INEQUALITY OF OPPORTUNITY IN CHILD HEALTH IN THE ARAB WORLD AND TURKEY

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It is by now well established in the public health literature that health and nutrition in the first years of life are critical to health and wellbeing later in life. In this paper, we examine the patterns of inequality of opportunity in health and nutrition outcomes, such as height-for-age and weight-for-height, for children under 5 years of age in selected Arab Countries and Turkey, using Demographic and Health Survey (DHS) data. Our objective is to decompose inequality into a portion that is due to inequality of opportunity and a portion that is due to other factors, such as random variations in health and genetics. Inequality of opportunity is defined as the inequality that is due to differences in circumstances, such as parental characteristics, household wealth, place of birth and gender. We measure inequality using decomposable general entropy measures, such as the Theil-T index, and use parametric decomposition methods to determine the share of inequality of opportunity in total inequality.

Results show that different levels and trends are evident across countries in both the overall inequality of child health outcomes and in the share of inequality of opportunity in total inequality. Inequality of opportunity is shown to contribute substantially to the inequality of child health outcomes, but its share in total inequality varies significantly both across countries and within countries over time. To further highlight the relative contribution of circumstances to the inequality of child health outcomes in different countries, we simulate height and weight outcomes for a most and least advantaged child in each context. Since these simulations set observed circumstances at their best and worst levels, the larger the difference in predicted outcomes between the most and least advantaged child, the larger is the inequality of opportunity facing children in that country.

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1. Introduction

It is by now well established in the public health literature that health and nutrition in the first years of life are crucial to health and wellbeing later in life. Poor health and inadequate nutrition in the first three years of life hamper a child's subsequent cognitive and physical development, leading to adverse health, productivity and wellbeing outcomes that persist into adulthood. Growth and development in childhood is determined by genotype (nature) and phenotype (nurture), with the influence of the latter being particularly crucial in the first two or three years of life (Martorell and Habicht 1986). Because parental inputs, such as the quantity and quality of food, and public health inputs, such as the availability of clean water and sanitation are unequally distributed across children, inequality of opportunity can be an important contributor to the observed inequality in child health outcomes, and, as such, an important source of inequality of opportunity later in life.

In this paper, we examine the patterns of inequality of opportunity in child health in selected Arab Countries and Turkey. Using Demographic and Health Survey (DHS) data we examine health outcomes as measured by anthropometric measures (such as height and weight) for children age five and younger in Egypt, Jordan, Morocco, and Turkey across a number of years to assess total inequality as well as the share of inequality that is attributable to unequal circumstances, such as parental education, parental wealth and place of residence. These anthropometric indicators are commonly used to assess both long-term and short-term malnutrition among children under five. Since malnutrition in childhood is the result of both inadequate food intake as well as an inability to absorb or assimilate nutrients due to disease or infections, it is a good indicator of the child's overall health.

It is standard practice in child health studies to use z-scores computed by comparing the observed anthropometric measures to reference distributions of height and weight for healthy children of the same age and sex. Since the transformations involved in computing these distributions would alter the scale of the measure and therefore change inequality indices in arbitrary ways, we rely instead on standardized height and weight measures that retain the original scale of the measures (i.e., centimeters and kilograms) but standardize for age and sex differences (see Pradhan, Sahn and Younger 2003).

Because our objective is to decompose inequality into a portion that is due to inequality of opportunity and a portion that is due to other factors, such as random variations in health, we measure inequality using decomposable general entropy measures, such as Theil's-L and Theil's-T indices. We use parametric decomposition methods to determine the share of inequality of opportunity in total inequality. The parametric estimation allows us to ascertain the separate contributions of different sets of circumstances, such as parental education or wealth, to the measured inequality of opportunity.

A variety of different trends are evident across countries in both overall inequality and in the share of inequality of opportunity. Inequality of opportunity is shown to contribute substantially to the inequality of child health outcomes. For example, total inequality of both height and weight measures rose significantly in Egypt in the period from 2003 to 2008 and so did the share of inequality of opportunity. Jordan has both low and slightly declining total inequality, with the exception of a spike in 2007, but the share of inequality of opportunity has been essentially flat in Jordan. Like Egypt, Morocco shows rising total inequality, but with a declining share of inequality of opportunity since 1992. This suggests that circumstances other than the ones we observe are increasingly contributing to inequality in Morocco. Turkey has both high total inequality and high inequality of opportunity, but exhibits a strong declining trend in both. To highlight the relative contribution of circumstances to the inequality of child health outcomes in different countries, we simulate height and weight outcomes for a most and least advantaged child in each context. Since these simulations set observed circumstances at their best and worst, the larger the difference in predicted outcomes between the most and least advantaged child, the larger is the inequality of opportunity facing children in that country.

Section 2 reviews the literature on the importance of child health to future health, productivity, and wellbeing outcomes. Section 3 presents the conceptual framework we use to ascertain inequality of opportunity in child health. Section 4 presents our data sources. Section 5 reviews the methodology we use to calculate standardized anthropometric measures and details the inequality decomposition method we use. Section 6 presents an overview of child health inequality based on a descriptive analysis of our data. Section 7 presents the findings on the contribution of inequality of opportunity to overall inequality in each country and over time and the results of the simulations on the most and least advantaged child. Section 8 concludes.

2 The Importance of Child Health to Future Health and Productivity Outcomes

The first few years of a child's life are the starting point for equality of opportunity. Physical, cognitive, and psychological development occurs early in life. The first three years of children's lives, when their synapses (connections within the brain) are forming at peak levels, are the most important for brain development (UNESCO 2006). Some have described the first few years of life as "an extended critical period, a window of opportunity for development, closed by age three" (UNESCO 2006, p. 109). These early years are also a period that is particularly sensitive to the conditions in which a child lives. Child development is quite fragile in the face of issues like poor nutrition. Any developmental deficits that occur in early childhood may be permanent (UNESCO 2006). This crucial childhood period also represents a time when individuals have the least control over their circumstances. Being born to a poor family, or in an underserved geographic location, is entirely outside of a child's control, but determines the child's opportunities to accumulate crucial health assets that could determine his or her entire life course.

Child health and nutrition play an important role in a variety of dimensions of child development and adult outcomes. Under-nutrition negatively impacts cognitive development, motor development, and social development and these effects can persist into adulthood (UNESCO 2006). Health, especially child health, can drive later labor market outcomes and productivity. For instance, height accumulated in childhood is connected to labor market outcomes later in life (Strauss and Thomas 1998). Crucial stages of development also occur *in utero*. Fetal development and birth weight affect later child health (Frankenberg and Thomas 2001).

Child under-nutrition, including stunting (excessively low height for one's age) and wasting (excessively low weight for one's height) increases the risk of child mortality, child illness, and poor adult health outcomes (Black et al. 2008). Height for age at two years old is the best predictor of human capital later in life, and under-nutrition is associated with lower human capital. Early health deficiencies have been shown to result in shorter adult height, lower attained schooling, reduced adult income, and decreased offspring birth weight (Victoria et al. 2008).

Importantly, these outcomes are alterable through public inputs and policies. For instance, a nutritional intervention among children under three in Guatemala has been shown to improve wages later in life (Hoddinot et al. 2008). There are a wide variety of different interventions that have been shown to be effective in improving child health outcomes. In Indonesia, the introduction of the 'midwife in the village' program improved child health outcomes, specifically child height (Frankenberg, Suriastini and Thomas 2005). Health improvements started with greater fetal development resulting in higher child birth weights (Frankenberg and Thomas 2001). Health services have a critical role to play in child health. One study in Bangladesh showed that mortality related to diarrhea was only reduced significantly within a two mile radius of a health clinic (Rahaman et al. 1982).

