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Abstract

This paper is an empirical investigation of inequality of education opportunities in the Middle East and North Africa (MENA). We use student scores from tests administered by the international consortium Trends in Mathematics and Science Study (TIMSS) for a number of MENA countries and over time since 1999 to estimate the effect of circumstances children are born into on their academic achievement in science and mathematics. From the variation in inequality of education opportunities across countries and over time we draw lessons on the influence of different education systems or changes in policy on equality of opportunity. We find that inequality of opportunities explains a significant part of the inequality in educational achievements in most MENA countries, but in a few cases, notably Algeria, its role is small. Family background variables are the most important determinants of inequality in achievement, followed by community characteristics. Inequality of education opportunities are high in several MENA countries, and have either stayed the same or worsened in recent years. The results show that, despite great efforts in past decades to invest in free public education, most MENA countries are less opportunity equal in educational achievement that European countries, and several are less equal than Latin American countries and the United States. There is plenty of room for policy to further level the playing field in education. We discuss how our results shed light on policy choices in education that can contribute to greater equality of education and income in the region.

JEL Classification: I2, D6

Keywords: Equality of opportunity; Education; Middle East and North Africa

ملخص

تقدم هذه الورقة تحقيق تجريبي لعدم المساواة في فرص التعليم في منطقة الشرق الأوسط وشمال أفريقيا (MENA). نستخدم النتائج الخاصة بالطلاب من الاختبارات التي يديرها الكونسورتيوم الدولي للاتجاهات في الرياضيات ودراسة العلوم (TIMSS) لعدد من بلدان المنطقة وعلى مر الزمن منذ عام 1999 لتقدير تأثير الظروف التى يولد فيها الأطفال على تحصيلهم الدراسي في العلوم والرياضيات. نستخلص من التباين في عدم المساواة في فرص التعليم في مختلف البلدان وعلى مر الزمن بعض الدروس حول تأثير أنظمة التعليم المختلفة أو التغييرات في السياسة العامة بشأن المساواة في الفرص. نجد أن عدم المساواة في الفرص يفسر جزءا كبيرا من التفاوت في التحصيل العلمي في معظم بلدان المنطقة، ولكن في حالات قليلة، ولا سيما الجزائر، يكون دورها صغير. متغيرات الخلفية العائلية هي أهم العوامل المحددة لعدم المساواة في التحصيل، تليها خصائص المجتمع. عدم المساواة في فرص التعليم مرتفعة في العديد من بلدان المنطقة، وظلت على حالها أو ساءت في السنوات الأخيرة. وتظهر النتائج أنه على الرغم من الجهود الكبيرة في العقود الماضية للاستثمار في التعليم العام المجاني، فان معظم بلدان هذه المنطقة لها أقل تكافؤ للفرص في التحصيل العلمي عن الدول الأوروبية، وعدد من هم أقل مساواة من دول أمريكا اللاتينية والولايات المتحدة. هناك متسع كبير فى السياسات للحصول على المزيد في مجال التعليم. نقوم بمناقشة دور النتائج التى تحصلنا عليها فى تسليط الضوء على خيارات السياسة العامة في مجال التعليم وكيف يمكن أن تسهم في تحقيق المزيد من المساواة في التعليم والدخل في المنطقة.

1. Introduction

Calls for economic justice have figured prominently in recent uprisings in the Arab world.[1] Yet income inequality levels in Arab countries are not particularly high by developing country standards (Bibi and Nabli 2009, 292), and are considerably lower than in Latin America, where public sentiments for economic justice do not seem to run as strong. Decades ago, following coups and revolutions, several countries of the region implemented large-scale land reforms and funded free public education systems that laid the foundation for a more equitable society. But over time, as land and schooling lost their importance in determining economic status, these gains were eroded and other forms of inequality have increased. Changes in some types of inequality, such as access to political power, may become widely known even without concrete data, but others, such as inequality of opportunity, remain largely unknown because they are not easily captured by simple measures of inequality applied to household survey data, such as the Gini index. In this paper we provide evidence on inequality of opportunity in education achievement for 16 countries of the Middle East and North Africa (MENA), which indicate a disturbing trend of increasing inequality.

We use scores from tests administered by the international consortium, Trends in Mathematics and Science Study (TIMSS) to random samples of 8th grade students to estimate the extent of inequality of opportunity (IOP) in 16 countries in 2007, and for a smaller set the change in IOP since 1999. With the help of techniques recently developed in the literature that have followed the seminal work of Roemer (1998), we measure the share of circumstances that affect learning but are beyond a child's control in inequality of scores using . The circumstances we include are gender, family background (parents' education and number of books at home), ethnicity (based on language at home), and community characteristics. Because we only have access to a subset of circumstances that affect a child's achievement -- those available in the TIMSS data -- our estimates of IOP are the lower bound to the true level of IOP. We use both parametric and non-parametric methods, developed in (Bourguignon, Ferreira, and Menendez 2007; Lefranc, Pistolesi, and Trannoy 2009; Checchi and Peragine 2010; Ferreira and Gignoux 2011a). The results of different techniques are substantially the same. Where they differ, it is mostly because of the differences in the range of circumstances that we can include (the parametric method allows the inclusion of more circumstances).

An important purpose of estimating IOP is to bring to light the difference between two notions of inequality, inequality of outcomes (such as income or education achievement) and inequality of opportunities. The ethical basis for reducing inequality of outcomes is well known, but so is the fact that beyond a certain level doing so would also reduce incentives for personal effort. Equality of opportunity, on the other hand, has unambiguous appeal because it corresponds to common beliefs about fairness; it is also good for growth (Ferreira and Gignoux 2011a). A level playing field increases the participation of a wider set of individuals and elicits greater effort from each. Generational mobility also reduces social tensions. In a society that is socially and economically rigid where advantages are largely inherited even low levels of income inequality may feel unfair. People will endure inequality easier if there is mobility and equality of opportunity. Empirical estimation of IOP is also important for understanding the sources of inequality and is the first step in identifying policies that help or hurt equity.

Education plays a central role in the lives of the people of the MENA region. Since the 1950s, post-independence and post-revolutions governments have promoted education as the

[1] See for example, this opinion piece in the New York Times, which stated, "The Arab spring is about justice and equity as much as it is about democracy, because societies in which millions of young men and women have no jobs and millions live with less than two dollars a day crave justice as much as democracy." Jean-Marie Guhenno, *New York Times*, April 21, 2011.

path to modernization and their people have come to view formal schooling as the main vehicle for social and economic mobility.Governments provided free education and instituted a meritocratic system of selection into higher levels of schooling that is the cornerstone of equality of opportunity policy in these countries. While these education systems are generally considered fair and provide access irrespective of social status, and have succeeded in producing record rates of increase in average years of schooling (World Bank 2007; Salehi-Isfahani 2011), they may have failed in terms of quality and fairness in access to learning opportunities.

TIMSS data reveals an important weakness of education in MENA countries. While the system has performed relatively well in expanding opportunities in access to schools, it has failed in raising average quality. All MENA countries are near the bottom of the list of the 60 countries that participated in TIMSS in 2007. In addition, in several countries there are large disparities in access to quality. Egypt, Iran, Jordan, Turkey and UAE (Dubai), exhibit degrees of inequality of opportunity that are close to what has been estimated for Latin America -- more than one-third of total inequality in test scores. In Algeria and Morocco inequality of opportunity explains a much smaller part -- less than 10 percent -- of the total inequality, and the rest are in between. For all the countries in this study, family background is the most important determinant of education opportunities, followed by the region of residence. This is in contrast to the role of these circumstances in health opportunities, where their order of importance is reversed (Assaadet al. 2011). In a few countries, notably Lebanon, Iran, Saudi Arabia, Syria, and Turkey, where we have data for more than one year, the share of education opportunities in total inequality has increased over time. In others, it has stayed the same or declined. Egypt and Jordan are two countries that show a decline in inequality of opportunities between 2003 and 2007.

This paper is organized as follows. The next section discusses the role of education in MENA societies. Section 3 reviews the methodology for measuring inequality of opportunity. Section 4 introduces TIMSS data and describes its complex methods of rescaling and weighting. Section 5 begins the presentation of the results by presenting the kernel estimates of the distribution of scores and taking a preliminary look at the extent of inequality of opportunity by examining how each of these distributions change as we condition them on key circumstances, such as gender and parental education. Section 6 uses simple decomposition of inequality measures to show variation in equality of opportunity across countries and over time, and Section 7 presents the results of decompositions using parametric and non-parametric methods. Section 8 offers concluding remarks.

2. The Role of Education in Equality of Opportunity in MENA

Education is by no means a comprehensive measure of welfare. Personal income and consumption are more closely identified with welfare, and education is mainly an intermediate input into their generation. However, for MENA countries education is more than an intermediate input for income generation; it is probably the most important measure of personal achievement and the main mechanism for social mobility. Therefore, education outcomes offer a more comprehensive view of equality of opportunity in MENA than in other countries.

Early on in the 20th century governments in the region promoted schooling as a way to modernize their countries and their bureaucracies, some even promising jobs in the public sector for high school and university graduates (Assaad 1997). With strong backing of the state, the education system developed rapidly, providing wider access to school and the chance for families to offer their children a better future than their own. In most MENA countries education was free and meritocratic in nature, thus bypassing many markers of social privilege (see World Bank 2004 and 2007 flagship reports on labor markets and

education flagship reports on labor markets and education). Thus education is both an important indicator of personal advancement and a valid way to judge the degree to which these governments succeeded in increasing equity and social mobility.

Decades on, the value of schooling in fulfilling these promises is being seriously questioned. Large numbers of educated youth across the region, many with university degrees, are unemployed and perhaps even unemployable (Dhillon and Youssef 2009). The production of diplomas and degrees -- quantity of education -- has been out of sync with what the labor markets of these countries have been able to absorb. Thus, despite the impressive growth of years of schooling and the narrowing of the gap in access to education, the value of education in promoting equity is in doubt.

MENA education systems are centralized, merit based, and highly competitive. Centralized national exams for entering into universities, which are common across the region, allow children from poor and rich backgrounds to compete for positions in public universities based on their own merit and irrespective of family background. In principle such a system appears good for equality of opportunity, but it does not make family background irrelevant. The success of children in school depends crucially on parental education and family resources. School quality may depend on the place a child grows up. Parental resources may help children with tutoring that increases their chances of getting into universities. In this case, even objective testing of students does not prevent unequal access to tertiary education. Whether highly competitive entrance examinations promote or hinder equality of opportunity is an empirical question. In the case of Italy, Bratti et al.(2008) has argued that the centralized and egalitarian tertiary education system in Italy does not necessarily help children from poorer families, and may actually "take away from them a fundamental tool to prove their talent and to compete with rich children." There is wide variation across MENA as to the degree of meritocracy in education systems, with Lebanon relying more on private education, and Egypt and Iran essentially providing free education for all. We will consider this institutional variation in interpreting our empirical findings of inequality of opportunity in achievement in math and sciences.

In this paper we focus on a different educational outcome, which we call achievement. Thanks to TIMSS, we are able to link the amount of learning by children in grade 8 (about age 14) to the circumstances in which they live. We know about their gender, education of their parents, ethnic background, the characteristics of their community, and their home environment (number of books, computer, and internet). These characteristics allow us to learn about the degree to which student scores are "explained" by circumstances, which we interpret as the degree of equality of educational opportunities in learning.

3. Review of Empirical Methods of Decomposition

Roemer's interpretation of the philosophical and ethical theory of equality of opportunity has fostered an empirical literature on measuring the extent of equality of opportunity that has rapidly expanded in recent years.[2] Roemer argued that opportunities for advancement are equal if outcomes ("advantages") that people seek are distributed independently of factors that lie beyond their control ("circumstances"). This condition can be written as:

$$f(y \mid C) = f(y), \qquad (1)$$

where y is the outcome of interest and C represents circumstances beyond individual control. Once the elements of C are agreed upon, the determination of inequality of opportunity is a matter of statistical strategy.

[2]For contributions to the political philosophy of inequality of opportunity, see Rawls (1971), Dworkin(1981), Sen (1985/1992), Cohen (1989), Arneson (1989), Roemer (1998), among others.

What particular variables are considered as circumstances depends on the purpose at hand. From a philosophical or moral point of view, it is often a question of whether the responsibility for adverse outcomes lie with the individual or society. Only that part of inequality of outcomes for which responsibility is assigned to society calls for social action. From this perspective, inequality due to differences in innate ability is not a compelling reason for egalitarian social action even though it is clearly beyond individual control because society may not wish to take responsibility for the resulting inequality. Many may also consider inequality due to luck, which is neither a circumstance nor something for which individuals can be held responsible for, outside the purview of egalitarian social policy (Lefranc, Pistolesi and Trannoy 2009). But from an empirical and practical point of view the choice of what to include in C is more straightforward because the set is limited by availability of data or method of estimation. Non-parametric methods often limit the number of elements that can be included in C to an even smaller set than data permits because in partitioning the data by types (individuals with the same circumstances) or tranches (individuals with the same level of effort), the number of cells quickly becomes too large and the number of observations in each cell too few to allow precise estimation.

The goal of the various empirical approaches to measurement of inequality of opportunity is to decompose the inequality in outcomes into inequality due to observed circumstances and inequality resulting from other factors (individual effort, choices, talent, and luck) which for convenience we call effort.[3] These approaches can be grouped into two groups, parametric and non-parametric. Non-parametric methods divide individuals into homogenous groups based on either their circumstances or effort (Ferreira and Gignoux 2011a). The grouping based on circumstances, sometimes called the ex-ante approach, first divides the population into "types," which are groups with the same circumstances, and then compares the level of inequality of outcomes (income or education) between and within these groups. The distribution of outcomes within each type is referred to as the opportunity set open to individuals of that type. Differences in opportunity sets then are an intuitive meaning of inequality of opportunity.

The grouping based on effort, known as the ex-post approach, collects individuals with different circumstances but with the same level of effort into "tranches," and then measures the level of inequality between them, which can be attributed to circumstances, as inequality of opportunity. This method begins with types first and then defines effort by the position of the individuals in the distribution of outcomes within each type. The tranche method, developed in Checchiand Peragine(2005) and Checchiand Peragine(2010), is closer in spirit and construction to Roemer's original formulation as its starting point is to identify individuals by their effort before looking at how their outcomes differ based on circumstances. In the non-parametric analysis, when the ex-ante approach is used, the inequality is decomposed into inequality within and between types. The between component represents the inequality of opportunity while the within component is interpreted as inequality due to effort. Similarly, in the ex-post approach, overall inequality is decomposed into between and within tranches. But in this case the inequality within, which is the inequality among those with the same level of effort, is interpreted as the inequality of opportunity and the inequality between as effort inequality. The two methods do not necessarily yield the same result.

The ex-ante method is implemented via a "smoothed" distribution, which is obtained from the original distribution of outcomes by giving all individuals of the same type the same (mean) value of the outcome for their type. The smoothed distribution $\{\mu_i^k\}$ is defined over a

[3]The empirical literature treats choices and luck, which also affect outcomes, as effort.

partition made up of K types where the elements of type k, y_i are replaced by their group means, μ^k. The level of inequality in the smoothed distribution, $I(\{\mu_i^k\})$, is then compared with the inequality in the original distribution, $I(y)$, via this index:

$$\theta_d = \frac{I(\{\mu_i^k\})}{I(y)}, \qquad (2)$$

where $I(.)$ is an appropriate inequality index, and subscript d denotes the direct method (that is, directly estimating the role of circumstances by keeping effort constant within each type). θ_d is an intuitive estimate of inequality of opportunity as it is a measure of the difference between the inequality in the original distribution and a synthetic distribution which eliminates all variation due to effort. The class of indices that yields the θ with desirable properties is the General Entropy class (Ferreira and Gignoux 2011a).[4]

Alternatively, one can perform the simulation by first obtaining a *standardized* distribution, which uses the same partition of outcomes into k groups, but this time leaves the inequality within each type as is and instead removes the differences in mean outcomes between types. This is done by rescaling the original series by the ratio of the means,

$$\tilde{y}^k = y^k \frac{\mu}{\mu^k}.$$

Whereas the smoothed distribution eliminates all within-types variation, the standardized distribution eliminates all between-types variation. Thus a new index of inequality of opportunity suggests itself:

$$\theta_r = \frac{1 - I(\{\tilde{y}^k\})}{I(y_i)}. \qquad (3)$$

The subscript r is used because this time inequality of opportunity is estimated as a residual. The index with the additional desirable property of path independence, that is, yielding $\theta_d = \theta_r$ is GE(0), which is also known as Theil's L index (Ferreira and Gignoux 2011a). Unfortunately, for the specific purpose at hand, because of the way TIMSS scores are standardized, GE(0) is not appropriate; GE(2) which is, does not have this property.

