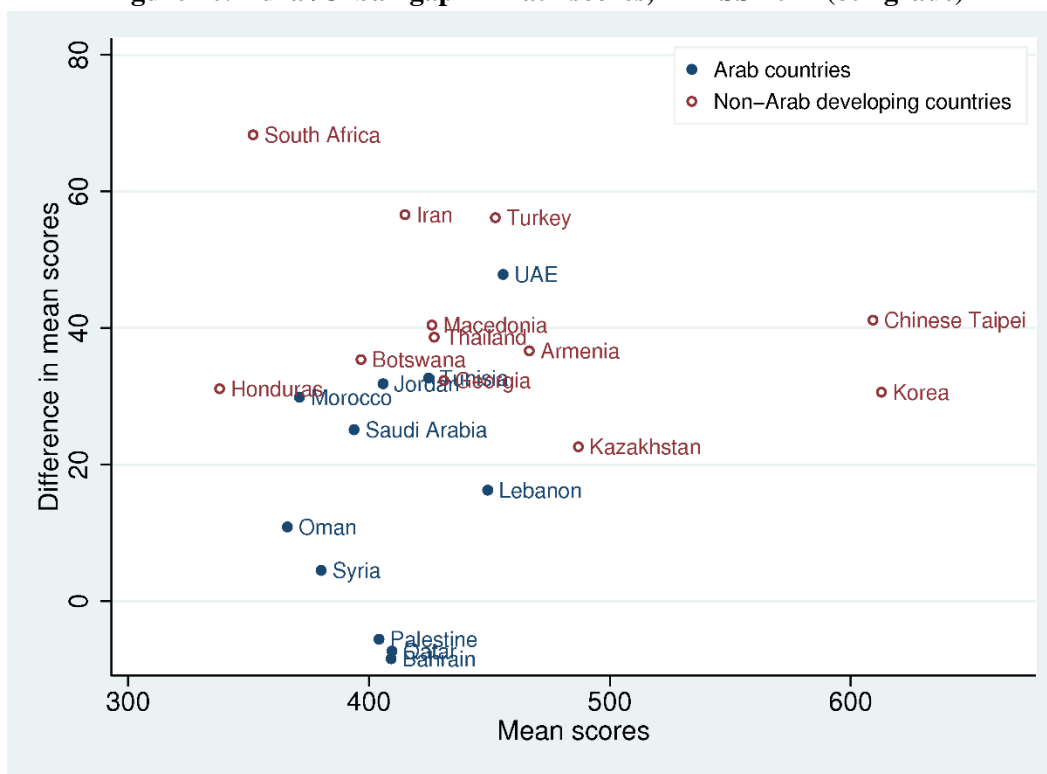


Figure 21. Rural/Urban gap in Science scores, TIMSS 2011 (8th grade)

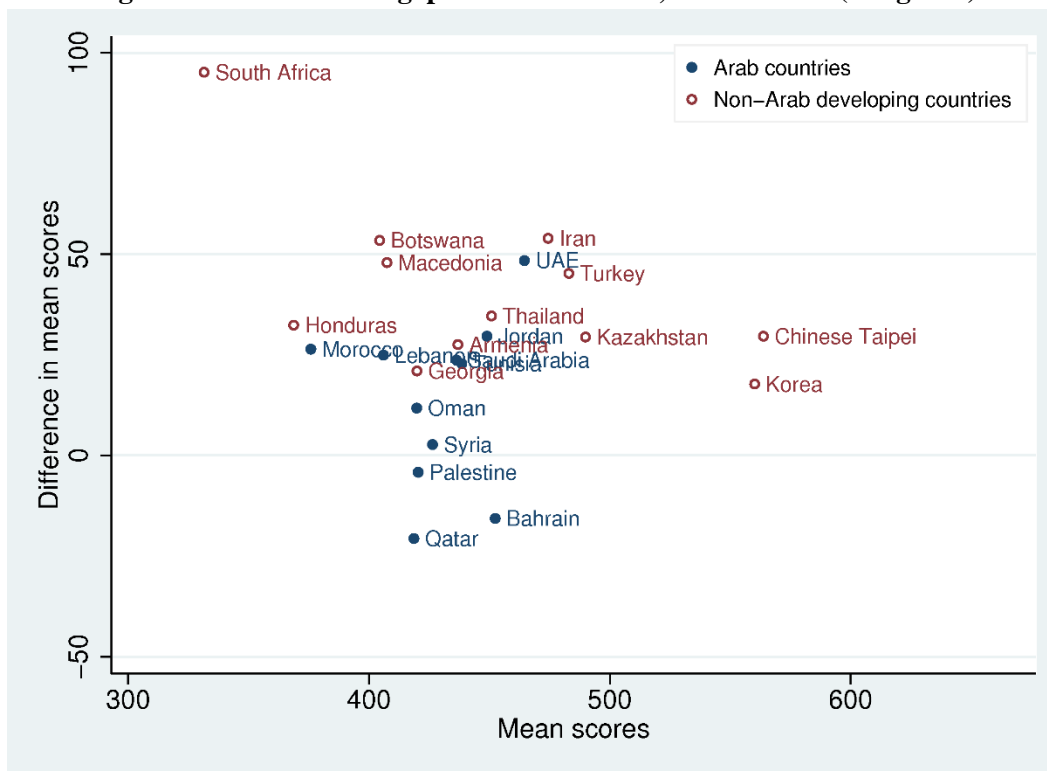


Figure 22. Rural/Urban gap in Math scores, TIMSS 2011 (4th grade)