Interventions do not necessarily have to be directly targeted at health services to improve child health outcomes. Water and sanitation play an important role in health. In Cairo, Egypt, adequate water and sanitation within the home were shown to make an important contribution to infant weight. Community-level sanitation also made an important contribution to health and disease prevention (Tekce, Oldham and Shorter 1994). Other community conditions can also make a substantial contribution to child health. In Haiti, the combination of poor roads and mountainous terrain was found to reduce the likelihood of appropriate antenatal care or delivery attended by trained medical professionals. Even controlling for individual family poverty, neighborhood poverty also substantially affected receipt of health services (Gage and Calixte 2006). Geographic access and community poverty can be effective targets for improving child health.

A wide variety of family characteristics can affect the course of child development, and interventions targeting these areas can cause important improvements in child health. Mother's education can be an important contributor to child health, both in terms of receiving formal education (literacy, numeracy) and, most importantly, in terms of health knowledge (Glewwe 1999). Improving education can therefore be an important but indirect route for improving child health. Poverty is also a substantial contributor to poor child health outcomes, and even un-conditional cash transfer programs have been shown to improve child health outcomes in South Africa (Aguero, Carter and Woolard 2007).

Investments in the first few years of a child's life also have the greatest potential for substantial returns. In the context of the United States, it has been argued that, while return from early interventions to develop human capital is high, the return from later interventions is lower; it is much costlier to engage in remedial programs (Heckman 2006). A recent review of 30 early childhood interventions in 23 countries found substantial benefits across a wide variety of childhood outcomes, including health, for a wide variety of interventions, and that these gains were sustained over time (Nores and Barnett 2010). Economic constraints on family investment in early childhood and externalities make public policy interventions particularly important (Nores and Barnett 2010). Gaps in child health emerge early, and policies to prevent these gaps are crucial to altering the life course of at risk or marginalized children. It is important to note that deficits in health outcomes as well as gaps or inequality can be substantial regardless of the absolute level of a country's income or other forms of development (Marmot 2005).

Children from disadvantaged backgrounds diverge from their more advantaged peers quite early in their development, and gaps persist throughout life (Heckman 2006). Childhood presents the best opportunity for preventing or remedying these inequalities. Childhood also represents a truly blameless time for inequality. Achievements in education or income later in life are shaped by individuals' efforts. However, the opportunities experienced *in utero* and in the early years of children's lives are determined by factors the children themselves have no control over. Parental wealth, education, and access to health services shape a child's health and later life outcomes, but children have no input into these circumstances.

Ideally, a society would offer equal opportunities to its citizens. In such a society, the factors children cannot control would have no role in shaping their life outcomes. Although genetic variation and luck alone are expected to lead to some natural variations in outcomes among children facing similar circumstances, inequality due to differences in circumstances is what concerns us here. The objective is not to fully equalize health outcomes, but to provide children with similar opportunities to develop into healthy and productive adults.

3 Inequality of Opportunity in Child Health: A Conceptual Framework

3.1 Inequality of opportunity

In studying inequality of opportunity in child health, we draw on a recent and growing body of literature on the distinction between inequality of opportunity and inequality of outcomes and on ways to measure the contribution of inequality of opportunity. The conceptual framework inspiring this literature is due to Roemer (1998), who made the distinction between circumstances and effort as determining individuals' rewards. He argued that inequality of rewards that are due to effort are morally justifiable, but those that are due to differences in circumstances that an individual has no control over are not morally justifiable. Roemer would include genetic differences and luck among the set of circumstances an individual has no control over and therefore among the factors that an individual should be compensated for. If we did that in the case of child health, then all observed health inequality would be inequality of opportunity, since a child is not accountable for any part of their health outcomes by age five. We take a different position. We include within inequality of opportunity, inequalities that are due to observable circumstances such as parental education, wealth, and place of residence. Genetic variation other than those directly attributable to parental characteristics and luck are presumably morally justifiable and therefore included in the residual inequality, which is not attributable to differences in opportunities.

In the context of child health, equality of outcome would imply that all children of the same age and sex would have the same height, which is clearly not realistic. Equality of opportunity means that, although individual children have different heights, differences in height are distributed independently of Parents' education or other circumstances. For any vector C defining an individual child's circumstances and any health outcome y, for equality of opportunity to prevail, the distribution of y given C should be equal to the distribution of y unconditional on C, i.e., F(y|C) = F(y). Inequality of opportunity is therefore the degree to which F(y|C) is not equal to F(y) (Ferreira and Gignoux 2008).

3.2 Child health production functions

In focusing on the determinants of child height and weight, we drew on the child health production function literature to include variables at the child and household level that are theoretically relevant to the determination of child health. In an adaptation of Strauss and Thomas (1998), we posit the following health production function:

$$H = h(N; A, B', \varepsilon_h) \qquad (3.1)$$

where H is a set of measured health outcomes, which are a function of a vector of health inputs, N. The inputs N can be partially controlled by parents, and depend on the parents' motivations and circumstances. There are also environmental and public service or infrastructure dimensions to these health inputs, which we refer to as B'. Health should be generally increasing with health inputs. The underlying health production technology may vary with socio-demographic characteristics, A, family background, and with environmental and public health characteristics B'. Included within the random disturbance ε_h are the elements of genetic variation, both observable and unobservable, as well as measurement error. In Vietnam, child health was shown to depend on both inputs and the variation of the underlying technology with the distribution of income. Half of the change over time in child health in Vietnam was shown to be due to changes in the distribution of observable characteristics, and half was attributed to changes in the technology that translates those inputs into child health outcomes (O'Donnell, Nicolas, and Van Doorslaer 2009). We therefore expect child health production functions to change over time and across countries.

Theoretically, relevant child level variables include gender and birth order, and whether a child is part of a multiple birth. Household-level variables include things such as mother's and father's schooling, parental occupation, mother's anthropometrics, mother's age at birth, access to piped water, and availability of flush toilets, as well as geographical location (Pradhan, Sahn, and Younger 2003, Blau, Guilkey, and Popkin 1996, Aturupane, Deolalikar, Gunewardena 2006, Kabubo-Mariara, Ndenge, and Mwabu 2008).

In terms of outcomes, we focus on child height and weight-for-height after appropriate standardization to account for variations in sex and age. Although child health can be characterized by a number of different measures, height is a preferred indicator for child health status because it is also a good measure of general health status and represents the accumulation of episodes of poor nutrition or illness (Pradhan, Sahn, and Younger 2003). Weight-for-height is also examined as an outcome. Although more weight for a given height is not necessarily healthier (Pradhan, Sahn, and Younger 2003), it is a measure that is more sensitive to short-term variations in nutrition.

4 Data

The data we use in this study come from Demographic and Health Surveys (DHSs) (Measure DHS). We used all the DHS surveys available for the Arab Countries and Turkey that include anthropometric data, specifically child height and weight for children five and under and that are available for multiple years. As such we include data from seven surveys for Egypt ('88,'92,'95,'00,'03,'05,08), five surveys for Jordan('90,'97,'02,'07,'09), three surveys for Morocco ('87,'92,'04), and three surveys for Turkey ('93,'98,'03). Some of these datasets collected anthropometric data for only a sub-sample of the entire DHS, but most collected it for all households with children under five. The different surveys, however, did not always include the same explanatory variables.