Another non-parametric method, due to Checchiand Peragine2010, begins with sorting individuals into effort categories. The key assumption here is that individuals at a particular position in the distribution of outcomes within each type exert the same level of effort, so any inequality between the individuals located, say, at the median outcome for each type can be attributed to circumstances beyond their control. This method is implemented by first sorting individuals in each type according to their percentile of outcome and then forming tranches of all individuals at the same percentile of each type.[5] Thus those in the same tranche -- say, individuals at the median -- have the same level of effort, and the inequality between them (within tranche) can be attributed to differences in circumstances. So, in a fashion analogous to the above, we can construct synthetic distributions to obtain direct and residual measures of inequality. In the residual case, we construct a standardized distribution by eliminating all between-tranche inequality, so that the inequality in the resulting distribution is solely due to effort. Similarly, we create a smooth distribution by removing all within-tranche inequality so that the inequality that remains is not due to circumstances. The difference between

[4] In our case, because of the way TIMSS scores are standardized, only GE(2) is appropriate (Ferreira and Gignoux 2011b).

[5] In practice to keep the number of cells manageable, we can only sort them into deciles.

inequality in the smoothed and original distributions is then an estimate of the inequality of opportunity.

Parametric estimation begins with a specific functional form, often linear, to describe the relationship between outcomes and circumstances, which is then estimated from micro data Bourguignonet al.(2007) and Dardanoni et al. (2006). A typical formulation is:

$$y_i = C_i\beta + \varepsilon_i, \quad (4)$$

where C here includes the circumstance variables as well as the constant. This could be the reduced form equation from a more complicated model in which circumstances also affect outcomes indirectly through effort Bourguignon et al.(2007). Inequality of opportunity is then estimated through simulation of the estimated relation.

An obvious way to measure the share of inequality of opportunity is to compare the inequality in y_i, $I(y_i)$, with the inequality in a synthetic distribution of y_i generated using parameter estimates from equation (4). Here, as with non-parametric methods, we have a choice of a synthetic standardized or smoothed distribution. In the standardized version we first equalize circumstances for all individuals and then predict their outcomes:

$$\tilde{y}_i = \overline{C}\hat{\beta} + \hat{\varepsilon}_i, \quad (5)$$

where $\overline{C}$ is a set of fixed values of circumstances representing, say, a female with parents with mean education and living in urban areas, and $\hat{\varepsilon}_i = y_i - C_i\hat{\beta}$ are the residuals from the above regression. In the parametrically standardized distribution, the variation in $\tilde{y}_i$ can be interpreted as the influence of "effort" because it results from the variation in $\hat{\varepsilon}$, which are obtained from y_i after the variation in C has been removed. Inequality in $\tilde{y}_i$ is naturally lower than the total inequality in y_i and can be compared to it using the same indicator of inequality of opportunity as before:

$$\theta_r^P = 1 - \frac{I(\tilde{y}_i)}{I(y_i)}, \quad (6)$$

with the superscript P indicating the parametric equivalent of θ_r.

Alternatively, we can use equation (4) to obtain a smoothed distribution by using the predicted values from the regression 4. The predicted values are obtained by using the actual circumstances while ignoring the remaining variation in the residuals:

$$\tilde{z}_i = C_i\hat{\beta}. \quad (7)$$

The parametric equivalent of θ_d is then given by:

$$\theta_d^P = \frac{I(\tilde{z}_i)}{I(y_i)}, \quad (8)$$

As noted above, if we use GE(0) to calculate $I(.)$, the direct and indirect method yield the same result because GE(0) is path independent. But, because of the standardization of test scores GE(0) is not appropriate, and we have to use GE(2), which is not path independent, so we have to choose between θ_r^P and θ_d^P. In the empirical section, we chose to work with the former because it yields more consistent results.

The main advantage of the parametric approach is that it allows for measuring the partial effect of circumstances on outcomes, and its main disadvantage is that it requires strong

assumptions about how circumstances and outcomes are related. The non-parametric approach, whether by types or tranches, does not impose any functional form on the relationship between circumstances, effort and the outcome, but it allows only a few number of circumstance variables in the decomposition. As demonstrated by Ferreira and Gignoux (2011a), the extent of measured inequality differs depending on the approach. Our results also show that the estimates of inequality of opportunity are sensitive to the method employed (see section 7).

Finally, other studies have sought to test the existence of equality of opportunity instead of measuring it. Lefrancet al.(2006), Lefrancet al.(2009), and Peragineand Serlenga(2008) use the concept of stochastic dominance to test the equality of opportunity based on an ex-ante approach. Others have tried to obtain either partial or complete ranking of the outcome distribution Bourguignon et al. (2007); Checchi and Peragine (2010); Ferreira and Gignoux (2011a); Peragine(2004); and Peragine and Serlenga(2008).

In this paper we use both parametric and non-parametric methods to estimate inequality of education opportunities. For the most part these techniques produce similar results, across countries and over time, but there are differences that arise from the fact that different techniques emphasize different aspects of the distribution of achievement scores. In presenting our results we focus mainly on the parametric results, which use equation (4) as the main vehicle for obtaining estimates of the decompositions. As noted earlier, the parametric method permits a wider set of circumstances to be included in the decomposition of inequality and enables us to estimate the contribution of individual circumstance variables.

The quality of the non-parametric inequality of opportunity measures depends on the quality of the estimates for the type/effort-specific means. The sampling variance of these means may be very large for cells with few observations and would cause an upward bias in the non-parametric estimates of opportunity inequality (Ferreira and Gignoux 2011a). Therefore, for the non-parametric approach, we recoded the circumstance categories in such a way as to reduce their number for each circumstance variable to three or fewer.

4. Data

We use data from three rounds of TIMSS(1999, 2003 and 2007). TIMSS provide internationally comparable data on students' achievement in mathematics and science at fourth and eighth grade levels. More than 60 nations participated in the 2007 round, 16 of which were MENA countries. In 2003 there were 45 countries of which 10 were from MENA, and in 1999 out of 38 participating countries only 5 were from MENA. The countries participating in the TIMSS 1999 study are Iran, Jordan, Morocco, Tunisia, and Turkey. TIMSS 2003 includes: Bahrain, Egypt, Iran, Jordan, Lebanon, Morocco, Palestinian National Authority, Saudi Arabia, Syria, and Tunisia; and TIMSS 2007 includes: Algeria, Bahrain, Dubai, Egypt, Iran, Jordan, Kuwait, Lebanon, Morocco, Oman, Palestinian National Authority, Qatar, Saudi Arabia, Syria, Tunisia, and Turkey.[6]

TIMSS uses a complex assessment design that ensures broad coverage of the cognitive subject matter content even though not all students answer the same set of questions. In particular, in order to test students on what they have been taught in school, the test is not uniform for all students across schools and countries. Using Item Response Theory (IRT), ex-post scores are scaled and standardized to make them comparable. As a result, the mathematics and science achievement scores generated by the IRT scaling have no inherent metric and are therefore mapped by a linear transformation onto an international achievement scale with a mean of 500 and a standard deviation of 100 (Martinet al. 2004, Olson et

[6] Due to difficulties in participation of some schools in Morocco, the data for 2007 is incomplete and the results for this year should be taken with caution (Olson et al 2008, p. 32).

al.2008). Placing the results on a common metric allows for comparison of student performance across country and over time, but creates difficulties for measurement of inequality (Ferreira and Gignoux 2011b). TIMSS reports five "plausible values" for test scores in mathematics and science as the relevant measure of educational outcome. These values are highly correlated and produce the same result in decompositions. We take the average of these values as our outcome variable.

TIMSS employs a two-stage sampling design in which each participating country selects a random sample of schools at the first stage, and one or two classes are randomly chosen at the second stage. All students of the sampled classes are tested in both mathematics and science, resulting in a representative sample of students within each country. Working with TIMSS data require sampling weights, which are provided, and which adjust for the probability of selection of the school and the classroom, as well as for student and school nonresponse. We use these weights throughout the estimations in this paper.

There are, as in any survey, missing values due to non-response. However, TIMSS missing data appear to follow a pattern. For example, in the two tables below we note that the share of missing values is very high for a number of countries, and, moreover, for some countries (especially Bahrain and UAE) the distribution of students by father's education level changes when we include missing values for father's education as a category.) While for the whole set of countries the percentage of missing values for family background variables does not exceed 13 percent in TIMSS 1999 and 7 percent in TIMSS 2003 and 2007, in some countries data on father and mother's education and on community location are missing for more than 25 percent and 15 percent of the students in TIMSS 1999 and TIMSS 2003 and 2007, respectively (cf. Table 16). Besides the reduction in sample size, dropping all students with missing data on these variables would disregard information available on the other variables for these students, and would probably introduce bias because missing values are not completely random. To avoid these problems, we include missing values but mark them with dummy variables. Sampled students are roughly equally divided by gender in all countries.

Morocco has the largest sample size across the MENA countries with 16,206 students in TIMSS 1999, while Syria and Lebanon have the largest number of sampled students at 14,800 and 15,176, respectively, for TIMSS 2003 and 2007. We construct a dataset combining the student standardized test scores in math and science, at the eighth grade, with the student-specific characteristics, information on family background, schooling resources and institutional settings. For estimation purposes, the qualitative survey data were transformed into dummy variables. Tables 16 and 17 in the Appendix give an overview of the variables used in this study and present their descriptive statistics.In addition to the test scores, TIMSS provides information about the students' family, community, and school quality. Family background variables include parents' education, number of books at home, and access to computers and internet and the like. Parents' education is recoded as a categorical variable with three levels: primary or less, secondary and post-secondary, and university. There is a wide variation across the countries in parents' education[7]. At the lower end are Iran, Morocco, Oman and Saudi Arabia, where less than 40 percent of mothers and 25 percent of fathers have any secondary education. At the other extreme are Kuwait, Qatar and Dubai, where about 30 percent of mothers and 35 percent of fathers have completed university education. Parents' education is also high in Jordan, Lebanon and Palestine. We also know the immigration status of students and their parents, whether the student was born in the country of residence and whether his mother or father were born in the country. We use this variable to distinguish between "natives" and expatriates, which in some countries, such as Dubai, outperform the local population by a large margin and bias our equality of

[7] Detailed summary statistics are available from the authors.

opportunity estimates.[8] When we exclude those whose fathers were born outside Dubai, the share of opportunities falls from 58% to 28%. Evidently, the children in the expatriate community in Dubai perform differently in the tests and much of the difference between their scores and those of the natives is explained by differences in their circumstances, mainly parents' education.[9]

TIMSS data report if the test is taken in the language spoken at home. This variable can be thought of as an indicator of minority status or ethnicity. There are also variables indicating whether the student lives with their father and mother or with one step-parent (for TIMSS 1999). Finally, TIMSS reports the number of books at the students' home, which is considered a good proxy for parental preferences and how conducive the home environment is for education. This variable is also categorical: 0-10 books, 11-25 books, and more than 26 books. Iran, Morocco, Egypt and Saudi Arabia fare relatively poorly according to this measure, while Qatar, Bahrain, Dubai, Kuwait, Jordan and Lebanon fare well.

For community characteristics (where the schools are located) we have community size, which is coded as less than 15000 inhabitants, 15,000-100,000 and more than 100,000. In 1999 the community type was recoded as village or isolated area, outskirts of a city, and close to a city. More than 40 percent of the students in Iran, Saudi Arabia, Turkey and Dubai go to a school in a community with more than 100,000 inhabitants. By contrast, countries such as Kuwait, Lebanon, Oman and Qatar feature a high share (over 40 percent) of schools located in smaller communities.[10]

TIMSS data contain fairly detailed information about school and teacher quality. We use this data only at the level of community because at the family level it can be endogenous to student performance. If a child is performing well in school, parents (or the school system) may decide to send her to a better school with better teachers. Schooling resources and class composition have been shown to affect student performance (Woessmann2003; Hanushek and Woessmann 2007). We controlled for such effects by including variables for class size; teacher characteristics such as age, gender, years of experience, and education levels; shortage of teachers; and the social and economic background of the student's classmates measured by the percentage of students coming from economically disadvantaged homes and the percentage of those from affluent homes. To avoid bias in the empirical analysis, we use averages at the sampling zone level of the resource and peer variables. Variable averages may be reasonably assumed to be exogenous as it is hard to imagine that there is important residential choice by parents across regions initiated by educational concerns, or that there is a mechanism allowing to move substantial educational resources between regions.

Finally, we should note a potential selection problem with TIMSS data. The students in the sample are those who have remained in school up to grade 8. If there is a large dropout, because students from lower social backgrounds are more likely to drop out of school before grade 8, the TIMSS sample would be a more homogeneous one than the population of 14 year olds. This will bias estimates of total inequality in achievement downward and also the estimates of inequality of opportunity, though the latter does not necessarily follow from the former. In all the countries we study, grade 8 is included in compulsory education, and even high school enrolment rates are quite high. Table 1 shows the (gross) enrolment rates at the lower secondary level for the countries under study. Since in most countries staying in school

[8] We call them “natives” though the criterion we use may exclude some natives who were born outside the country.

[9] Surprisingly, the drop in the case of Qatar is much smaller -- from 31% to 30% -- perhaps because its expatriate community is smaller.

[10] The community variable for Qatar shows that only about 7% of the students in the sample lived in a community with more than 500,000 inhabitants, which is surprising since Doha, the capital city, has about 450,000 people and accounts for about a third of Qatar's population.

up to grade 8 is compulsory, enrolment rates are generally high and selection should not be a major issue. Based on these numbers we do not expect selection to be a serious issue in general, but caution is advised in interpreting too finely the differences between countries or over time. For example, Algeria, which shows exceptionally low levels of inequality of opportunity also has one of the lowest enrolment rates. It is quite likely that the estimates for Algeria are more severely affected by selection bias.

5.A First Look: the Distribution of Scores by Key Circumstance Variables

In this section we review the broad pattern of scores for math and science across countries and how they relate to key circumstance variables before turning to the full decomposition results. At the outset we face a daunting task of presenting results on three rounds of TIMSS tests for as many as 16 countries (in 2007) for math and science test scores. In addition, there are at least three distinct methods for decomposing the variation in scores into the part attributable to circumstances and the part due to effort and luck. To make the presentation manageable, we have to make some choices. We focus the main part of our discussion of the descriptive statistics to the 2007 round of TIMSS, which involved the largest number of countries in MENA (16), noting important changes over time for those countries that have participated more than once in TIMSS. In presenting the decomposition results, we also economise on space by focusing on our parametric estimates, noting any differences with the non-parametric methods using tranche and types approaches.

Tables 2-4 compare the mean scores across the countries by gender in 1999, 2003, and 2007. There is a wide variation in the performance of 8th graders across the region, but for the most part MENA countries fall below global average achievement. In 2007 none of the 16 MENA countries reached the Intermediate International Benchmark (475), and 5 were even below the Low International Benchmark (400).[11] Students from Bahrain, Jordan, Lebanon, Tunisia and Turkey do consistently better than the rest. At the other end, Qatar stands out as the country with the worst performing students, followed by Saudi Arabia. There is no pattern that identifies the top performing countries. The comparative view from these tables does not offer any meaningful generalizations about what contributes to a high average level of achievement. At the low end we have countries that certainly have the resources to enable their children to do better, Qatar and Saudi Arabia, so resource availability is not the obvious constraint and one would have to look at parental education and the incentives to learn for clues as to why students from these countries do poorly.