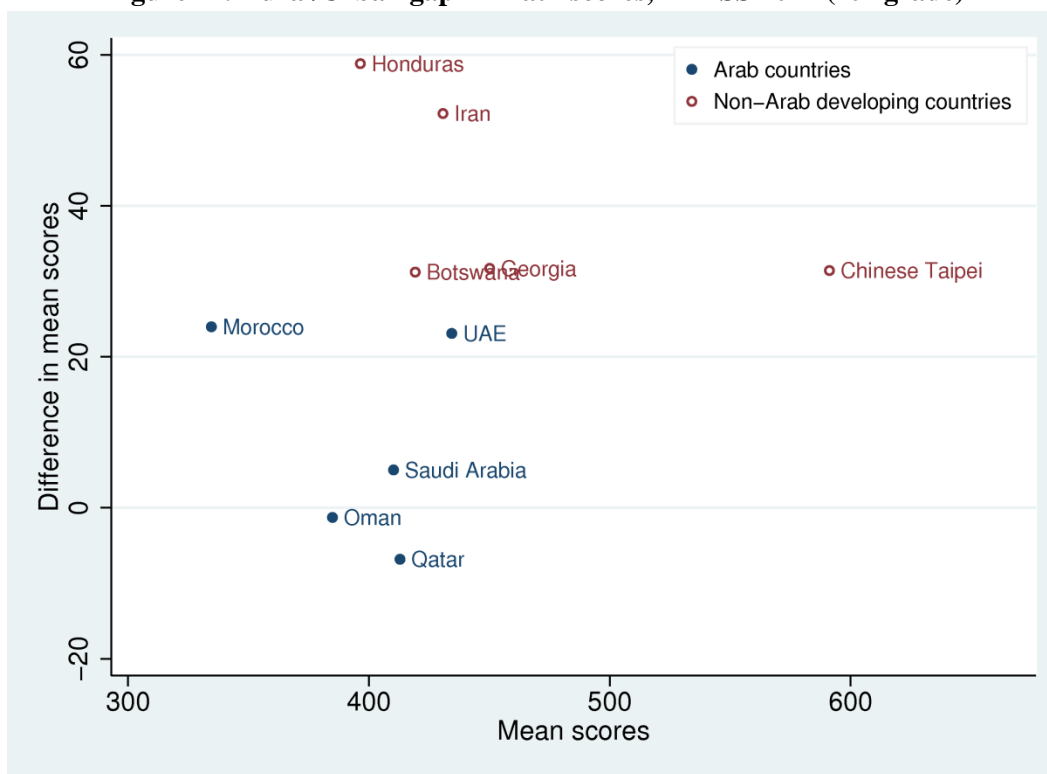
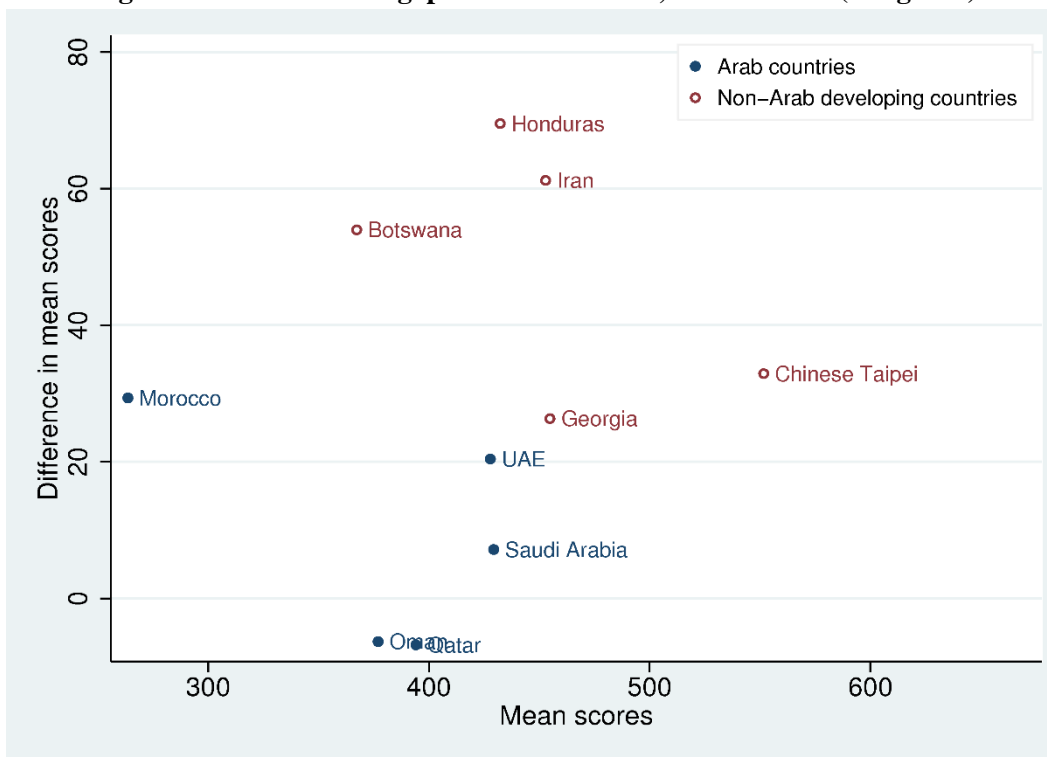


Figure 23. Rural/Urban gap in Science scores, TIMSS 2011 (4th grade)



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