Additionally, although the DHS is laudable for consistently naming common variables across rounds (countries and years), response categories vary by country and year, and each round has round and country-specific variables with their own variable names and response categories. For instance, the sewage connections question may be represented by different variables in different countries or years, and even if named the same thing, it could include anywhere from two to thirteen categories. A substantial amount of data harmonization was necessary in order to create comparable variables and categories across different rounds and countries.

In order to harmonize data across countries and rounds, we created additional variables or collapsed categories. For instance, partner's occupation in the original DHS data had 13 categories, which we collapsed into six. We retained (1) professional, technical, and managerial, combined (2) clerical and sales (3) agricultural self-employed and agricultural employees (4) household domestic and sales workers (5) skilled manual and unskilled manual (6) and missing, don't know, other, and did not work.

In a few countries and rounds, a wealth variable was not directly available from the DHS. We use the DHS methodology and created a wealth index using factor analysis from the household assets and housing quality variables in the data. Wealth quintiles are computed as relative measure within a country and year, and refer to the position of the household in the wealth distribution of households. Finally, we used the sampling weights provided in each survey to undertake our analysis.

5 Methodology

Our methodology consists of computing appropriate standardized anthropometric indicators, calculating decomposable General Entropy measures of inequality for these indicators, and then decomposing these measures into a portion that is due to observable circumstances and a residual; the former being the share that can be attributed to inequality of opportunity. We undertake this decomposition using parametric decomposition methods.[2] Finally, we undertake simulations as to the extent of the impact of circumstances on inequality, by estimating standardized height and weight for children with the "best" (most advantaged) and "worst" (least advantaged) combination of observed circumstances.

5.1 Standardized anthropometric measures

The two outcome variables that are the focus of our analysis are child height and weight.
Both height and weight increase in variance with age and also vary by sex. In order to abstract from normal variations in height and weight, it is typical in the child health literature to use a reference distribution for "healthy" children put together by the US Center for Disease Control (CDC) (Kuczmarski et al. 2002) to calculate either the percentile of the child's height and weight in the reference distribution of children of the same sex and age (in months) or his or her z-score; the latter being the child's deviation from the median of the reference distribution measured in units of standard deviations of the reference distribution. Because both of these transformations of the height and weight variables alter the scale of measurement, they would alter inequality measures in arbitrary ways and would therefore not be suitable for our analysis. To avoid this problem, we follow a method proposed by Pradhan, Sahn and Younger (2003) to create "standardized"

[2] Results using non-parametric methods are comparable to those using parametric methods when the same set of circumstances is used. However, given cell size limitations, it is impossible to replicate the same level of detail in the circumstance variables using non-parametric methods. See Assaad et al. (2012) for the comparison of parametric and non-parametric results.

height and weight variables. This is done by transforming the z-score of the height or weight of the child using the reference CDC distribution into the equivalent height or weight for a twenty four month old female with the same z-score. Following Pradhan, Sahn and Younger (2003) "standardized" height can be denoted as:

$$h_s = F^{-1}_{\bar{a},\bar{g}}(F_{a,g}(\mathrm{h})) \tag{5.1}$$

F being the distribution function of heights in the CDC reference population for the age and sex group of an individual of age a and gender g. h is the actual height of that individual and $\bar{a}$ = 24 months, $\bar{g}$ = female. The resulting h_s is the standardized height.

Figure 1 provides an example of this process. From the DHS data we observe a 46-month-old male who is 95.3 centimeters in height. Using the 2000 CDC growth charts for a 46-month male (Kuczmarski et al. 2002), we calculate his z-score to be -1.40. We then use this relative position to determine what his height would be if he were a 24-month-old female, which is 80.1 centimeters. This 46-month old male with 95.3 centimeters thus maintains his relative position, but has a standardized height that can be compared to standardized heights for other children at a different ages and sex. Height z-scores that were less than -7 or more than 7, or that were flagged in the DHS data, were recoded as missing.

Figure 1 Height Transformation Example

Original			Z-score		Z-score		Standardized height
Height	= 95.3 cm	→	-1.40	=	-1.40	→	80.1 cm
for a			for a		for a		for a
Male			Male		Female		Female
46 months			46 months		24 months		24 months

Because height-for-age and weight-for-age are highly correlated across individuals, a more independent measure of the short-run nutritional achievement of a child, controlling for long-run nutrition, is weight-for-height. To obtain a standardized weight-for-height measure, we follow a similar procedure as in the case of height-for-age. We calculate the z-score of the child in the relevant weight-for-height reference distribution and then map this z-score into the weight of a 24-month-old female of median height to obtain the standardized weight at a given height. Like in the case of height, weights for height z-scores of less than -7 or more than 7 and those flagged in DHS data were recoded as missing.

5.2 Inequality decomposition methodology

In order to estimate the contribution of circumstances to total inequality and thus get at the share of inequality of opportunity, we must both measure and decompose inequality. As Ferreira and Gignoux (2008) discuss, even when examining the same set of outcomes and circumstances, estimates of the share of inequality of opportunity in total inequality can differ on three grounds: (1) the specific inequality index used in the decomposition (2) the path of the decomposition, whether direct or indirect and (3) the procedure used for decomposition (parametric or non-parametric). In what follows we discuss all three of these issues.

5.2.1 The Choice of Inequality Index

There are a number of inequality measures such as the well-known Gini index or the decile ratio index, however only some of these measures are decomposable into within and between group inequality; a property that is necessary to estimate the contribution of inequality of opportunity. We therefore use a general class of decomposable inequality measures called the general entropy (GE) measures (see Duclos and Araar 2006). The GE class of measures depends on a parameter α that determines the degree of sensitivity of the index to differences in the welfare measure at different points in the distribution. A well-known special case is GE(α=0), which is known as the Theil-L index or the mean logarithmic deviation. GE(0) puts more weight on deviations from the mean at the lower end of the distribution. It is also the only measure of inequality among the decomposable inequality indices that is path independent.[3] Another special case is GE(1), or the Theil-T index. This shifts the emphasis to deviations from the mean in the middle of the distribution. GE(2) is equal to half the square of the coefficient of variation. This measure puts more weight on deviations from the mean higher up in the distribution. We estimate inequality using all three GE measures, but since they produce similar results, we only present those using GE(1), the Theil-T index.

5.2.2 *The path of the decomposition*

Our analysis depends on subdividing the population of children under 5 into *k* types based on their circumstances. Children with the same vector of observed circumstances C are grouped in the same type *k*. The decomposition consists of decomposing the observed inequality into a between-type inequality and a within-type inequality. Based on Roemer's framework, the share of between-type inequality to total inequality, which we denote by θ, is our measure of inequality of opportunity.