In most countries and years boys do better than girls, but the gaps are not statistically significant. In Morocco, Syria, and Tunisia boys have maintained an edge throughout. In Iran girls have caught up with boys, reversing their score gap between 1999 and 2007 in both math and science, an indication of expanding opportunities for girls. Jordan, a top performer by MENA standards, is an exception in that Jordanian girls have outperformed boys throughout. The role of gender in achievement is more clearly seen in the kernel density estimates. Figures 1 and 2 present the kernel density estimates of the distribution of math and science scores. In these graphs (and in subsequent analysis unless otherwise noted) we focus on students whose parents were born in the country ("natives"). The scores for math and sciences tell very similar stories of variation across countries and gender. The summary results for the effect of gender, which is the most obvious circumstance variable, and one that is generally considered to have a large influence on labor market outcomes in the Middle East, are quite interesting and reveal three patterns. As in other countries, the gender gap in achievement in mathematics and science is difficult to explain (Xic and Shauman 2003). In

[11]The TIMSS benchmarks describe four levels of student achievement in each subject based on the kinds of skills and knowledge students would need to successfully answer the mathematics and science questions. For example, reaching the Intermediate Benchmark for 8th graders in science means that the student "can recognize and communicate basic scientific knowledge across a range of topics (Olson, Martin, Mullis 2008).

the larger countries of Algeria, Egypt, Iran, Morocco, and Turkey, as well as in Lebanon, the distribution of scores for boys and girls are basically the same. In Syria and Tunisia there is a gender gap in favor of boys, while in the oil-rich nations of the Persian Gulf, Jordan, and Palestine girls seem to do substantially better than boys. The gap in scores in favor of girls in Bahrain, Dubai, Oman, Qatar, and Saudi Arabia, all of whom enjoy rent income from oil and gas, is particularly unusual to see in math, and raises interesting questions about incentives to learn for boys who are generally favored in government employment and access to rent income. A similar gap is observed in the rates of enrolment of men and women in universities in these countries, which is often attributed to the fact that in these traditional countries young women are less likely than men to go abroad for higher education. The gap in scores for 8th grade children is more troubling in that it seems to result from a lower level of effort applied by boys than girls.

Before turning to the full decomposition results, we view the partial effects of two other key circumstance variables, father's and mother's education. Figures 2 and 3 present the distributions of math and science scores by father and mother's education. Parental education is measured as primary or less, secondary, and tertiary. Across countries the patterns of the effect of father and mother's education on scores tend to be very similar, so we simplify the discussion by referring to parental education on test scores. These graphs show, for each country, how the distribution of parental education changes as we move from low to high deciles of the distribution of scores. For example, in Algeria it seems that parental education does not affect scores; students with educated parents at the tertiary level account for about 20 percent of the low as well as high scores. In contrast, in Dubai students with tertiary educated parents account for less than 10% of the math scores in the lowest decile but more than 40% of the scores in the highest decile. A very similar pattern is seen in Figures 4 and 5 which represent the distribution of science scores by parents' education. From this particular perspective Algeria appears to be the country with the highest degree of equality of opportunity whether looking at math or science scores or parental education.

We also note from these graphs that the effect of parental education on the distribution of scores changes with the education level. In Egypt, parents with tertiary education are equally represented at low and high scores (about 10% for fathers and 5% for mothers), but not for those with high school education, which seems to significantly affect the likelihood of ending up at the top deciles. Only 40% of students who scored at the bottom decile had a father with a high school education compared to 60% at the top. By contrast, in Iran, Jordan, Lebanon, Morocco, and Turkey, tertiary education of the parents appears to matter most for a child's achievement. In Iran and Turkey very few students in the bottom deciles had fathers with tertiary education compared with nearly 40% of those at the top decile. The fact that in these countries the effect of parental tertiary education is flat for children who scored in the bottom 4 deciles and appears most effective at the top two deciles may mean that their competitive mechanisms of selection into universities, which rewards only the top 20%, discourages parents from getting involved when it appears early on that their child's prospects for making it to the top 20% appear to be low. In Dubai, Qatar, and Tunisia, all education levels of parents seem to count equally toward the child's success.

Several MENA countries that participated in TIMSS for more than one year offer a view of changes in average achievement over time (see Table 5). Iran, Jordan, Morocco, and Tunisia are the only four countries with four rounds of surveys (Iran also participated in 1995). The trend for the group is mixed. Iranian average scores show more declines than improvements, with a steady decline in boys' math scores, but improvement in girls' science scores. In Jordan, boys have improved their scores in science but not in math, whereas girls show improvement in both subjects. Moroccan boys and girls show significant improvement during 1999-2003, but not thereafter. In Tunisia, the performance of boys and girls declined during

1999-2003 but improved in 2007. For the group of countries that participated only in the last two rounds, the results are also mixed. In Egypt and Palestine, and Saudi Arabia nearly all scores declined slightly, the only exception being science scores for girls in Saudi Arabia. Lebanese and Syrian students experienced increases in performance. Turkey, which participated in 1999 and 2007 only, has seen modest gains across genders and subjects.

6. The Inequality of Test Scores and Their Decomposition

We begin the discussion of our decomposition results with a comparison of total inequality of test scores across countries and its standard decomposition into within and between components (tables 6 and 7). The "between" component is based on groups of students separated into "types" based on a set of observable circumstances that are common across all countries and all years of TIMSS surveys. We follow this with our parametric and non-parametric methods of decomposition in the next section. We report total inequality using General Entropy, GE(2), and Gini indices, but the decomposition is only reported for GE(2) because of its decomposability (columns 2 and 3). Column 4 is the ratio of between-group inequality to total inequality using GE(2). For purposes of comparison we also present our estimates of inequality of opportunity (IOP) using the parametric method in column 5 of these tables, and sort countries according to this index from low to high IOP. As noted earlier, we limit our sample to those students whose fathers were born in the country, and keep observations with missing values flagging them as such.

First note the considerable variation in the level of total inequality of test scores across the region. We observe the highest levels of total inequality in Qatar, Turkey, Palestine, Oman and Egypt, and the lowest in Algeria, Lebanon, and Tunisia. The Gini index ranges from 0.1 to 0.13 and GE(2) from 0.01 to 0.03. The levels of total inequality in scores shown here are generally lower than in Latin America and are closer to those for the OECD countries (using scores from PISA tests; see Ferreira and Gignoux 2011a). The rankings of these regions based on inequality of test scores follows closely the inequality of income and expenditures. But in terms of inequality of opportunity, the story is different, and most MENA countries are less opportunity equal in achievement that European countries, and several are less so than Latin America and the United States.

The rankings of the MENA countries in term of inequality of opportunity (IOP) based on the standard decomposition in table 6 and the full parametric estimation presented in the next section are very similar. For the most part countries with higher levels of total inequality in test scores also exhibit greater inequality of opportunity. Algeria has the lowest levels of IOP in our sample of countries and also the lowest total inequality. Dubai, Egypt, Oman, Qatar, and Turkey have higher levels of IOP and also high levels of inequality. This is not surprising because one would expect within-group inequality, which is closer to effort, to vary less across countries than inequality due to circumstances. In the extreme case that all other differences between countries have been captured by circumstances, the within distributions should reflect natural ability, which we presume are similar across countries. But the correlation is not strong. Lebanon has low inequality but high IOP, and Palestine has with moderate IOP and high inequality.

7. Parametric and Non-parametric Decompositions

We now turn to our main results using parametric and non-parametric methods of estimating inequality of opportunity. Reporting on two subjects -- math and science -- for multiple countries and several years is a challenge. We report two sets of results. The first set is the parametric results, which uses the largest number of circumstances that are available for all countries and for all three years of TIMSS surveys. The list includes gender, ethnic background (as indicated by the variable that codes how frequently the language of the test is spoken at home), parental education, the number of books at home, access to a computer and

the internet (no information on internet for 1999), and the characteristics of the community. These results help us consistently compare countries with each other and over time (for those with more than one year of data). These results are presented in tables 8-13, which report the total inequality of opportunity as well as the contribution of several key individual factors, as well as in a summary table (table 14) which includes the estimates of inequality of opportunity for all countries in all years. The full decomposition results are presented in the Appendix, and the estimated regressions that underlie them (equation 4) are available upon request.

The second set of results we present uses a smaller set of circumstances, small enough for the non-parametric methods to work. The purpose of presenting these results is to check the extent to which the full parametric decomposition results are sensitive to the method of decomposition. Non-parametric methods sharply limit the number of circumstances that can be included in the decomposition. The tranche method is the more limiting of the two non-parametric methods in terms of differentiation by circumstance because with 10 deciles of test scores (for 10 levels of "effort") every additional circumstance variable with, say, three levels or categories adds 30 new cells, reducing the number of observations in each cell quickly. The set of circumstances we use for this purpose includes gender, mother's education, number of books, and community type. The results of the comparison across methods (in Section 7.2 below) is reassuring in that the magnitudes of the estimates are similar across methods, and where there are differences they are easily explained in terms of the mechanics of the method in question. We begin with the parametric results and follow with the results that compare parametric and non-parametric results. We present these results graphically in figures 8 - 12. The full results are found in the Appendix.

7.1.Parametric results with the extended set of circumstances

As we noted in section 3, the way standardized TIMSS test scores are constructed, the indicator of choice for the decomposition of inequality is GE(2), which is decomposable but not path independent (Ferreira and Gignoux 2011a). As a result, the two measures of inequality suggested by the parametric method, θ_d^P and θ_r^P (see equations 6 and 8) do not yield the same result, and we had to choose which one to work with. We opted for the residual method that estimate θ_r^P because it produced more consistent results.

Tables 8-13 present the share of inequality in achievement explained by all circumstances using this measure. We break down these results by groups of circumstances and by individual circumstances. The contribution of family background and community characteristics to total inequality are calculated by setting the values of groups of variables to their means while allowing other characteristics to vary. Family background includes parental education, number of books at home, how often the the language of the test is spoken at home, and access to computer and the internet at home. Community characteristics include the size of the community (from a few to over half a million), as well as school and teacher quality variables at the community level.

Figure 7 and table 14 present the summary view of these results arranged by the level of IOP estimated from math scores in 2007. For the moment we focus on the 2007 results, and compare them with prior years subsequently. There is a fair amount of consistency in the results across years and subject matter. The pattern of inequality of opportunity we observe in 2007 is also very similar whether viewed from the perspective of math or science scores. Only in Qatar do we notice a significantly larger level of IOP in science relative to math scores. Bahrain, Lebanon, and Jordan also show greater IOP in the science results. In the case of Qatar, both family and community variables show greater contributions to inequality in science relative to math.

There is a wide range of estimates of IOP across the region. Algeria is by far the most opportunity equal country in MENA, with about 7% of its inequality in math and science achievements due to circumstances beyond individual control. The level of IOP estimated here is lower than comparable estimates for Canada and the Scandinavian countries. Morocco is a distant second with IOP shares of 20.5% in math and 16.6% in science.[12] At the other extreme is Turkey with IOP shares of 38.8% in math and 36.5% in science. Egypt, Dubai, Iran, Lebanon, and Qatar are also among the region's least opportunity equal countries. These result compare unfavourably with a median IOP estimate of about 16% for Europe and less than 0.30 for Latin America, Germany and the USA.

It is not obvious what the high IOP countries have in common. Looking down the rows in tables 12 and 13 we note significant differences between these countries in the sources of IOP. Table 15 shows more conveniently the contributions of family background and community characteristics, as proportions of the total IOP.[13] In Lebanon the contribution of community variables is the highest, about three-fourth of the total IOP (with a contribution ot total inequality of 27.6% compared to all circumstances of 37.0%). This is not surprising since Lebanese society is more segmented along sects and tribes, and the role of government in provision of education is less comprehensive than in most MENA countries. Morocco and Syria are also similar to Lebanon in this respect, with a higher proportion of the total IOP due to circumstances coming from community characteristics.

In Iran, also a high IOP country, family background variables are the main drivers of IOP (with 27.9% compared to total IOP of 33.3%). This is similar to the findings of de Barroset al. (2009) in Latin America. In terms of sources of IOP, Jordan, Tunisia, and Turkey have similar profiles as Iran, whereas in Algeria and Egypt family background and community characteristics are more equally influential. The most important circumstances in the group of variables we call family background are parental education, which is high in all of the countries just mentioned. In Iran, community size is the most important contributor to IOP among community characteristics (9.5% of total inequality explained compared to 33.3% for all circumstances).

The influence of family background on IOP depends on the quality of public schools and the availability of private schools, and the extent of private tutoring as remedial education. The importance of private schools in education is increasing across the region. In Iran nearly 10% of students at the secondary level attend private or semi-private schools which are only available to students from better-off backgrounds. In Egypt, Iran, Jordan, and Turkey, despite free and extensive provision of public education, private tutoring is an important reason why family background matters. To give their children a leg up in the competitive education systems of these countries in which success is doing well in national university entrance examinations, parents spend significant resources on private tutoring (Assaad and El-Badawy 2004; Tansel and Bircan 2006). Private tutoring is also important in Dubai, which also has high IOP. A recent survey conducted by the Dubai School of Government found that more than 65% of Emirati students in grade 12 attend private tutoring lessons (Farah 2011).

The number of books and access to a computer and the internet at home also matter in most countries. The share of the number of books at home is about one quarter of total inequality

[12]As noted earlier, a large number of observations from Morocco had to be thrown out because of the failure to follow the standard sampling procedures. We are not sure to what extent this has affected how representative the reduced sample is. In addition, enrollment rates in Morocco are lower than other countries in our sample, 81% for boys and 68% for girls in 2007. This likely increases selection on higher ability children, in which case our IOP results would underestimate the share of circumstances in inequality. Morocco's results in 2003 are quite similar to 2007, suggesting that the sample in 2007 is fairly representative, but since enrollments were even lower in 2003, the problem with selection was present then as well. The low IOP in Morocco should therefore be interpreted with caution.

[13]The proportions do not add to one because of the way the two parts are estimated.

of opportunity across the region as a whole, but varies between 38% in Algeria and 14% in Egypt. Other studies have found even greater influence of books at home (Woessmann 2003; Woessmann 2004; Fuchs and Woessmann 2004). Schutz et al. (2008) use only the number of books, arguing that they are a stronger predictor of scores than parents' education, but we find that for all MENA countries mother's and father's education explain as much as twice the variation explained by the number of books. The share of computers at home in inequality of opportunities varies from zero in Syria to 22% in Kuwait.

Gender relations in the MENA region are often described as highly unequal. The evidence in this paper suggest a different view. The enrollment data in table 1 show gender equality in enrollment and the TIMSS scores in tables 2 -4 show that, in terms of average math and science scores, girls do at least as well as boys in most countries, especially in 2007, and in several countries they do better. Even in Saudi Arabia, where women are unable to drive, girls did better in science than boys in 2007. The kernel density estimates in figures 1 and 2 also show that in many countries, especially the GCC, girl scores are higher than boys. Our results offer a similar view, that in most countries gender no longer plays an important role in equality of opportunity. The share of gender in IOP in 2007 is near zero in the largest countries of the region -- Egypt, Iran, and Turkey -- but relatively high in the GCC, mainly because girls score higher than boys. In Qatar, the share of inequality in 2007 math scores explained by gender is 17.1% compared to the share of all circumstances, which is 32.3%. Gender is also important in Tunisia, but for the opposite reason, because girls do worse than boys (tables 12 and 13).

There is no strong pattern to changes in IOP over time. Comparing the results for 1999, 2003, and 2007 (see table 14), we can conclude that there is certainly no trend towards greater equality of opportunity. Only in Egypt do we notice a small decrease in IOP between 2003-2007. In four of the five countries that participated in all three TIMSS rounds under consideration, inequality of opportunity has increased. Of this group, only Jordan has managed to stay about the same in terms of the share of circumstances in inequality of scores. In Jordan the share of inequality of opportunity increased from 0.27 to 0.32 between 1999-2003 and then fell to 0.25 in 2007. For several countries we observe large increases in IOP over time, notably Saudi Arabia and Turkey. Turkey, which seemed least opportunity unequal in this group, in eight years has managed to become the most opportunity unequal in MENA, doubling its share of inequality of scores that is explained by the set of circumstances we include in our decomposition. Iran and Tunisia have also experienced noticeable deterioration in inequality of opportunity. In Tunisia, the increase in IOP occurred along with an increase in the contribution of family background and a decrease in the contribution of community characteristics. In Iran and Turkey, the increase in IOP seems to have occurred as a result of greater influence of both sets of factors. In Saudi Arabia, gender has played a large role in worsening IOP, though not for the usual reason -- being a boy was more of a disadvantage in 2007 than it was in 2003!