The share of inequality of opportunity in total inequality can either be measured directly or as a residual depending on the path of the decomposition, which in turn depends on whether a smoothed distribution or a standardized distribution is used. Let $\{y_i^k\}$ be the distribution of child health outcomes across a sample of children i=1,…N distributed in K types. A smoothed distribution $\{\mu_i^k\}$ emphasizes the between-type differences by substituting the mean of each type μ^k for y_i^k , thus neutralizing any within-type variation in outcomes. A standardized distribution v_i^k emphasizes within-type differences by replacing each y_i^k with $v_i^k = y_i^k \frac{\mu}{\mu^k}$ where μ is the grand mean. By insuring that the mean outcome in each type is equal to μ, the standardized distribution eliminates all between-type inequality. Following Ferreiera and Gignoux (2008), the direct and residual measures of the share of inequality of opportunity can thus be denoted by:

$$\theta_d = {I(\{\mu_i^k\})}/{I(\{y_i^k\})} \quad (5.2)$$

$$\theta_r = 1 - {I(\{v_i^k\})}/{I(\{y_i^k\})} \quad (5.3)$$

where *I(…)* denotes an appropriate decomposable inequality index.[4]

The most straightforward way to operationalize the measurement of θ_d and θ_r is to assign individuals to the K-types according to their circumstances and then assign them values of μ_i^k and v_i^k and then use the resulting distributions to calculate the inequality measures. This would essentially be the non-parametric *types* approach. The main disadvantage of this approach is that with any realistic set of circumstances the numbers of cells K is so large that the cell sizes would be inadequate to obtain good estimates of the inequality measures given the sample sizes we have available to us. An alternative approach is to use parametric methods to control for circumstances and predict the smoothed and standardized distribution parametrically. This is what we turn to next.

5.2.3 *Parametric estimation*

The parametric approach consists of postulating a parametric equation describing how the welfare outcome y depends on the vector of circumstances C. For simplicity, we assume a linear relationship and estimate the following regression:[5]

$$y_i = C_i\psi + \varepsilon_i \quad (5.4)$$

Using the vector of estimated coefficients $\hat{\psi}$, we estimate the smoothed distribution as follows:

$$\widetilde{\hat{z}_i} = C_i\hat{\psi} \quad (5.5)$$

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[3] Path independence means that the result of the decomposition is the same whether the direct or residual methods are used (see below).
[4] We focus in this paper on results where the Theil-T or GE(1) index is used as the inequality measure *I(…)*, but we generally find that results using GE(0) and GE(2) are similar. Results using these alternative inequality indices are available from the authors upon request.
[5] The presentation in this section closely follows the framework elaborated in Ferreira and Gignoux (2008). See also Hassine (2012).

where $\widetilde{\widehat{z}_i}$ is the predicted value of y using the estimated regression coefficients. Since this distribution depends only on the circumstances vector C_i it eliminates any within-types variability and retains only between-types inequality. This smoothed distribution is then used to obtain the direct parametric estimate of the share of inequality of opportunity (θ_d) as in Equation 5.2 above by substituting $\widetilde{\widehat{z}_i}$ for μ_i^k.

The standardized distribution is obtained as follows:

$$\widetilde{\widehat{y}_i} = \bar{C}\widehat{\psi} + \hat{\varepsilon}_i \qquad (5.6)$$

where $\bar{C}$ is the vector of sample mean circumstances. Once differences in circumstances are controlled for, the remaining variability is exclusively *within* types. The residual parametric estimate of the share of inequality of opportunity (θ_r) can thus be calculated as shown in Equation 5.3 above by substituting $\widetilde{\widehat{y}_i}$ for v_i^k.

5.2.4 Partial Effects in Parametric Estimation

With parametric estimation it is possible to obtain the partial contribution of each group of circumstances on the share of inequality of opportunity. For instance, we can determine what portion of inequality of opportunity is due to wealth, parental education, or gender. To obtain the partial effect of a particular circumstance J, we can construct the following counterfactual standardized distribution:

$$\hat{\tilde{y}}_i^J = \bar{C}^J\widehat{\psi}^J + C_i^{j\neq J}\psi^{j\neq J} + \hat{u}_i \qquad (5.7)$$

This allows us to neutralize the variation due to circumstance J, while maintaining the variation due to other circumstances. The share of inequality attributable to circumstance J is then given by:

$$\theta_r^J = 1 - {I(\{\hat{\tilde{y}}_i^J\})}/{I(\{y_i\})} \qquad (5.8)$$

6 An Overview of Child Health Status in Selected Arab Countries and Turkey

In this descriptive overview of child health status in Arab countries that are the focus of our analysis here and Turkey, we use a number of child health indicators, such as the proportion of children suffering from stunting or wasting. Stunting and wasting are defined as having a height-for-age and weight-for-height z-scores that are below two standard deviations from the median of the relevant CDC's healthy child distribution. This threshold corresponds to approximately the third percentile of height-for-age and weight-for-height in the reference distribution (Kuczmarski et al. 2002). Height-for-age, as the accumulation of nutrition and morbidity status over time, is an important measure of long-term child health outcomes. Weight-for-height is a good indicator of short-term nutritional stress and tends to be less correlated with height-for-age than weight-for-age. Besides the rates of stunting and wasting, which are good indicators of the health of the most vulnerable children, we also report the mean percentile of height-for-age and weight-for-height (relative to the healthy child CDC distribution), which are good indicators of the health of the average child in that country at that time (see Table 1). A healthy child population, on average, would have a mean percentile of 50%.

In general the Arab countries and Turkey appear to perform poorly relative to the healthy child distributions in terms of height-for-age and stunting, but perform well relative to the relevant distribution for weight-for-height. The percent wasting is much closer to the expected 3% and the mean percentile of weight-for-height is closer to the expected 50% than are the respective statistics for height-for-age. This suggests that long-term nutrition deficits are more important in this region than short-term nutritional stress. Egypt generally exhibits a high rate of stunting and a low mean percentile of height-for-age even though it's wasting and weight-for-height statistics look fairly good. Although the worst year for stunting in Egypt was 1995, with a rate of 28.2%, the dramatic improvement in the subsequent decade appears to have been reversed in the latter part of the 2000s decade, with stunting going up to 24.4% in 2008 after having declined to as low

11.3% in 2003. This poor child health performance in 2008 is confirmed by a large increase in wasting during that period as well, which increased from 6.2% in 2005 to 10.6% in 2008.

Some of this sharp deterioration in child nutrition in Egypt in recent years may be attributable to the sudden disruption in the supply of poultry and eggs to households after millions of poultry were culled during the avian influenza outbreak of 2006 and 2007 (El-Zanaty and Way 2009, FAO 2009). As many households bred poultry for their own consumption, the outlawing of such activities seems to have seriously affected the protein intake of young children as well as possibly straining household financial resources (Geerlings et al. 2007). According to the FAO, the culling program has had the greatest impact on the very poor in terms of the number of households keeping birds and the number of birds kept (FAO 2009). The FAO report, which was based on an evaluation of two governorates, one in Lower Egypt and one in Upper Egypt, suggests that the Lower Egypt governorate was much more strongly affected because they had on average much larger flock sizes. It is ironic that a measure designed to solve one public health problem appears to have caused a possibly more serious problem in relation to the nutrition of the most vulnerable children.

Generally, Jordan exhibits better child health outcomes. Starting in 1990, it had a rate of stunting of 13.5%, which declined quite substantially up to 2002, worsened in 2007 and then fell to its lowest level (5.4%) in 2009. The short-term worsening of the health of the most vulnerable children in Jordan in 2007 is made readily apparent by the rate of wasting that increased from 5.5% in 2002 to 12.1% in 2007, only to drop to 4.3% in 2009. The average child in Jordan was less affected by this reversal as indicated by the mean percentiles for height-for-age, which continued to rise through 2007 and the mean percentile of weight-for-height, which only declined slightly from 2002 to 2007, before rising again in 2009.

Morocco exhibits a consistently improving trend in the rate of stunting and the mean percentile of height-for-age, with the proportion stunted dropping from 31.2% in 1987 to 16.3% in 2004 and the mean percentile of height rising from 22.5% in 1987 to 33.2% in 2004. In contrast, there appears to have been a short-term reversal in the nutrition of the most vulnerable children in Morocco in 2004 when the rate of wasting rose to 14.4%, and the mean percentile of weight for height dropping to 50% from 57% in 1992. This could well be due to the impact of the frequent droughts that Morocco experiences. Morocco started the observation period with stunting rates that were highest among the countries represented, save for Yemen, but managed to significantly improve child nutrition over time.