7.2 Comparing parametric and non-parametric results

Figures 8-12 (math) and figures 8-12 (science) summarize our main results for math and science scores for 1999-2007 for a more limited set of circumstances.[14] In these figures we arrange countries in order of increasing share of inequality due to circumstances in math scores according to the parametric estimates, as we did before, from the lowest inequality of opportunity in education achievement (Algeria) to the highest (Turkey).

Non-parametric methods are generally expected to yield higher estimates of inequality of opportunity for a given set of circumstances because when cell sizes become too small

[14] Detailed results of the decomposition are available from the authors upon request.

estimates of the variance within those cells become too large (Ferreira and Gignoux 2011b). With the exception of the small oil-rich emirates of Dubai, Oman, and Qatar, parametric and non-parametric results, both in math and science scores, produce similar ranking of countries in terms of inequality of opportunity, which inspires confidence in the results. The results are also similar to the decomposition of GE(2) in tables 8 - 13 discussed above.

The parametric results and the non-parametric results using the "types" approach are quite similar, which indicates that the specific functional form we have chosen for the parametric estimation does not play a big role.[15] Since the functional form assumption is the main drawback of the parametric approach, this should inspire confidence in our results. But the results for the "tranches" approach show generally higher levels of inequality of opportunity. This method is likely to overestimate the degree of inequality of opportunity because, in order to keep the number of cells (equal to the number of type $\times$ 10 deciles) manageable, fewer types are allowed than the "types" approach. The assumption behind this method is that students at the same quantile of scores apply the same effort, whereas if there are more types their efforts may be different.

8. Conclusion

Education has played a central role in the social and economic development of the Arab world. For decades nationalist governments, some with a socialist bend, have promoted free public education as the main instrument for spreading the benefits of economic development widely. These policies have been successful in some respects but not others. They have increased years of schooling at a rapid pace, but have failed to raise the quality of education. Large numbers of high school and university educated youth have had very tough times finding jobs and are now challenging the system that has encouraged them to acquire an education that appears not worth much in the labor market. The returns to schooling in MENA below the university level, where the greatest expansion has occurred, are very low (Salehi-Isfahani, Tunali and Assaad 2009). In this paper we examine the extent to which the education system has fulfilled its distributional goals in terms of educational achievement. In theory, the meritocratic system of education with free public schools should have given everyone an equal chance in attainment. High enrollment rates up to high school suggest that the system has worked well in this respect.

But not everyone who attends school achieves the same amount of learning. International tests taken by 8th grade students globally and across the MENA region show that, like everyone else, students in the region vary in how much they learn in school. There are differences in achievement that result from different levels of student effort and the choices they make that we ordinarily equate with personal responsibility, and there are differences due to natural ability that, while not the responsibility of the individual, societies and governments may not consider their obligation to reduce or eliminate. But there are differences that arise because of circumstances beyond individual control that are ethically unfair and may be properly considered the responsibility of the state. To quantify the extent to which inequalities are due to circumstances is the standard topic in the burgeoning literature in equality of opportunity.

In this paper we use test scores administered by TIMSS in 1999, 2003, and 2007 to learn about inequality of opportunity in the Arab world as well as two large MENA countries, Iran and Turkey, as comparators. We estimate IOP using parametric and non-parametric methods, using a set of circumstances that TIMSS data makes available. It is important to note that our estimates of IOP are the lower bound to the true level of IOP because we only observe a subset of circumstances that affect a child's achievement. The results are fairly consistent

[15]This is also the case in the study of inequality of health opportunities in MENA (Assaad et al. 2011).

across methods, and show a wide range of IOP in the Arab world. Algeria and Morocco are at the lower end of IOP, while Dubai, Egypt, Lebanon, Qatar, and Jordan are at higher than similar estimates of IOP for Latin America, Germany, and the US, some of the least opportunity equal countries for which such estimates are available. Iran and Turkey, the two non-Arab countries included in this study, are even less opportunity equal than most of the Arab countries in our sample.

The examination of test scores reveal, first, that the region's success in raising the quantity of education has not extended to education quality. Test scores in the Arab world are low compared to the international benchmarks specified by TIMSS. Some of the richest nations in the Arab world that have provided free and open access to education have failed to motivate their students to learn. Qatari students, especially their boys, have the lowest average scores in math and science in the region and rank second from the bottom globally. Second, the test scores reveal that a large share of inequality in achievement is due to circumstances -- family background and community characteristics -- that are beyond individual control. While there is a fair degree of equity in access to education, the observed outcomes in terms of learning appear unfair.

What to do? We find that community characteristics play a large role in IOP in many countries of the region. This is an area where public policy is most effective in leveling the playing field. In this respect Iran and Turkey do worse than the average Arab country. But there is large room in many countries to increase equality of opportunity by providing more uniform access to educational resources to all communities, rural and urban, large and small, irrespective of sect or ethnicity, and in all sections of the large cities. But success in the education race in most countries of the region do not depend alone on resources that communities provide. Our results show that in several countries families play an even greater role than communities in child achievement. Policies can also influence IOP by reducing the role of family background. Equalizing access at the community level will go a long way in reducing the influence of family background. Families bring their resources to support their children's education where public resources fail most. But there are also specific policies that provide more room for families to influence their children's success in education, leaving behind the children from less educated and poorer families. Policies to promote private schools, often under the non-profit banner, have the potential to increase IOP. As Banerjee and Duflo (2011) write:

> It should now be clear why private schools do not do better at educating the average child: their entire point is to prepare the best-performing children for some difficult public exam that is the stepping-stone toward greater things, which requires powering ahead and covering a broad syllabus.

In several countries with high IOP, and a few with increasing IOP, private resources spent on private schools or private tutoring play an increasing role in children's success in entering university. In most of these countries a large proportion of these successful students absorb a large proportion of the public resources for education. In this sense, even public resources are contributing to higher inequality of opportunity.

What not to do? Reduce incentives for high achievers. There are two ways to look at a low IOP country such as Algeria. The optimistic view is that children in Algeria play on a level playing field and that the nation is therefore enjoying its benefits in terms of equity and economic growth. The pessimistic view is that the incentives to apply effort in education are so low in Algeria -- for parents and children -- that high achievers achieve less. Equity is achieved by lowering scores at the top rather than increasing them at the bottom. Algerian economy is sluggish enough -- it has the highest youth unemployment rate in the Arab region (Salehi-Isfahani, Abbasi, and Hosseini-Chavoshi 2010) -- and the average scores of its 8th

graders in TIMSS are low enough to warrant caution in presenting its education system as a model for others to follow.

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Figure 1: Kernel Density Functions for Mathematics Score for 8th Grade Boys and Girls by Country, 2007

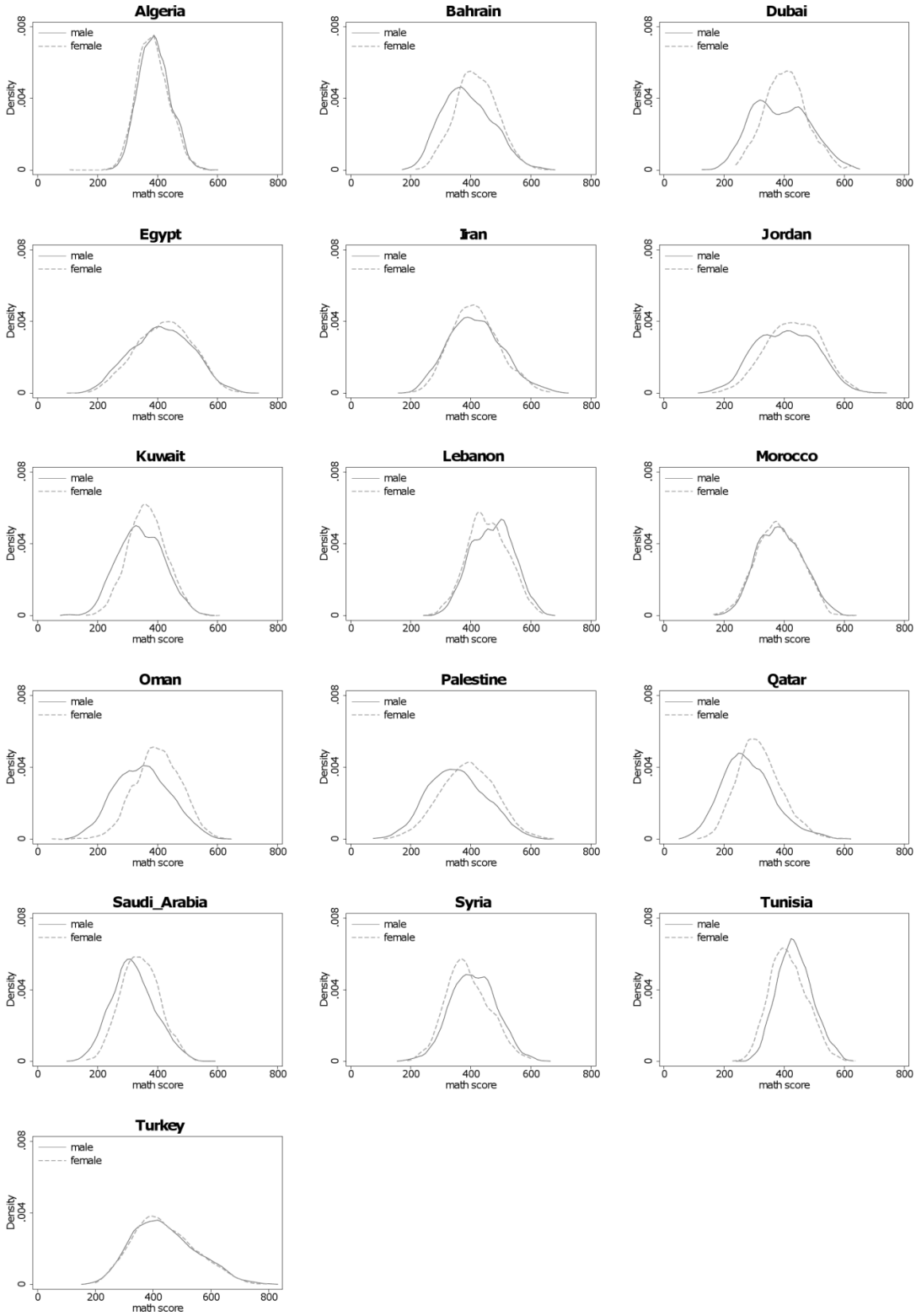

Figure 2: Kernel Density Functions for Science Score for 8th Grade Boys and Girls by Country, 2007

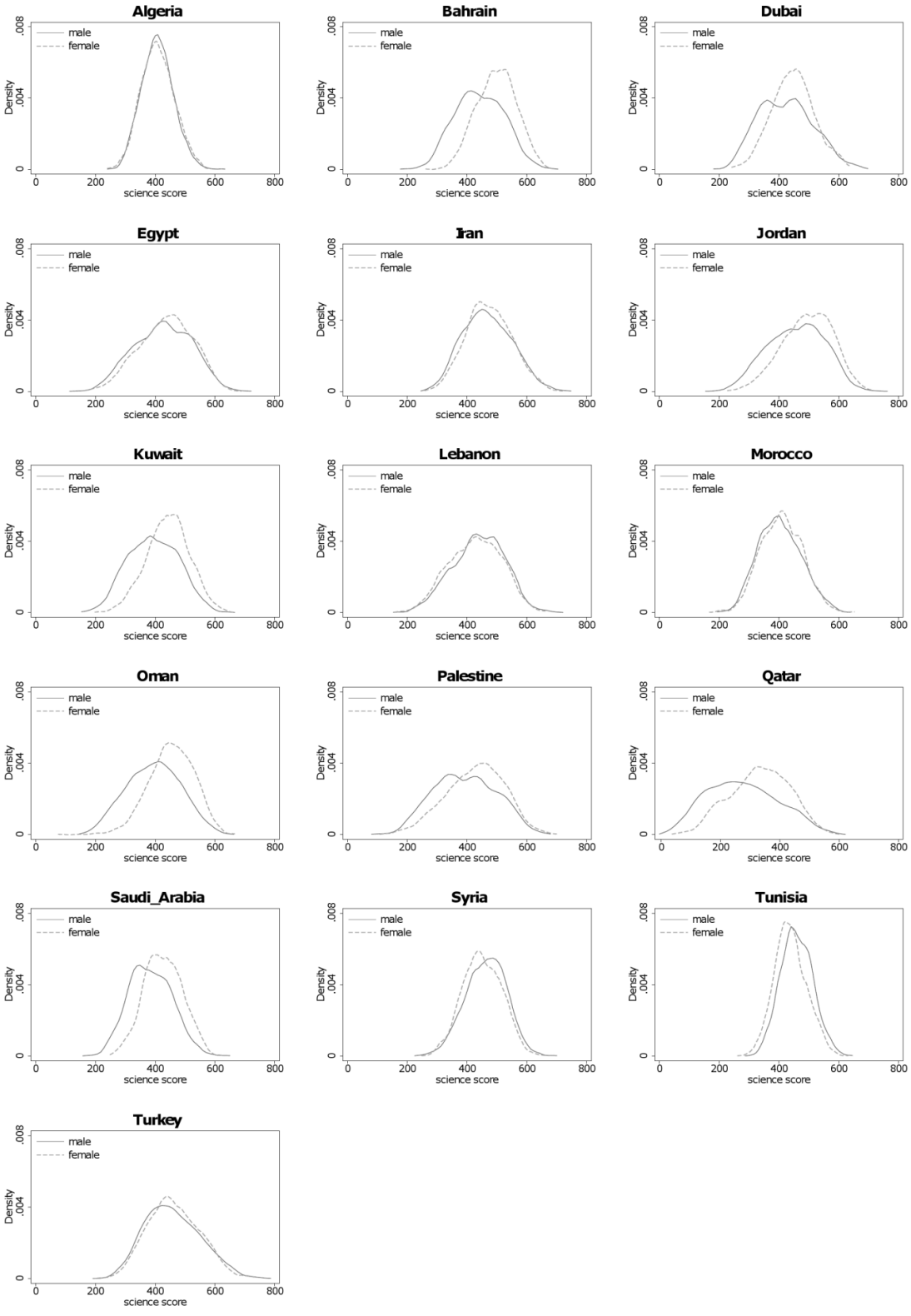

Figure 3: The Distribution of Math Scores by Father's Education, 2007

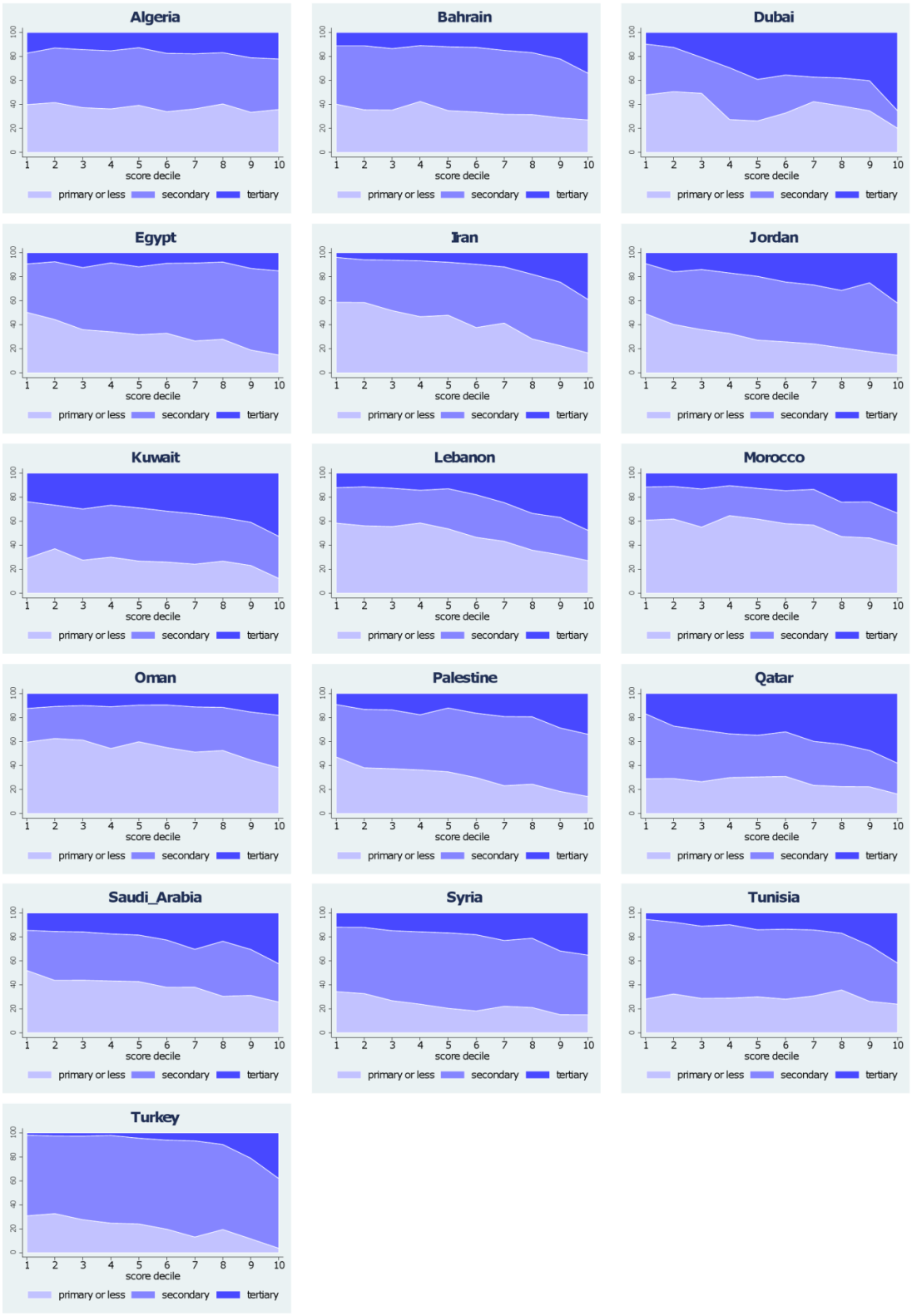

Figure 4: The Distribution of Math Scores by Mothers Education, 2007

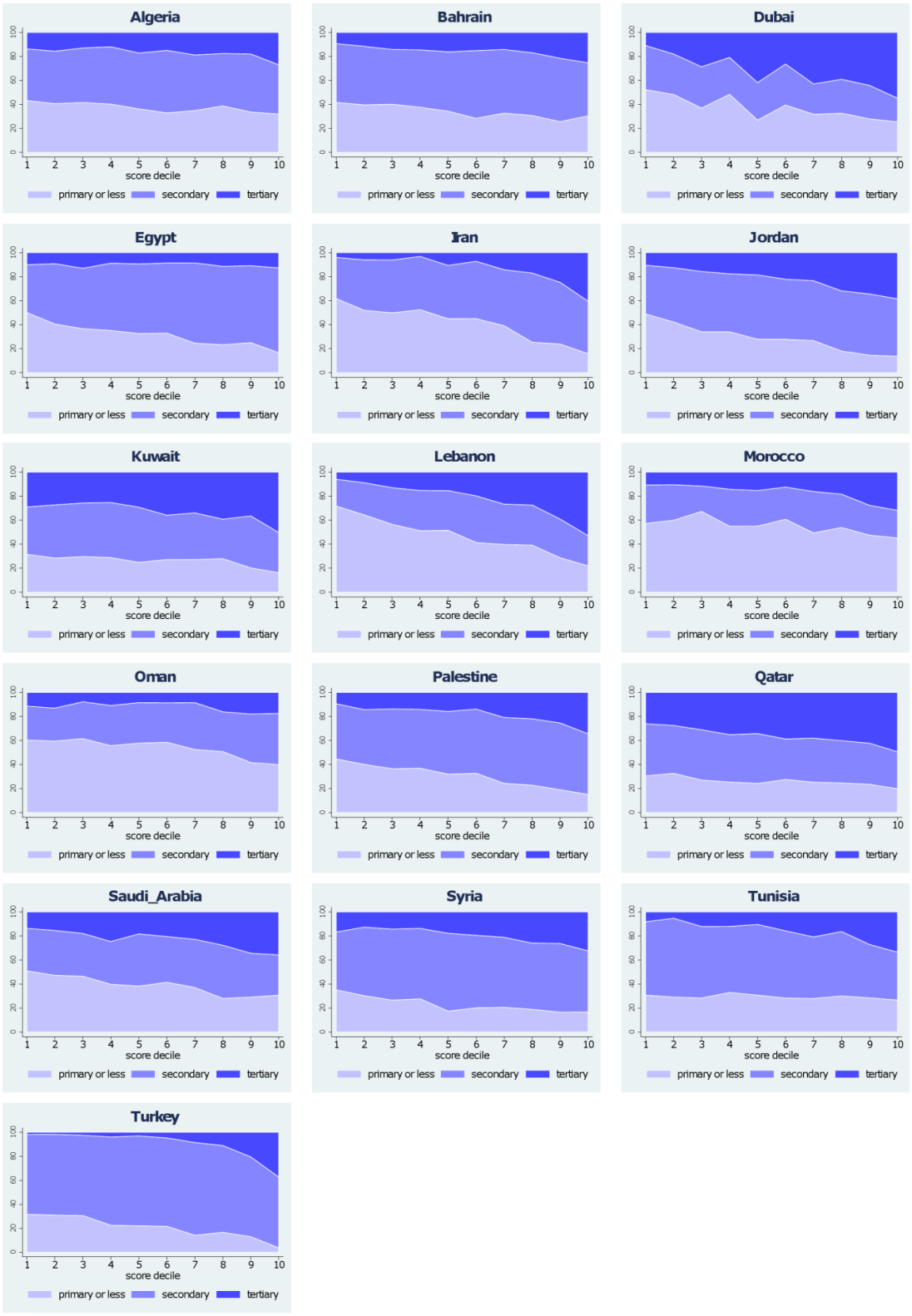

Figure 5: The Distribution of Science Scores by Father's Education, 2007

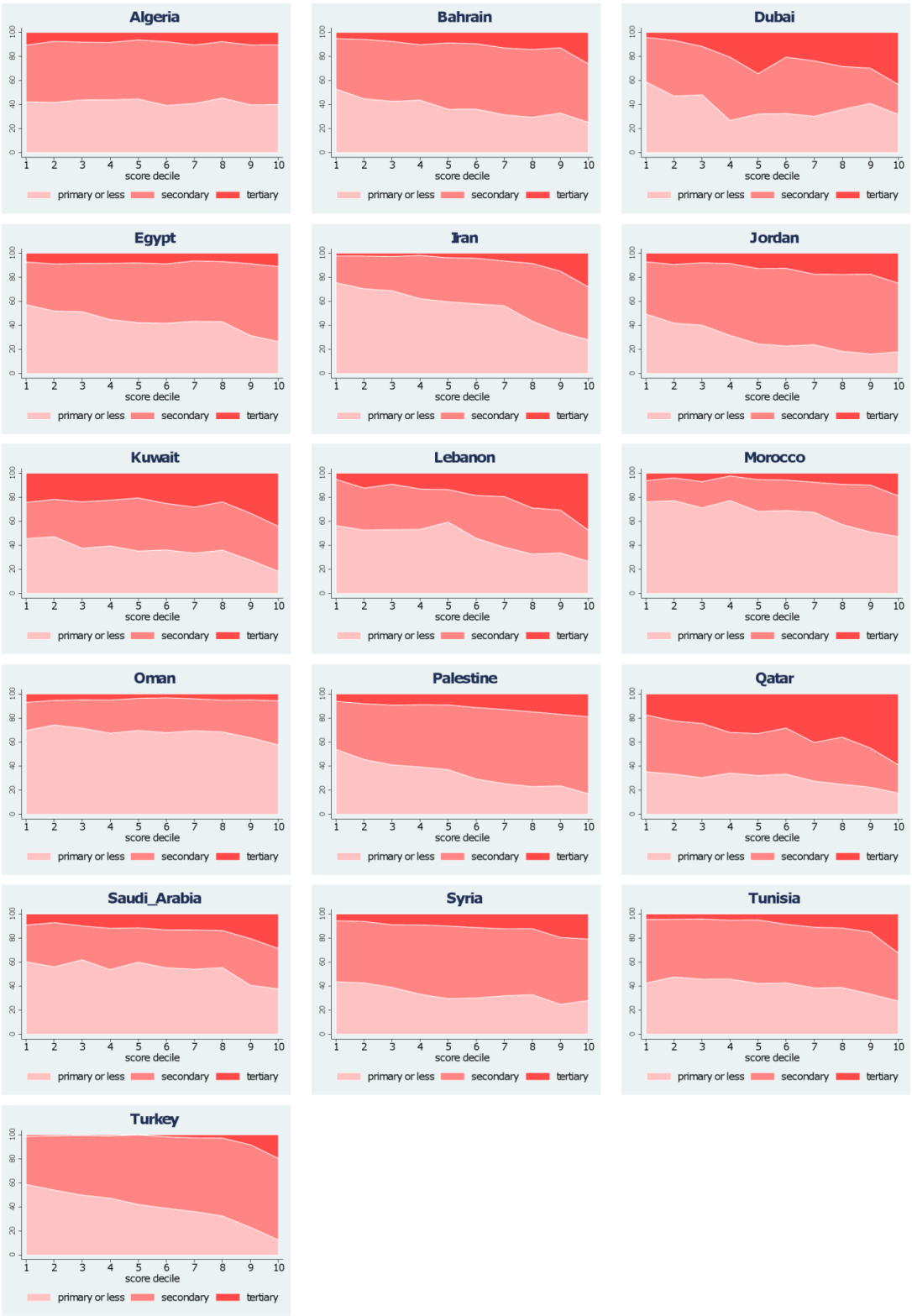

Figure 6: The Distribution of Science Scores by Mother's Education, 2007

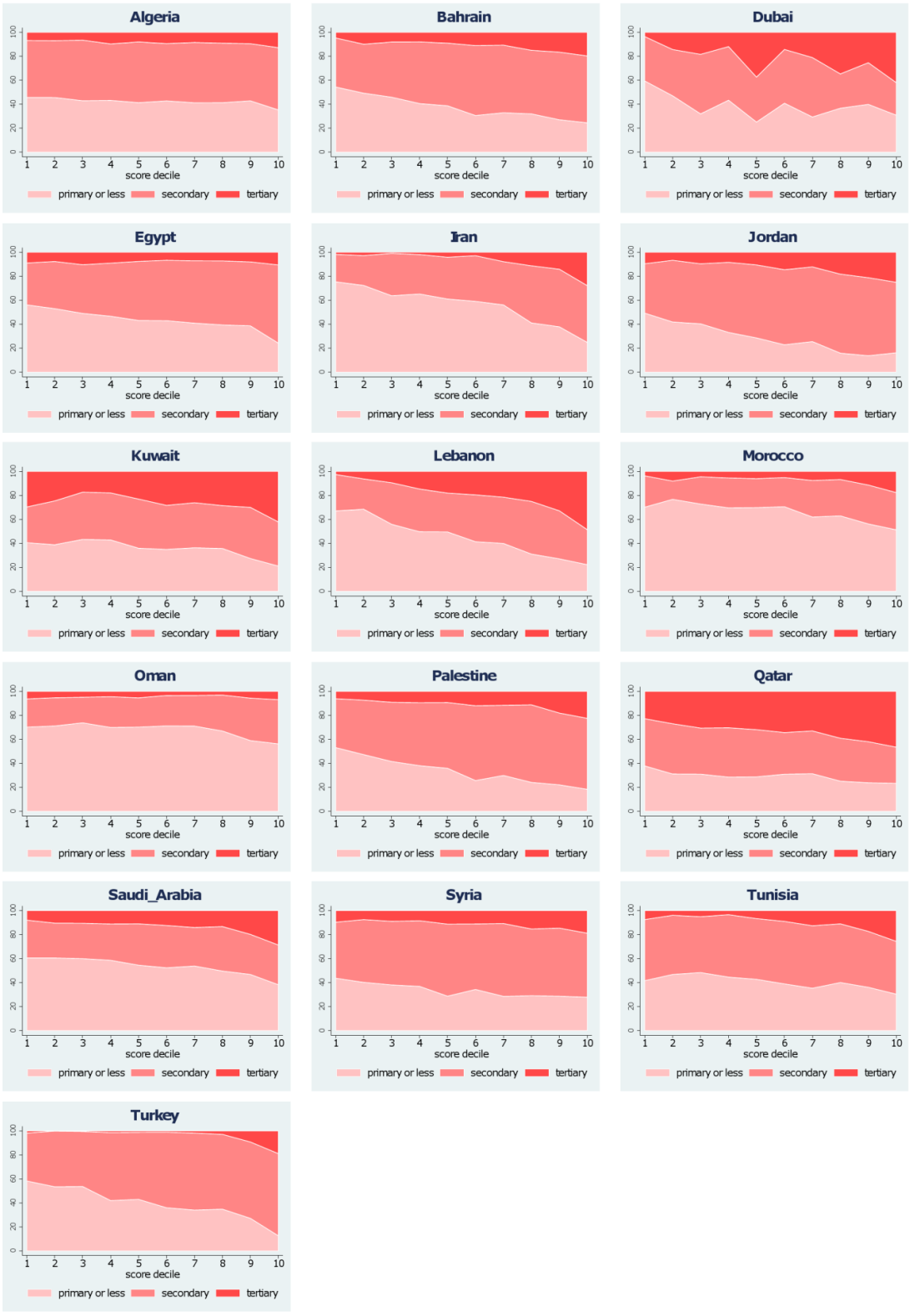

Figure 7: Inequality of Opportunity in Educational Achievement, 2007

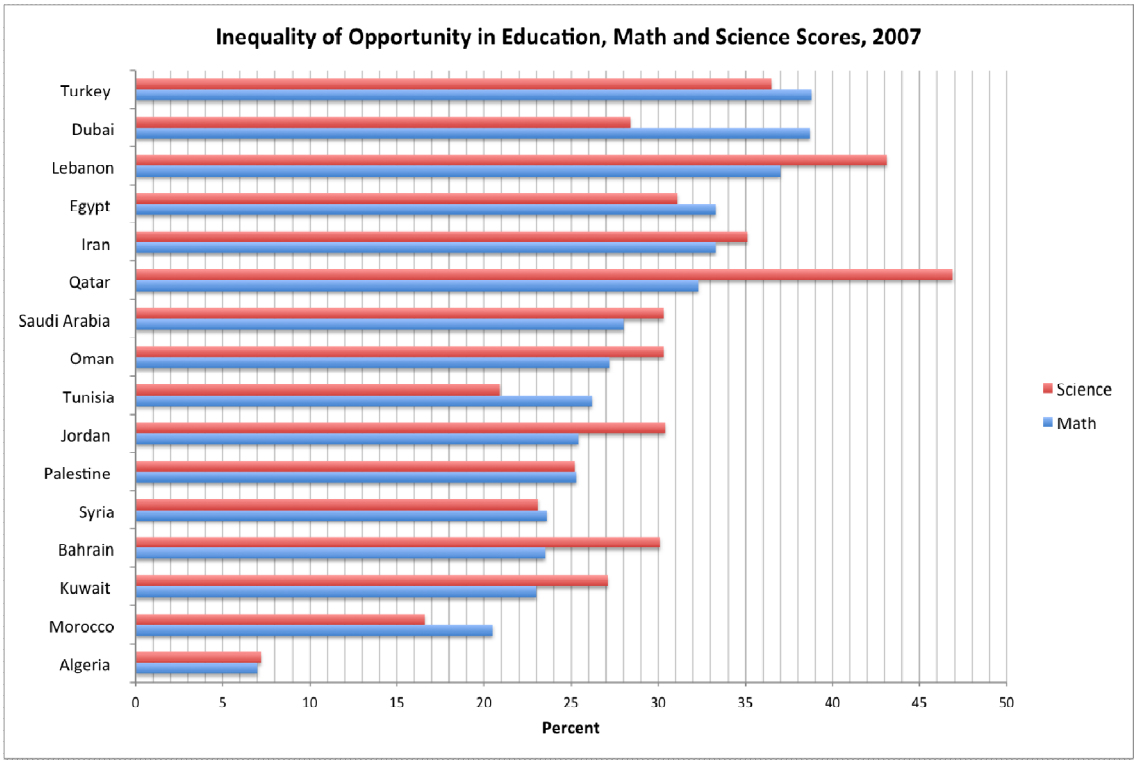

Figure 8: Decomposition of Inequality of Opportunity in Math Scores, 1999

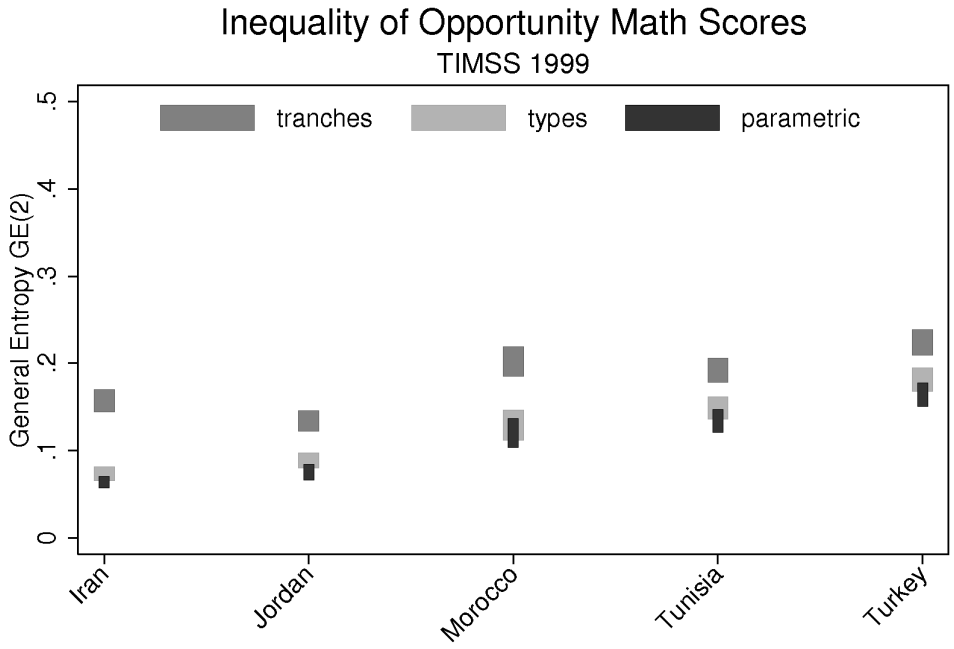

Figure 9: Decomposition of Inequality of Opportunity in Science Scores, 1999

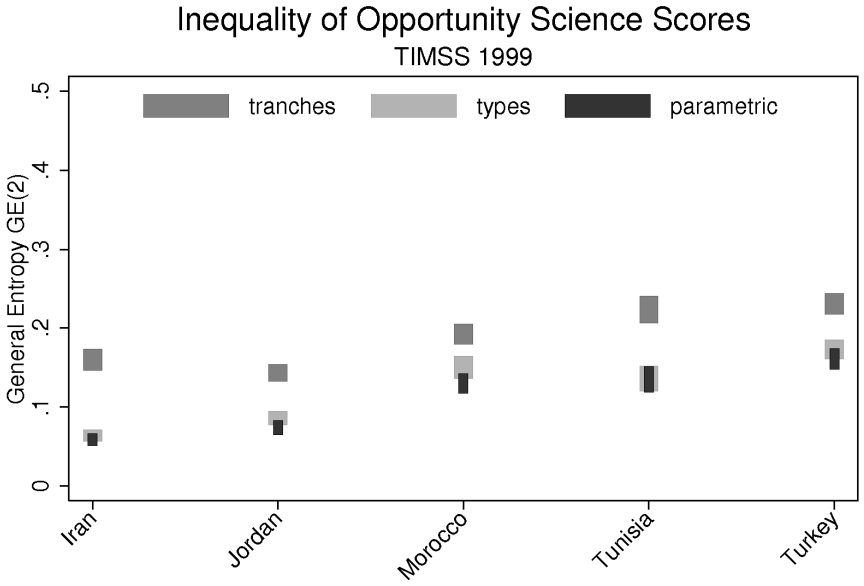

Figure 10: Decomposition of Inequality of Opportunity in Math Scores, 2003

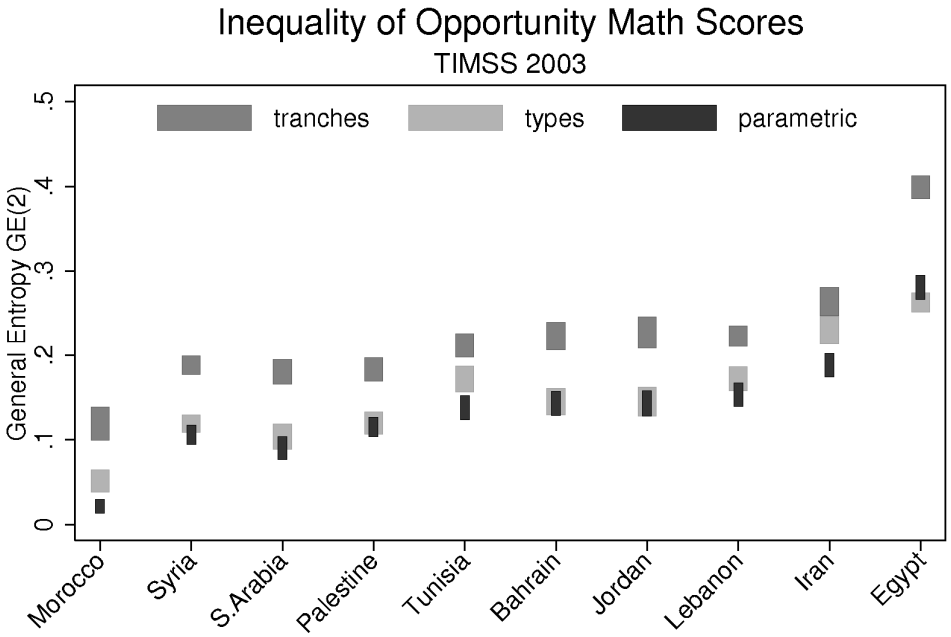

Figure 11: Decomposition of Inequality of Opportunity in Science Scores, 2003

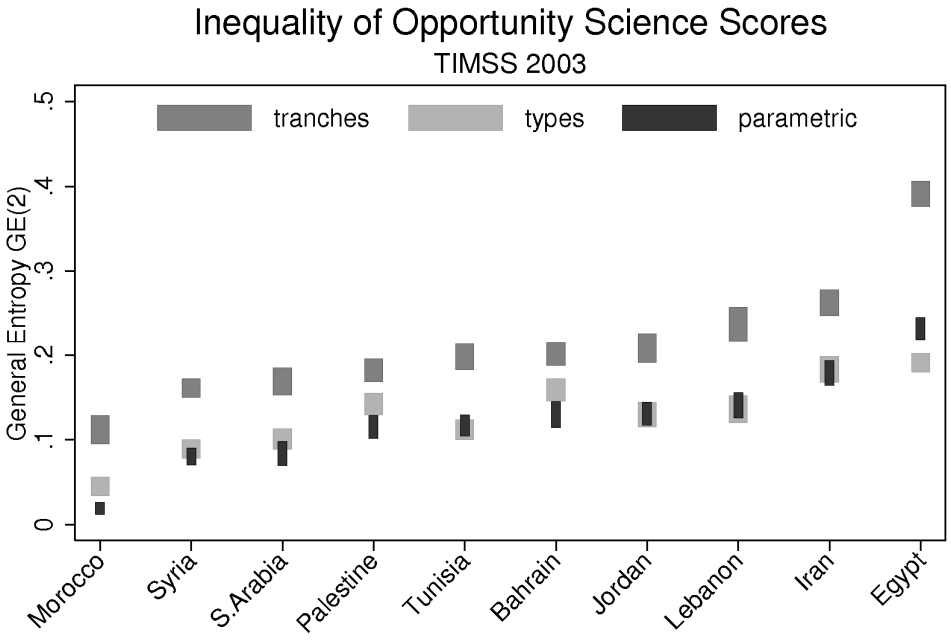

Figure 12: Decomposition of Inequality of Opportunity in Math Scores, 2007

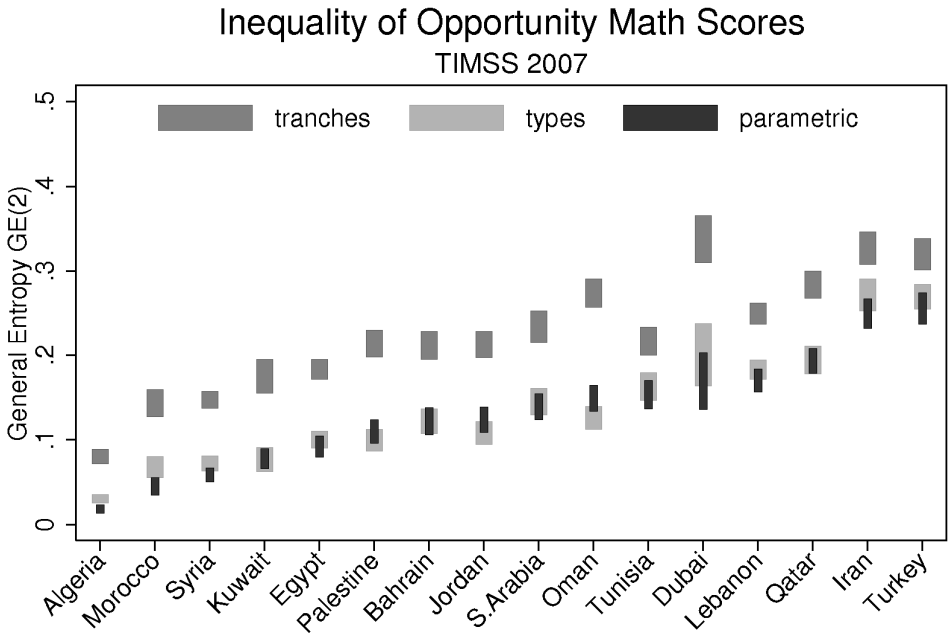

Figure 13: Decomposition of Inequality of Opportunity in Science Scores, 2007

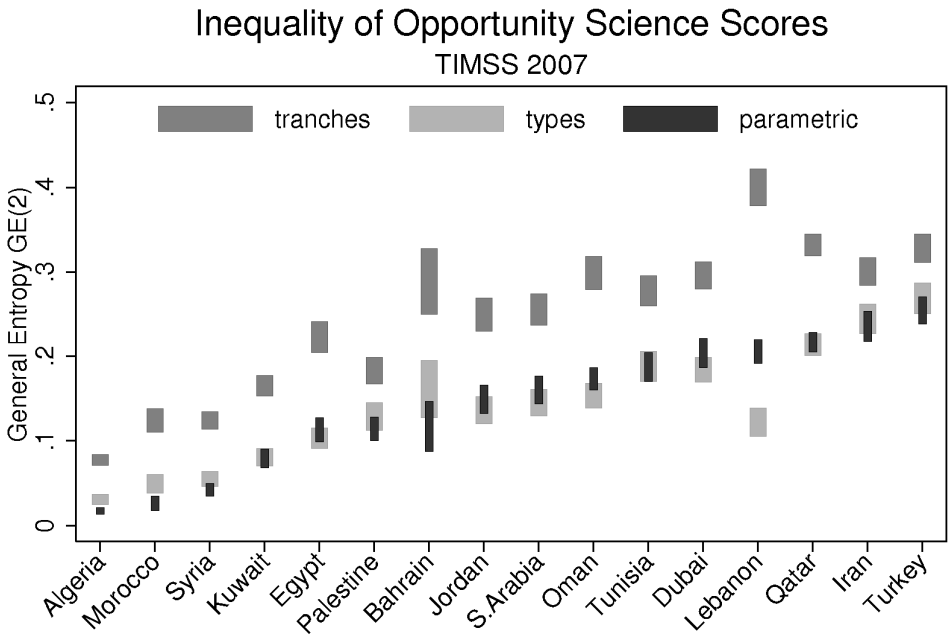

Table 1: Gross Enrollment Rates, Lower Secondary School

	Male			Female		
	1999	2003	2007	1999	2003	2007
Algeria	104	106	140	96	100	129
Bahrain	103	102	102	110	105	101
Egypt	88	91	90	80	84	88
Iran	109	109	100	94	97	91
Jordan	92	89	91	93	91	93
Kuwait	102	90	97	102	90	96
Lebanon	87	89	86	95	96	94