Table 1 Percent Stunted and Wasting and Mean Percentile of Height-for-Age and Weight-for-Height by Country and Year

	Height-for Age		Weight-for-Height		Per Capita GDP (2000 constant USD)
	% Stunted	Mean Percentile	% Wasting	Mean Percentile	
Egypt 08	24.4	29.1	10.6	57.0	1,786
Egypt 05	14.2	30.6	6.2	54.3	1,539
Egypt 03	11.3	26.7	9.1	45.1	1,470
Egypt 00	16.5	28.3	3.6	62.1	1,423
Egypt 95	28.2	23.8	6.0	56.4	1,214
Egypt 92	22.3	25.0	4.8	58.4	1,148
Egypt 88	27.6	20.2	3.1	55.1	1,075
Jordan 09	5.4	42.6	4.3	52.5	2,497
Jordan 07	11.3	39.5	12.1	46.7	2,378
Jordan 02	6.9	36.8	5.5	49.1	1,871
Jordan 97	6.1	35.8	5.3	47.5	1,710
Jordan 90	13.5	30.6	6.7	53.4	1,618
Morocco 04	16.3	33.2	14.4	50.3	1,499
Morocco 92	24.5	24.6	3.7	57.3	1,159
Morocco 87	31.2	22.5	5.0	49.4	1,059
Turkey 03	12.1	38.5	1.7	61.4	4,052
Turkey 98	18.3	33.5	3.0	50.3	4,012
Turkey 93	22.6	30.5	4.5	49.4	3,596

Source: Measure DHS. Per-capita GDP is from World Bank, World Development Indicators.

Turkey, like Morocco, shows a strongly improving trend over time in both stunting and wasting. In 1993, 22.6% of children five and under were stunted and the mean percentile of height-for-age was 30.5%. It is interesting to compare this to Jordan in 1990, which had nearly the same mean percentile (30.6%), but a much lower percentage stunted (only 13.5%), suggesting larger inequality in health status in Turkey. Over time, however, Turkey has improved substantially, with the rate of stunting reaching 12.1% and the rate of wasting 1.7% by 2003.

Comparing across countries using data from the 2000s, Jordan clearly performs the best in terms of child health outcomes. Turkey is close behind thanks to its improving trend and Morocco not too far behind. Egypt's most recent data is less promising, especially for the most vulnerable children affected by stunting and wasting, a reversal that could well be attributed to seemingly misguided public health policies. While Jordan, Morocco, and Turkey show clearly improving trends, Egypt' initial improvements appear to have stagnated or even reversed.

It is noteworthy that the relationship between per capita annual GDP (in 2000 constant USD) and health outcomes is not simple or clear. Evidence from Vietnam illustrates a case of inequality rising slightly along with substantial increases in economic growth, driving a decrease in stunting (O'Donnell, Nicolas, and Van Doorslaer 2009). Economic growth, absolute health outcomes, and health inequality, although related do not exhibit an unidirectional deterministic relationship.

In the Arab world, Jordan has had quite a modest per capita GDP when compared to Turkey; however, it has also had substantially lower stunting, and better or comparable mean height percentiles. Nor does the trend for a given country appear to necessarily be the result of changes in per capita GDP. In Turkey, between 1998 and 2003, per capita GDP rose very little, but stunting and wasting fell significantly. In Morocco, on the other hand, improvements in stunting have tracked with increases in GDP, but not so for wasting which deteriorated significantly in 2004 despite rising GDP per capita. Aside from the aberration in 2008, Egypt's child health indicators tracked its rising GDP per capita.

The key question from an inequality of opportunity point of view is whether these observed differences in child health outcome can be attributed to inequality in circumstances. An initial way to address this question is to examine the bivariate association between the distribution of a health outcome variable and observable circumstances, such as region of residence, parental education, etc. Due to space limitations, we do that only with the distribution of standardized height. Standardized weight-for-height showed very similar patterns.

The graphs shown in Figure 2 show the distribution of children by region for each decile of standardized height. If region had no effect on child height outcomes, the share of childrent in each region would be the same across deciles and the horizontal lines would be totally flat. A region that has a larger share in lower deciles has relatively more disadvantaged children. One that has a larger share in higher deciles has relatively advantaged children.

We focus on Egypt in 1988, 2000, and 2008 in order to illustrate how the effect of region on child height changes over time. We also include Jordan 2002, Morocco 2004, and Turkey 2003 graphs for a comparison across countries at a similar point in time. In Egypt, as shown in Figure 2, the slope of the curve indicates that there is a fairly strong relationship between where a child lives and his or her position in the height-for-age distribution, but this relationship appears to have gotten weaker in 2008. Much of the relationship appears to be the result of rural Upper Egypt's over-representation in the lower deciles of the distribution in the two earliers years. In 2008, children in rural lower Egypt seem to fare the worst, which is consistent with the FAO finding that rural households in Lower Egypt were the most impacted by the poultry culling that followed the Avian Influenza scare because of their larger initial flock sizes (FAO 2009).

Jordan in 2002 shows a weaker relationship between region and height. Although the South is over-represented and the Central region under-represented in the lowest decile, there is only a very slight gradient past that point. Morocco is likewise only weakly differentiated by region, with some regions (such as the South and Tensfit) over-represented at both ends of the spectrum, and others (such as the Central and Northwest regions) over-represented towards the middle deciles.

Turkey in 2003 shows a much clearer and more dramatic association between region and the distribution of child height. The Eastern region of Turkey, known to be the poorest region of the country, dominates the lower end of the distribution, and all the other regions are strongly skewed towards the higher height deciles. To summarize, regional differences are comparatively small in Jordan, modest in Morocco and Egypt, and large in Turkey. Based on these results, we would expect geography to play an important role in the inequallity of child health, especially in Egypt and Turkey.

Household wealth has an obvious and important role as a determinant of child health, as it influences the resources parents are able to dedicate to their children's health and nutrition and even their access to publicly provided resources through their residential choices. Figure 3 shows the bivariate association between the household's wealth quintile and the position of the child on the distribution of standardized height. In Egypt in 1988, there is a strong relationship between the distribution of wealth and child height. The poorest children are over-represented in the lower two height deciles. Children from the third and fourth decile are also somewhat skewed towards the lower end of the distribution. While children from the next four deciles of height are slightly under-represented in the lowest quintiles of wealth, they are otherwise generally evenly distributed. It is the wealthiest children that dominate the high end of the height distribution. A similar, but weaker, gradient is visible in Egypt in 2000. The wealthiest kids were the most likely to benefit from improvements in child health from 1988 to 2000. By 2008, the relationship between wealth and child height had practically disappeared.

In Jordan, the poorest quintile of wealth is slightly more represented among the lower height deciles. The next three quintiles are relatively evenly distributed throughout the height distribution, but the top quintile of wealth is skewed toawrd the high end of the height distribution. Morocco shows a pattern similar to Jordan, with the top and bottom wealth quintiles skewed to the bottom and top of the height distributions, respectively, but the middle quintiles evenly distributed acorss the height distribution. The relationship between household wealth and child height is even more dramatic in Turkey. Children from the poorest wealth quintile represent nearly half of the lowest height decile, but less than twenty percent of the highest decile. The second wealth quintile is fairly evenly distributed across the height distribution, but past that point, increasing wealth skews height towards the high end of the distribution. In Turkey the poorest quintile is by far the worst off, while other countries have more consistent gradients. While Egypt shows a modest gradient fluctuating over time by wealth, all the other countries show strong health outcome inequality by wealth. Turkey's is the most dramatic, while Jordan's and Morocco's are fairly similar in gradient, with Jordan being consistently better at each level.