Morocco	54	63	81	42	51	68
Oman	89	97	94	85	88	90
Palestine	86	94	96	88	98	99
Qatar	88	102	108	92	104	124
Saudi Arabia		93	105		88	91
Syria	61	81	97	54	74	93
Tunisia	97	99	116	98	99	116
Turkey	86	96	96	64	83	87
UAE	84	85	101	83	83	100

Note: For some countries in some years the nearest available year is chosen.
Source: UNESCO education database.

Table 2: TIMSS Scores for Mathematics and Science, MENA Countries, 1999

1999	Boys				Girls			
	Mathematics		Science		Mathematics		Science	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Iran	431.8	76.4	460.6	74.3	408.1	73.3	429.6	71.4
Jordan	424.6	102.9	442.1	99.5	431.1	90.3	459.7	88.3
Morocco	343.7	72.7	330.2	80.3	326.3	71.1	312.3	80.6
Tunisia	460.4	54.7	442.4	55.0	435.8	56.8	417.0	52.2
Turkey	429.2	80.6	434.2	71.5	427.7	76.8	431.2	65.3

Note: Includes only students whose parents are born in the country.

Table 3: TIMSS Scores for Mathematics and Science, MENA Countries, 2003

2003	Boys				Girls			
	Mathematics		Science		Mathematics		Science	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Bahrain	385.9	73.0	423.8	72.0	417.1	64.4	452.5	61.5
Egypt	415.8	91.0	432.5	100.7	415.5	83.5	432.5	93.2
Iran	410.1	70.3	454.8	67.2	418.6	66.4	455.7	67.1
Jordan	408.9	81.4	460.7	85.1	438.1	81.4	487.8	80.8
Lebanon	442.2	63.2	399.8	86.9	434.9	61.7	400.2	85.4
Morocco	398.7	61.1	407.0	61.0	383.8	61.9	397.2	61.3
Palestine	392.0	85.3	434.6	88.5	398.3	84.1	445.4	81.7
Saudi Arabia	337.8	70.9	393.0	66.5	324.6	64.2	407.4	59.5
Syria	360.9	70.4	418.6	72.4	354.4	68.6	405.4	71.1
Tunisia	424.0	52.5	417.4	53.0	399.7	54.3	393.4	50.7

Note: Includes only students whose parents are born in the country.

Table 4: TIMSS Scores for Math and Science, MENA Countries, 2007

2007	Boys				Girls			
	Mathematics		Science		Mathematics		Science	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Algeria	389.4	52.4	407.7	53.6	384.1	53.0	408.3	55.8
Bahrain	383.3	81.7	437.4	81.3	415.4	67.8	499.5	65.1
Dubai	405.5	95.4	436.5	90.9	410.6	72.9	448.5	71.2
Egypt	395.5	95.6	411.1	94.4	403.8	91.9	423.3	91.2
Iran	401.6	84.1	454.8	77.4	407.4	78.6	465.9	75.4
Jordan	413.2	101.7	463.6	97.5	436.4	91.0	499.1	84.5
Kuwait	345.4	75.3	395.5	83.8	364.0	64.1	441.1	71.8
Lebanon	461.9	70.4	425.0	90.2	446.3	68.8	413.6	90.7
Morocco	389.7	75.4	404.4	71.6	378.5	74.8	404.9	71.8
Oman	350.0	90.8	396.4	91.2	402.1	76.1	455.3	75.9
Palestine	355.7	95.3	394.9	103.9	388.3	91.3	426.6	98.5
Qatar	279.9	86.7	274.1	119.5	317.3	74.1	332.0	99.4
Saudi Arabia	317.2	70.7	383.0	70.9	339.4	62.7	423.8	63.6
Syria	409.9	76.5	464.1	69.6	391.1	72.9	451.7	65.6
Tunisia	434.4	59.1	458.2	53.3	411.8	62.1	437.0	54.3
Turkey	434.7	106.1	454.3	89.2	433.0	102.7	457.5	84.8

Note: Includes only students whose parents are born in the country.

Table 5: TIMSS Mean Scores Over Time, 8th Grade

	Mathematics						
	Boys				Girls		
	1999	2003	2007		1999	2003	2007
Algeria			389.4				384.1
Bahrain		385.8	383.3			417.4	415.4
Dubai			395.5				410.6
Egypt		415.8	405.5			415.5	403.8
Iran	432.1	410.1	401.6		408.9	418.6	407.4
Jordan	413.7	409.0	413.2		421.1	438.0	436.4
Kuwait			345.4				364.0
Lebanon		442.0	461.9			435.0	446.3
Morocco	345.8	398.7	389.7		327.9	383.8	378.5
Oman			350.0				402.1
Palestine		392.1	355.7			398.3	388.3
Qatar			279.9				317.3
Saudi Arabia		337.8	317.2			324.6	339.4
Syria		360.9	409.9			354.4	391.1
Tunisia	460.5	424.0	434.4		436.3	399.7	411.8
Turkey	429.5		434.7	427.8			433.0
	Science						
	Boys				Girls		
	1999	2003	2007		1999	2003	2007
Algeria			407.8				408.4
Bahrain		423.9	437.4			452.2	499.5
Dubai			436.5				448.5
Egypt		432.5	411.1			432.4	423.3
Iran	461.2	454.8	454.8		430.8	455.7	465.9
Jordan	431.3	460.8	463.6		451.2	487.8	499.1
Kuwait			395.5				441.1
Lebanon		399.7	425.0			400.3	413.6
Morocco	334.2	407.0	404.4	315.5	397.2	404.9	
Oman			396.4				455.3
Palestine		434.7	394.9			445.3	426.6
Qatar			274.1				332.0
Saudi Arabia		393.0		383.0		407.3	423.8
Syria		418.6		464.1		405.4	451.7
Tunisia	442.7	417.4	458.2		417.3	393.4	437.0
Turkey	434.8		454.3		431.7		457.5

Note: Includes only students whose parents are born in the country.

Table 6: Decomposition of Inequality of TIMSS Math Scores for MENA Countries, 2007

	Total	Within	GE(2) Between	Between/Total	IOP	Gini
Low IOP						
Algeria	0.0093	0.0086	0.0007	0.0707	0.0699	0.0769
	(0.00011)	(0.00001)	(0.00004)		(0.00395)	(0.00044)
Morocco	0.0184	0.0146	0.0043	0.2310	0.2050	0.1090
	(0.00029)	(0.00022)	(0.00019)		(0.00817)	(0.00085)
Kuwait	0.0197	0.0152	0.0048	0.2431	0.2300	0.1120
	(0.00030)	(0.00024)	(0.00020)		(0.00829)	(0.00085)
Bahrain	0.0189	0.0145	0.0045	0.2360	0.2350	0.1110
	(0.00028)	(0.00024)	(0.00021)		(0.00901)	(0.00085)
Medium IOP						
Syria	0.0175	0.0134	0.0044	0.2537	0.2360	0.1060
	(0.00023)	(0.00019)	(0.00015)		(0.00630)	(0.00071)
Palestine	0.0320	0.0240	0.0084	0.2609	0.2530	0.1440
	(0.00045)	(0.00036)	(0.00032)		(0.00844)	(0.00106)
Jordan	0.0260	0.0194	0.0087	0.3350	0.2540	0.1300
	(0.00034)	(0.00031)	(0.00035)		(0.01040)	(0.00085)
Tunisia	0.0105	0.0078	0.0028	0.2619	0.2620	0.0821
	(0.00017)	(0.00013)	(0.00012)		(0.00903)	(0.00066)
Oman	0.0277	0.0202	0.0079	0.2856	0.2720	0.1340
	(0.00042)	(0.00034)	(0.00032)		(0.00863)	(0.00106)
Saudi Arabia	0.0216	0.0156	0.0059	0.2722	0.2800	0.1180
	(0.00037)	(0.00030)	(0.00028)		(0.00873)	(0.00103)
High IOP						
Qatar	0.0388	0.0263	0.0125	0.3222	0.3230	0.1560
	(0.00057)	(0.00039)	(0.00043)		(0.00823)	(0.00113)
Iran	0.0212	0.0142	0.0064	0.3009	0.3330	0.1160
	(0.00035)	(0.00022)	(0.00026)		(0.00835)	(0.00099)
Egypt	0.0267	0.0178	0.0088	0.3296	0.3330	0.1320
	(0.00033)	(0.00022)	(0.00031)		(0.00750)	(0.00084)
Lebanon	0.0111	0.0070	0.0045	0.4081	0.3700	0.0850
	(0.00012)	(0.00010)	(0.00012)		(0.00704)	(0.00048)
Dubai	0.0216	0.0132	0.0093	0.4301	0.3870	0.1180
	(0.00067)	(0.00042)	(0.00059)		(0.01700)	(0.00187)
Turkey	0.0306	0.0187	0.0112	0.3660	0.3880	0.1400
	(0.00040)	(0.00029)	(0.00041)		(0.00964)	(0.00091)

Note: IOP is estimated using the residual method. See Section 3

Table 7: Decomposition of Inequality of TIMSS Science Scores for MENA Countries, 2007

	Total	Within	GE(2) Between	Between/Total	IOP	Gini
Low IOP						
Algeria	0.0089	0.0083	0.0007	0.0740	0.0718	0.0755
	(0.00010)	(0.00009)	(0.000042)		(0.00413)	(0.00042)
Morocco	0.0151	0.0126	0.0029	0.1921	0.1660	0.0985
	(0.00022)	(0.00020)	(0.00015)		(0.00817)	(0.00074)
Tunisia	0.0075	0.0059	0.0016	0.2067	0.2090	0.0693
	(0.00011)	(0.00008)	(0.00008)		(0.00763)	(0.00050)
Syria	0.0108	0.0083	0.0027	0.2500	0.2310	0.0835
	(0.00014)	(0.00012)	(0.00010)		(0.00714)	(0.00054)
Medium IOP						
Palestine	0.0308	0.0231	0.0081	0.2636	0.2520	0.1420
	(0.00048)	(0.00037)	(0.00036)		(0.00928)	(0.00112)
Kuwait	0.0187	0.0137	0.0052	0.2786	0.2710	0.1100
	(0.00030)	(0.00023)	(0.00022)		(0.00909)	(0.00092)
Dubai	0.0173	0.0124	0.0056	0.3225	0.2840	0.1060
	(0.00050)	(0.00040)	(0.00039)		(0.01600)	(0.00156)
High IOP						
Bahrain	0.0145	0.0101	0.0046	0.3166	0.3010	0.0969
	(0.00024)	(0.00018)	(0.00020)		(0.00967)	(0.00079)
Oman	0.0219	0.0152	0.0069	0.3151	0.3030	0.1190
	(0.00034)	(0.00023)	(0.00026)		(0.00865)	(0.00094)
Saudi Arabia	0.0154	0.0107	0.0046	0.3006	0.3030	0.0996
	(0.00025)	(0.00020)	(0.00020)		(0.00920)	(0.00082)
Jordan	0.0189	0.0131	0.0068	0.3608	0.3040	0.1110
	(0.00030)	(0.00021)	(0.00028)		(0.01010)	(0.00089)
Egypt	0.0234	0.0161	0.0079	0.3393	0.3110	0.1230
	(0.00029)	(0.00022)	(0.00028)		(0.00721)	(0.00079)
Iran	0.0145	0.0094	0.0046	0.3172	0.3510	0.0967
	(0.00022)	(0.00015)	(0.00016)		(0.00821)	(0.00076)
Turkey	0.0192	0.0122	0.0067	0.3479	0.3650	0.1110
	(0.00026)	(0.00020)	(0.00021)		(0.00839)	(0.00075)
Lebanon	0.0203	0.0115	0.0101	0.4975	0.4310	0.1150
	(0.00025)	(0.00015)	(0.000240)		(0.00610)	(0.00071)
Qatar	0.0698	0.0371	0.0327	0.4685	0.4690	0.2140
	(0.00104)	(0.00057)	(0.00079)		(0.00659)	(0.00165)

Note: IOP is estimated using the residual method. See Section 3

Table 8: Inequality of Opportunity Shares for Achievements in Mathematics, 1999

	Iran	Jordan	Morocco	Tunisia	Turkey
All circumstances	0.237***	0.272***	0.145***	0.194***	0.176***
	(0.00734)	(0.00888)	(0.00549)	(0.00715)	(0.00644)
Shares of combined circumstances					
Family Background	0.162***	0.247***	0.103***	0.088***	0.142***
	(0.00717)	(0.00877)	(0.00551)	(0.00625)	(0.00588)
Community characteristics	0.061***	0.034***	0.021***	0.084***	0.058***
	(0.00573)	(0.00531)	(0.00228)	(0.00504)	(0.00415)
Shares of individual circumstances					
Gender	0.015***	-0.006*	0.013***	0.046***	-0.004***
	(0.00317)	(0.00283)	(0.00184)	(0.00397)	(0.00077)
Mother's Education	0.053***	0.069***	0.020***	0.026***	0.041***
	(0.00743)	(0.00822)	(0.00323)	(0.00417)	(0.00562)
Father's Education	0.051***	0.064***	0.018***	0.031***	0.054***
	(0.00701)	(0.00736)	(0.00384)	(0.00481)	(0.00480)
Books at home	0.065***	0.069***	0.030***	0.038***	0.044***
	(0.00499)	(0.00636)	(0.00282)	(0.00408)	(0.00381)
Community type	0.056***	0.010**	0.013***	0.031***	0.001
	(0.00466)	(0.00299)	(0.00208)	(0.00358)	(0.00242)
Computer at home	-0.003	-0.001	0.001	0.002	0.006***
	(0.00198)	(0.00157)	(0.00075)	(0.00245)	(0.00190)

Table 9: Inequality of Opportunity Shares for Achievements in Science, 1999

	Iran	Jordan	Morocco	Tunisia	Turkey
All circumstances	0.252***	0.292***	0.154***	0.184***	0.166***
	(0.00722)	(0.00984)	(0.00526)	(0.00701)	(0.00497)
Shares of combined circumstances					
Family Background	0.175***	0.273***	0.110***	0.065***	0.144***
	(0.00688)	(0.01010)	(0.00517)	(0.00534)	(0.00499)
Community characteristics	0.0461***	0.032***	0.018***	0.084***	0.041***
	(0.00493)	(0.00523)	(0.00231)	(0.00484)	(0.00315)
Shares of individual circumstances					
Gender	0.022***	0.003	0.008***	0.055***	-0.003***
	(0.00391)	(0.00410)	(0.00172)	(0.00465)	(0.00065)
Mother's Education	0.058***	0.070***	0.028***	0.021***	0.046***
	(0.00680)	(0.00771)	(0.00316)	(0.00381)	(0.00517)
Father's Education	0.058***	0.064***	0.018***	0.026***	0.057***
	(0.00700)	(0.00723)	(0.00345)	(0.00402)	(0.00451)
Books at home	0.057***	0.086***	0.041***	0.019***	0.037***
	(0.00463)	(0.00744)	(0.00307)	(0.00350)	(0.00409)
Community type	0.038***	0.013***	0.012***	0.045***	0.001
	(0.00376)	(0.00337)	(0.00180)	(0.00433)	(0.00200)
Computer at home	0.004	-0.001	-0.002***	-0.008***	0.003
	(0.00283)	(0.00150)	(0.000395)	(0.00166)	(0.00174)

Table 10: Inequality of Opportunity Shares for Achievements in Mathematics, 2003

	Bahrain	Palestine	Iran	Jordan	Lebanon	Morocco	S. Arabia	Syria	Tunisia	Egypt
All circumstances	0.287***	0.238***	0.273***	0.324***	0.336***	0.186***	0.154***	0.210***	0.244***	0.391***
	(0.01030)	(0.00668)	(0.00906)	(0.00928)	(0.00714)	(0.00982)	(0.00993)	(0.00684)	(0.00817)	(0.00726)
Shares of combined circumstances										
Family Background	0.162***	0.174***	0.170***	0.181***	0.162***	0.075***	0.124***	0.0411*	0.121***	0.345***
	(0.00834)	(0.00629)	(0.00875)	(0.00847)	(0.00667)	(0.00718)	(0.00771)	(0.01600)	(0.00680)	(0.00763)
Community characteristics	0.0518***	0.0598***	0.163***	0.0665***	0.239***	0.077***	0.039***	0.087***	0.109***	0.056***
	(0.00755)	(0.00489)	(0.00729)	(0.01800)	(0.00646)	(0.00786)	(0.00820)	(0.00490)	(0.00701)	(0.00748)
Shares of individual circumstances										
Gender	0.049***	0.001	0.002*	0.031***	0.010***	0.011***	0.000	0.001	0.048***	0.001
	(0.00459)	(0.00104)	(0.00094)	(0.00638)	(0.00202)	(0.00336)	(0.00631)	(0.00075)	(0.00431)	(0.00083)
Mother's Education	0.055***	0.084***	0.041***	0.054***	0.057***	0.015**	0.048***	0.057***	0.018**	0.165***
	(0.00655)	(0.00573)	(0.00789)	(0.00780)	(0.00728)	(0.00484)	(0.00568)	(0.00604)	(0.00627)	(0.0145)
Father's Education	0.060***	0.086***	0.047***	0.058***	0.051***	0.024***	0.042***	0.086***	0.062***	0.201***
	(0.00695)	(0.00565)	(0.00831)	(0.00658)	(0.00585)	(0.00503)	(0.00870)	(0.00556)	(0.00562)	(0.01150)
Books at home	0.054***	0.034***	0.088***	0.059***	0.081***	0.004	0.045***	0.033***	0.047***	0.035***
	(0.00532)	(0.00442)	(0.00667)	(0.00738)	(0.00576)	(0.00369)	(0.00542)	(0.00331)	(0.00506)	(0.00612)
Community type	0.020***	0.010***	0.077***	0.000	-0.010*	0.014***	0.033***	0.016***	0.020***	0.023***
	(0.00430)	(0.00242)	(0.00732)	(0.00316)	(0.00465)	(0.00401)	(0.00554)	(0.00297)	(0.00417)	(0.00689)
Computer at home	0.021***	0.024***	0.005	0.043***	0.007	-0.001	0.014**	0.003	0.014**	0.054***
	(0.00393)	(0.00354)	(0.00367)	(0.00545)	(0.00390)	(0.00208)	(0.00485)	(0.00205)	(0.00470)	(0.00852)
Internet at home	0.015***	-0.006***	0.000	-0.002	-0.009***	-0.001	0.000	0.000	0.000	0.000
	(0.00408)	(0.00170)	(0.00000)	(0.00406)	(0.00247)	(0.00060)	(0.00000)	(0.00000)	(0.00000)	(0.00000)