We move next to an examination of the association between mother's education and child height.[6] First, note the significant increase in the education of mothers over time in Egypt, as indicated by the shrinking area for the two lightest colors and the expansion of the two darkest colors in Figure 4. The slope of the curves shows the association between mother's education and child height. Children whose mothers have no education are over represented in the lower end of the height distribution. Children with primary-educated mothers are over-represented towards the middle and under-represented at both ends. Once mothers reach secondary education, children's height starts to skew towards the high end of the distribution, and children with mothers with higher education are definitively over-represented in the highest two or three deciles. In 2000 in Egypt, the gradients with respect to mother's education are less dramatic, but continue the same trend of increasing height with increasing mother's education. By 2008 in Egypt, like in the case of household wealth there is a much weaker association between children's height and parental education.

Jordan in 2002 does show a concentration of children with uneducated mothers in the lower end of the distribution. The distribution of children with secondary-educated mothers is fairly symmetric, but children with highly educated mothers are definitively concentrated at the higher end of the distribution. In the case of Morocco in 2004, children with uneducated mothers are the majority and are definitively over-represented in the lower deciles. Children of mothers with at least secondary education are skewed towards the higher end of the distribution. Morocco and Jordan provide a particularly interesting contrast on this measure; Jordan does by far the best of these four countries on providing high levels of education to mothers, and Morocco by far the worst. However, the gradients associated with mother's education and height deciles are quite similar despite the very different compositions of mother's education. This suggests that in both countries, educated mothers are more able to contribute to child health, but that in Jordan many more mothers have the requisite level of education.

In the case of Turkey in 2003, children with uneducated mothers are highly over-represented at the lower end of the height distribution; they are over 50% of the lowest decile but less than 20% of the highest. Children with mothers educated at the primary level are over-represented in the middle of the height distribution, and children with secondary or university-educated mothers overrepresented at the top of the distribution

[6] Since the association with father's education is similar, we skip it in this descriptive section.