Table 11: Inequality of Opportunity Shares for Achievements in Science, 2003

	Bahrain	Palestine	Iran	Jordan	Lebanon	Morocco	S. Arabia	Syria	Tunisia	Egypt
All circumstances	0.239***	0.247***	0.207***	0.329***	0.324***	0.181***	0.161***	0.168***	0.199***	0.348***
	(0.00847)	(0.00857)	(0.00723)	(0.0110)	(0.00639)	(0.0108)	(0.00999)	(0.00663)	(0.00827)	(0.00685)
Shares of combined circumstances										
Family Background	0.150***	0.174***	0.132***	0.199***	0.192***	0.034***	0.106***	0.026	0.093***	0.306***
	(0.00797)	(0.00811)	(0.00720)	(0.01000)	(0.00793)	(0.00655)	(0.008110)	(0.01750)	(0.00554)	(0.00752)
Community characteristics	0.024***	0.054***	0.115***	0.060***	0.210***	0.088***	-0.024	0.066***	0.072***	0.049***
	(0.00622)	(0.00627)	(0.00624)	(0.01230)	(0.00737)	(0.00848)	(0.02450)	(0.00469)	(0.00527)	(0.00675)
Shares of individual circumstances										
Gender	0.042***	0.004*	-0.001	0.017	0.002*	0.004	0.014	0.005***	0.051***	0.000
	(0.00448)	(0.00145)	(0.00075)	(0.00891)	(0.00078)	(0.00350)	(0.00890)	(0.00134)	(0.00427)	(0.00080)
Mother's Education	0.058***	0.083***	0.040***	0.070***	0.065***	0.011**	0.040***	0.047***	0.009*	0.151***
	(0.00715)	(0.00595)	(0.00815)	(0.00822)	(0.00658)	(0.00403)	(0.00541)	(0.00473)	(0.00463)	(0.01230)
Father's Education	0.064***	0.083***	0.047***	0.063***	0.043***	0.021***	0.033***	0.070***	0.050***	0.187***
	(0.00744)	(0.00616)	(0.00661)	(0.00877)	(0.00594)	(0.00438)	(0.00813)	(0.00437)	(0.00531)	(0.01050)
Books at home	0.050***	0.033***	0.056***	0.068***	0.103***	0.000	0.043***	0.021***	0.040***	0.032***
	(0.00557)	(0.00445)	(0.00535)	(0.00765)	(0.00563)	(0.00662)	(0.00478)	(0.00335)	(0.00484)	(0.00672)
Community type	0.001	0.009***	0.052***	-0.001	-0.003	0.020***	0.006	0.019***	0.007	0.021***
	(0.00360)	(0.00190)	(0.00539)	(0.00240)	(0.00402)	(0.00478)	(0.00340)	(0.00289)	(0.00333)	(0.00617)
Computer at home	0.013***	0.026***	-0.009**	0.028***	0.018***	-0.002	0.012**	-0.003*	-0.005	0.042***
	(0.00381)	(0.00407)	(0.00339)	(0.00482)	(0.00349)	(0.00103)	(0.00392)	(0.00162)	(0.00320)	(0.00861)
Internet at home	0.009**	-0.006***	0.000	0.007	-0.010***	-0.001	0.000	0.000	0.000	0.000
	(0.00320)	(0.00154)	(0.00000)	(0.00421)	(0.00300)	(0.00056)	(0.00000)	(0.00000)	(0.00000)	(0.00000)

Table 12: Inequality of Opportunity Shares for Achievements in Mathematics, 2007

	Algeria	Bahrain	Palestine	Iran	Jordan	Kuwait	Lebanon	Morocco	Oman	Qatar	S. Arabia	Syria	Tunisia	Turkey	Egypt	Dubai
All circumstances																
	0.070***	0.235***	0.253***	0.333***	0.254***	0.230***	0.370***	0.205***	0.272***	0.323***	0.280***	0.236***	0.262***	0.388***	0.333***	0.387***
	(0.00395)	(0.00901)	(0.00844)	(0.00835)	(0.01040)	(0.00829)	(0.00704)	(0.00817)	(0.00863)	(0.00823)	(0.00873)	(0.00630)	(0.00903)	(0.00960)	(0.00750)	(0.01700)
Shares of combined circumstances																
Family Background	0.040***	0.159***	0.148***	0.279***	0.200***	0.114***	0.140***	0.0689***	0.138***	0.152***	0.162***	0.077***	0.185***	0.313***	0.164***	0.121***
	(0.00340)	(0.00748)	(0.00730)	(0.00885)	(0.00838)	(0.00740)	(0.00599)	(0.00577)	(0.00690)	(0.00613)	(0.00771)	(0.00487)	(0.01030)	(0.01000)	(0.00648)	(0.01480)
Community characteristics	0.026***	0.072***	0.112***	0.122***	0.050***	0.090***	0.276***	0.118***	0.113***	0.137***	0.041***	0.125***	0.078***	0.175***	0.101***	0.217***
	(0.00252)	(0.00732)	(0.00709)	(0.00934)	(0.00777)	(0.00729)	(0.00731)	(0.00772)	(0.01090)	(0.00827)	(0.01210)	(0.00667)	(0.00553)	(0.00950)	(0.00604)	(0.01710)
Shares of individual circumstances																
Gender	0.003**	0.028***	-0.007	-0.000	0.010	0.007	0.01***	-0.002	0.038**	0.055***	0.031***	0.016***	0.031***	-0.002*	0.001	0.000
	(0.00085)	(0.00460)	(0.01240)	(0.00066)	(0.00551)	(0.00707)	(0.00163)	(0.00155)	(0.01440)	(0.00487)	(0.00474)	(0.00235)	(0.00430)	(0.00094)	(0.00072)	(0.00750)
Mother's Education	0.012***	0.045***	0.055***	0.079***	0.081***	0.038***	0.046***	0.033***	0.023***	0.037***	0.034***	0.031***	0.042***	0.092***	0.060***	0.073***
	(0.00239)	(0.00663)	(0.00627)	(0.01300)	(0.00843)	(0.00497)	(0.00583)	(0.00461)	(0.00450)	(0.00515)	(0.00701)	(0.00408)	(0.00819)	(0.00980)	(0.00782)	(0.01470)
Father's Education	0.013***	0.044***	0.058***	0.100***	0.082***	0.030***	0.065***	0.022***	0.025***	0.043***	0.042***	0.038***	0.047***	0.129***	0.078***	0.084***
	(0.00238)	(0.00685)	(0.00583)	(0.01190)	(0.00724)	(0.00431)	(0.00579)	(0.00539)	(0.00381)	(0.00483)	(0.00718)	(0.00362)	(0.00780)	(0.00906)	(0.00716)	(0.01660)
Books at home	0.017***	0.067***	0.037***	0.071***	0.050***	0.024***	0.038***	0.020***	0.060***	0.047***	0.068***	0.012***	0.095***	0.105***	0.026***	0.069***
	(0.00235)	(0.00657)	(0.00489)	(0.00841)	(0.00569)	(0.00441)	(0.00482)	(0.00400)	(0.00531)	(0.00407)	(0.00668)	(0.00259)	(0.00794)	(0.00802)	(0.00486)	(0.01150)
Community type	0.003*	-0.003	0.018***	0.095***	-0.015**	0.003	0.032***	0.017***	0.013***	0.085***	0.010**	-0.004	0.014***	0.041***	0.010	0.017
	(0.00126)	(0.00229)	(0.00318)	(0.00741)	(0.00583)	(0.00314)	(0.00419)	(0.00418)	(0.00311)	(0.00775)	(0.00387)	(0.00306)	(0.00386)	(0.00498)	(0.00529)	(0.03940)
Computer at home	-0.002***	0.004*	0.025***	0.047***	0.043***	0.032***	0.018***	0.018***	0.042***	0.046***	0.012**	-0.002	0.051***	0.021**	0.012*	0.014
	(0.00046)	(0.00173)	(0.00423)	(0.00936)	(0.00498)	(0.00383)	(0.00373)	(0.00454)	(0.00382)	(0.00401)	(0.00439)	(0.00148)	(0.00643)	(0.00664)	(0.00537)	(0.00753)
Internet at home	-0.001*	0.016***	0.006*	0.032**	0.001	0.013***	-0.011**	-0.002	0.015***	0.002	0.041***	0.007***	-0.004	0.025***	-0.004	0.031**
	(0.00024)	(0.00364)	(0.00287)	(0.01050)	(0.00263)	(0.00288)	(0.00369)	(0.00234)	(0.00323)	(0.00346)	(0.00674)	(0.00155)	(0.00548)	(0.00746)	(0.00590)	(0.01010)

Table 13: Inequality of Opportunity Shares for Achievements in Science, 2007

	Algeria	Bahrain	Palestine	Iran	Jordan	Kuwait	Lebanon	Morocco	Oman	Qatar	S. Arabia	Syria	Tunisia	Turkey	Egypt	Dubai
All circumstances																
	0.072***	0.301***	0.252***	0.351***	0.304***	0.271***	0.431***	0.166***	0.303***	0.469***	0.303***	0.231***	0.209***	0.365***	0.311***	0.284***
	(0.00413)	(0.00967)	(0.00928)	(0.00821)	(0.01010)	(0.00909)	(0.00610)	(0.00817)	(0.00865)	(0.00659)	(0.00920)	(0.00714)	(0.00763)	(0.00941)	(0.00721)	(0.01600)
Shares of combined circumstances																
Family Background	0.046***	0.138***	0.149***	0.304***	0.220***	0.091***	0.225***	0.042***	0.154***	0.293***	0.142***	0.088***	0.123***	0.309***	0.136***	0.069***
	(0.00338)	(0.00685)	(0.00765)	(0.00867)	(0.00945)	(0.00685)	(0.00656)	(0.00596)	(0.00850)	(0.00718)	(0.00807)	(0.00502)	(0.00810)	(0.00902)	(0.00702)	(0.0123)
Community characteristics	0.025***	0.084***	0.101***	0.111***	0.047***	0.130***	0.301***	0.107***	0.132***	0.195***	-0.018	0.098***	0.067***	0.141***	0.090***	0.167***
	(0.00289)	(0.00917)	(0.00747)	(0.00964)	(0.00979)	(0.0102)	(0.00621)	(0.00669)	(0.01080)	(0.00803)	(0.01960)	(0.00547)	(0.00594)	(0.00874)	(0.00655)	(0.01540)
Shares of individual circumstances																
Gender	-0.000	0.118***	-0.012	0.000	0.039***	0.067***	0.004***	0.000	0.051***	0.067***	0.095***	0.008***	0.035***	-0.002**	0.003**	-0.001
	(0.000138)	(0.00700)	(0.00989)	(0.00163)	(0.00494)	(0.00968)	(0.000913)	(0.000790)	(0.01390)	(0.00387)	(0.00670)	(0.00161)	(0.00400)	(0.000601)	(0.00111)	(0.01170)
Mother's Education	0.015***	0.050***	0.059***	0.088***	0.097***	0.020***	0.094***	0.019***	0.033***	0.019***	0.0302***	0.032***	0.0278***	0.082***	0.047***	0.052***
	(0.00268)	(0.00558)	(0.00531)	(0.01340)	(0.00897)	(0.00430)	(0.00624)	(0.00424)	(0.00525)	(0.00292)	(0.00710)	(0.00409)	(0.00658)	(0.00965)	(0.00780)	(0.01270)
Father's Education	0.020***	0.030***	0.055***	0.106***	0.080***	0.020***	0.083***	0.018***	0.025***	0.019***	0.033***	0.036***	0.037***	0.135***	0.066***	0.044**
	(0.00242)	(0.00582)	(0.00636)	(0.01160)	(0.00756)	(0.00407)	(0.00614)	(0.00484)	(0.00440)	(0.00284)	(0.00811)	(0.00412)	(0.00600)	(0.00917)	(0.00690)	(0.01410)
Books at home	0.020***	0.057***	0.045***	0.085***	0.057***	0.042***	0.064***	0.010**	0.062***	0.034***	0.073***	0.019***	0.064***	0.100***	0.026***	0.064***
	(0.00243)	(0.00696)	(0.00540)	(0.00852)	(0.00634)	(0.00489)	(0.00510)	(0.00346)	(0.00607)	(0.00357)	(0.00667)	(0.00267)	(0.00604)	(0.00720)	(0.00476)	(0.01200)
Community type	0.000	-0.003	0.011***	0.084***	-0.011*	0.005	0.046***	0.012***	0.017***	0.130***	0.008*	-0.005*	0.008**	0.036***	0.014**	-0.019
	(0.00122)	(0.00290)	(0.00263)	(0.00781)	(0.00475)	(0.00331)	(0.00393)	(0.00341)	(0.00309)	(0.00742)	(0.00316)	(0.00233)	(0.00306)	(0.00479)	(0.00476)	(0.03450)
Computer at home	-0.002***	0.001	0.016***	0.044***	0.040***	0.022***	0.024***	0.008**	0.046***	0.021***	0.004	0.000	0.007	0.025***	0.008*	0.008
	(0.00059)	(0.00090)	(0.00395)	(0.00933)	(0.00520)	(0.00373)	(0.00400)	(0.00301)	(0.00463)	(0.00251)	(0.00401)	(0.00124)	(0.00483)	(0.00612)	(0.00413)	(0.00621)
Internet at home	-0.001**	0.005	0.010***	0.018	0.005	0.001	-0.018***	0.000	0.012***	-0.003*	0.029***	-0.002*	-0.013***	0.017**	-0.005	0.002
	(0.00030)	(0.00234)	(0.00293)	(0.01020)	(0.00298)	(0.00137)	(0.00352)	(0.00150)	(0.00286)	(0.00145)	(0.00579)	(0.00097)	(0.00314)	(0.00596)	(0.00441)	(0.00629)

Table 14: Summary of the Parametric Estimates of Inequality of Opportunity in Educational Achievement, 1999-2007 (percent)

	1999		2003		2007	
	Math	**Science**	**Math**	**Science**	**Math**	**Science**
Algeria					7.0	7.2
Morocco	14.5	15.4	18.6	18.1	20.5	16.6
Kuwait					23.0	27.1
Bahrain			28.7	23.9	23.5	30.1
Syria			21.0	16.8	23.6	23.1
Palestine			23.8	24.7	25.3	25.2
Jordan	27.2	29.2	32.4	32.9	25.4	30.4
Tunisia	19.4	18.4	24.4	19.9	26.2	20.9
Oman					27.2	30.3
S. Arabia			15.4	16.1	28.0	30.3
Qatar					32.3	46.9
Egypt			39.1	34.8	33.3	31.1
Iran	23.7	25.2	27.3	20.7	33.3	35.1
Lebanon			33.6	32.4	37.0	43.1
Dubai					38.7	28.4
Turkey	17.6	16.6			38.8	36.5

Source: Tables 8 -13.

Table 15: The Contribution of Family Background and Community Characteristics to IOP, Mathematics, 2007

	Algeria	**Bahrain**	**Palestine**	**Iran**	**Jordan**	**Kuwait**	**Lebanon**	**Morocco**
All circumstances	0.070	0.235	0.253	0.333	0.254	0.230	0.370	0.205
Shares of combined circumstances								
Family Background	0.040	0.159	0.148	0.279	0.200	0.114	0.140	0.069
Share FB	0.572	0.677	0.585	0.838	0.787	0.496	0.378	0.336
Community variables	0.026	0.072	0.112	0.122	0.050	0.090	0.276	0.118
Share of CC	0.366	0.307	0.443	0.366	0.195	0.390	0.746	0.576

	Oman	**Qatar**	**S. Arabia**	**Syria**	**Tunisia**	**Turkey**	**Egypt**	**Dubai**
All circumstances	0.272	0.323	0.280	0.236	0.262	0.388	0.333	0.387
Shares of combined circumstances								
Family Background	0.138	0.152	0.162	0.077	0.185	0.313	0.164	0.121
Share FB	0.507	0.471	0.579	0.325	0.706	0.807	0.492	0.313
Community variables	0.113	0.137	0.041	0.125	0.078	0.175	0.101	0.217
Share of CC	0.415	0.424	0.148	0.530	0.297	0.451	0.303	0.561