Figure 2 Regional Distribution by Decile of Standardized Height

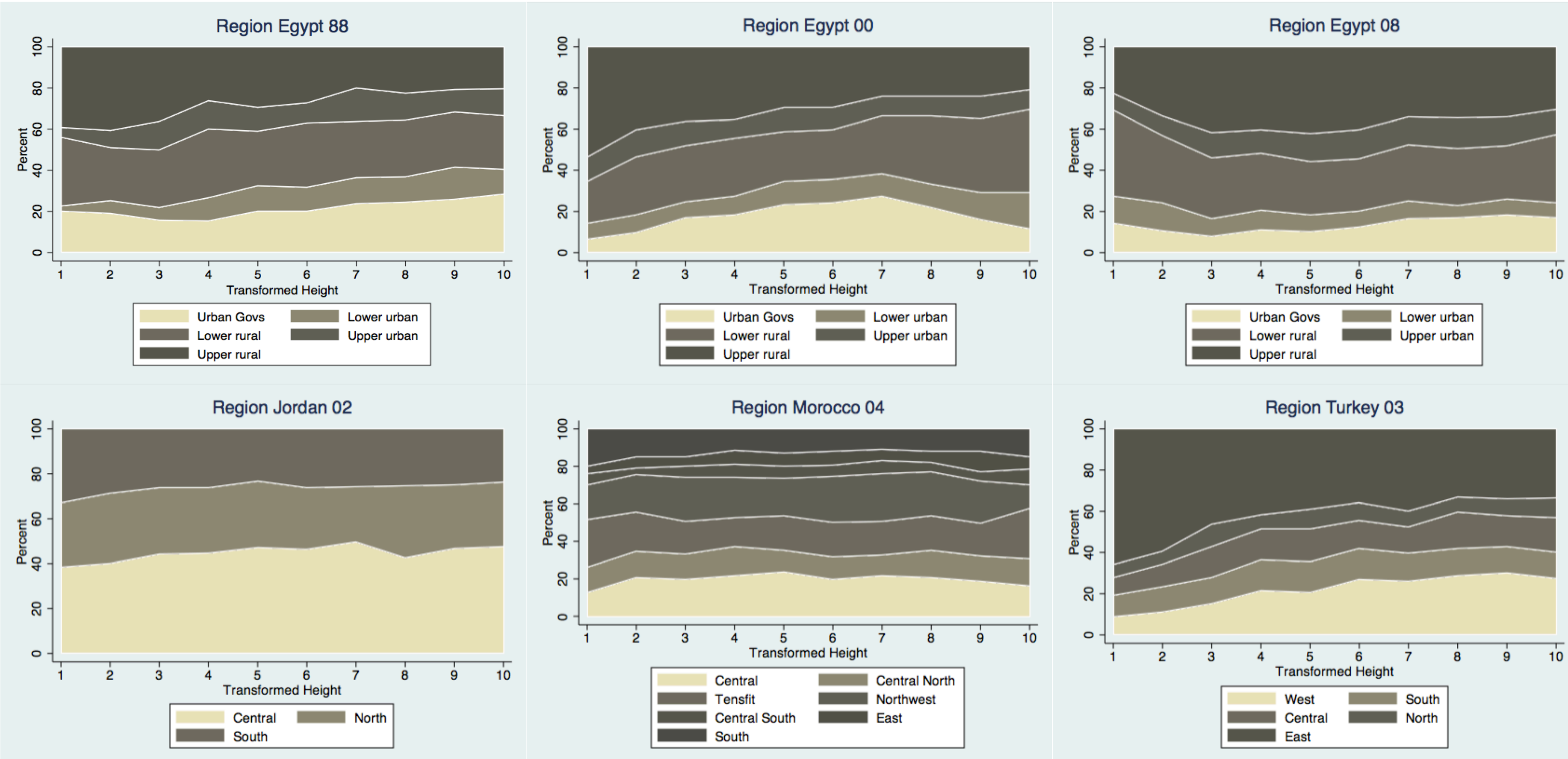


Figure 3 Wealth Distribution by Decile of Standardized Height

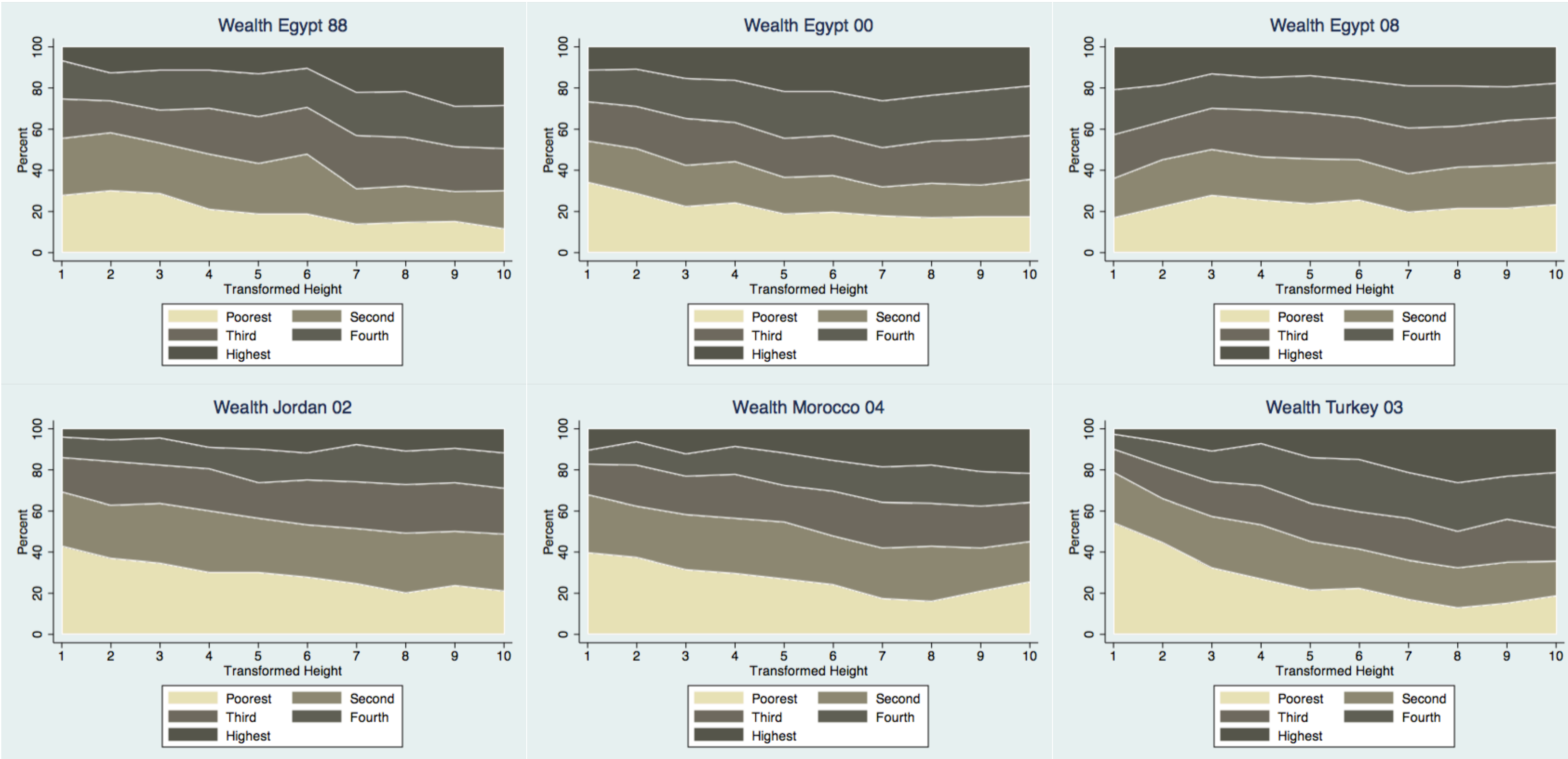
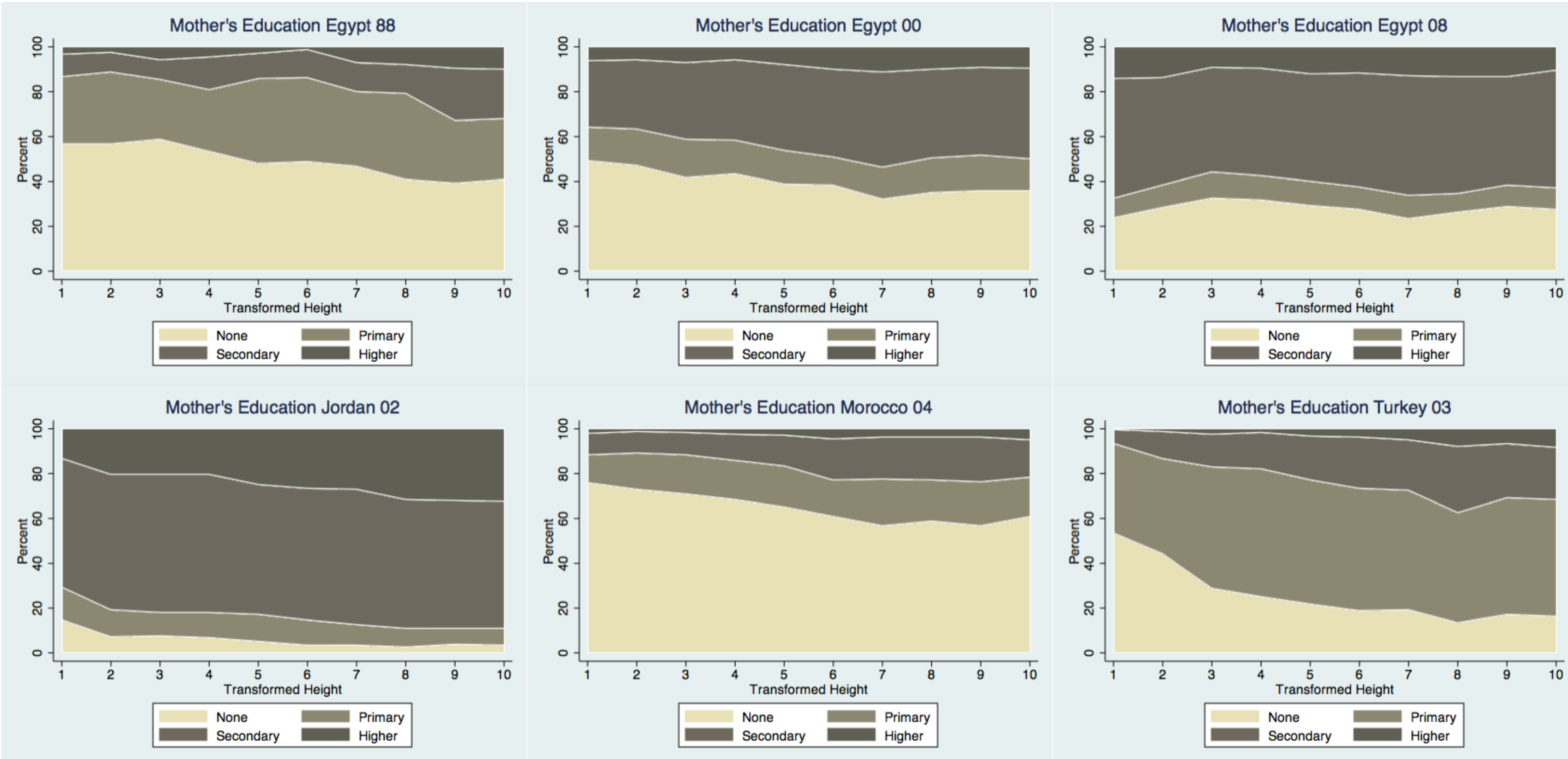


Figure 4 Mother's Education Distribution by Decile of Standardized Height



7 Findings: Inequality Measurements and Decompositions

7.1 An overview

In order to measure inequality of opportunity, the inequality due to circumstances, we now turn to the decomposable inequality measures discussed in the methodology section. First we measure and discuss total inequality across countries, then we describe the parametric specifications we use and present the direct and residual estimates of the share of inequality of opportunity by country. This is followed by a discussion of the partial effects of different sets of circumstances in contributing to inequality of opportunity and a simulation of the observed differences in outcomes that are obtained by setting circumstances at their combined best and worst case levels.

7.2 Comparing across countries: Total inequality

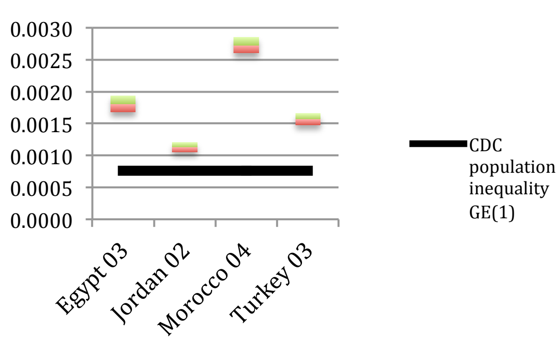
In order to examine the contribution of inequality of opportunity, we must first measure total inequality. Countries with greater total inequality would also be expected to have greater contributions of inequality of opportunity, since the level of "natural" inequality in healthy children in terms of standardized height and standardized weight-for-height should be relatively constant across countries.

A consistent ranking emerges when we compare inequality across countries (Figure 5). Among the four countries for which we have data at a similar point in time (Egypt, Jordan, Morocco and Turkey), Morocco consistently has the highest total inequality for both standardized height and weight-for-height. Egypt is the next most unequal, with Turkey close behind, at least in terms of height. Jordan has lower inequality in both measures but Turkey has the lowest inequality in weight-for-height, a figure that approaches the observed inequality in the CDC reference population, shown as a solid black line in the figure.

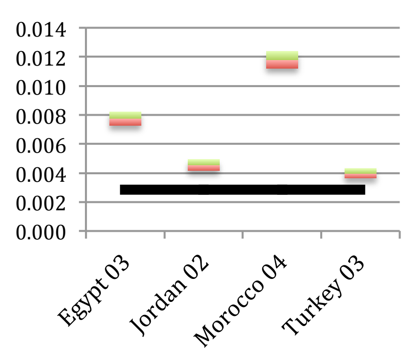
We include only the Theil-T or GE(1) measure of inequality here. The rank-order of the countries using GE(0) and GE(2) is the same. As shown by the confidence intervals around the measures, all the differences across countries are statistically significant, except for the differences in weight-for-height inequality between Jordan and Turkey.

Figure 5 Total Inequality in Standardized Height and Standardized Weight-for-Height (with 95% confidence intervals) by Country as Compared to Inequality in CDC Reference Population of Healthy Children

Height



Weight-for-Height



7.3 Measuring the contribution of circumstances

To get the most accurate measures of the contribution of inequality of opportunity, it would be best to get the most detailed possible measure of the child's observable circumstances. Since there are limits as to how precisely we can measure all the relevant circumstances, the estimate of the contribution of inequality of opportunity is by necessity a lower bound. Data limitations will clearly dictate how accurately circumstances can be measured. With the parametric approach, the main limitation is the extent to which the DHS survey measures these circumstances and how consistent the measurements are across countries and years. Because different circumstance variables are available for different countries and years, we selected a basic parametric specification that uses only variables that are available across all the DHS samples we use. If we had limited the analysis to some of the later waves of the DHS, we could have used a more complete specification and an even more complete specification would have been possible if we had limited it to individual countries. We experimented with two more complete specifications, but found that the results were essentially similar across specifications, although the share of inequality of opportunity we estimated was indeed higher with more complete specifications.

The "base" specification, is consistent across all the years and countries and uses variables that are available in all years and countries. The circumstances variables that it includes are mother's education (4 categories), father's education (4 categories), governorate or province (varying by country), urban/rural residence, wealth quintile (as determined from a wealth index estimated for each country and year), whether a child was part of a multiple birth, mother's age and age squared at birth (continuous), birth order, and the sex of the child.[7]

Additional explanatory variables that we could have used and that are only available in the more recent waves of the DHS for all countries are father's occupation (6 categories), mother's height (continuous), mother's body mass index (continuous), whether the household has a modern toilet, and whether the household has drinking water piped into the house. Additional variables that are only available for some countries or whose specification varies by country are time to water source (continuous), sewage type (varies by country), kitchen trash disposal, whether toilet facilities are shared, and type of cooking fuel.

7.4 The contribution of inequality of opportunity to total inequality: Cross-country comparison

Inequality of opportunity is measured as a share of total inequality and answers the question of 'what proportion of total inequality is due to circumstances?' Using the parametric specification, we estimated inequality of opportunity both directly and as a residual. This section compares the share of inequality of opportunity across countries for the period around 2003.

As shown in Figure 6, the estimates of the share of inequality of opportunity in total inequality suggest a clear ranking of inequality of opportunity in standardized height across countries, but this ranking does not necessarily correspond to the country's rank in the extent of total inequality. As shown by comparing Figure 5 and Figure 6, Turkey has the third highest total inequality in height among the four countries but has the highest share of inequality of opportunity. With respect to child height, Egypt, Jordan and Morocco have similar shares of inequality of opportunity in total inequality (around 4-7%) although Morocco and Egypt have much higher total inequality in height than Jordan. There are only minor differences between the direct and residual approaches to measurement using the Theil-T or GE(1) index.[8]

There are smaller cross-country differences in the share of inequality of opportunity in total inequality for the weight-for-height variable, which measures shorter term fluctuations in nutrition. As shown in Figure 6, inequality of opportunity of this outcome is highest for Egypt followed by Morocco, Turkey and Jordan. Again, this ranking is different from that of total inequality of weight-for-height, where Morocco comes out highest, followed by Egypt, Jordan and Turkey (see Figure 5).

It is important to remember that the estimated shares of inequality of opportunity only capture the inequality of opportunity due to *observed* circumstances. There are a number of dimensions of potential inequality of opportunity we are unable to capture from the DHS data and which are therefore not observed. Language

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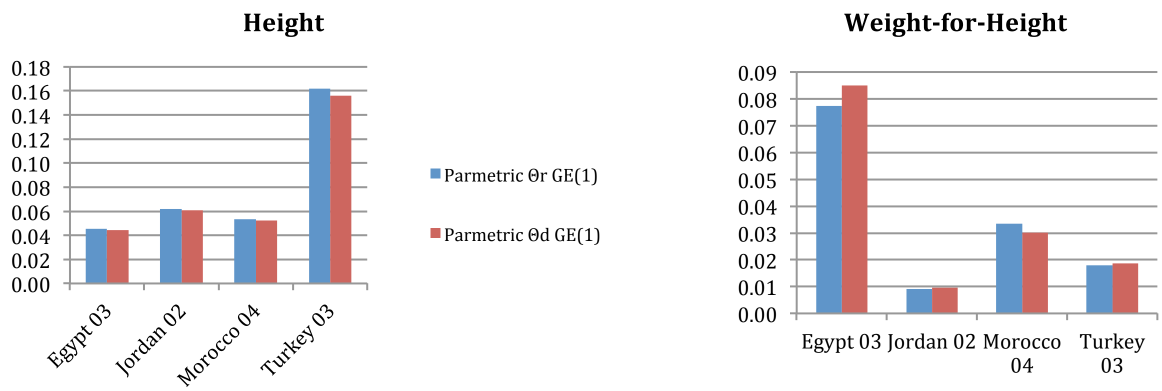
[7] Regressions results for standardized height and standardized weight for height are not shown here due to space limitations but can be found in the Appendix Tables A6 and A7 of Assaad et al. (2012).

[8] Recall that the Theil-L or GE(0) measure is path independent and therefore produces the exact same results using the direct and residual methods.

barriers or ethnic discrimination may limit access to health care in some countries. Wealth is merely a proxy for household resources, whereas income is more likely the relevant variable in case of a child health crisis. Environmental contributors to health—such as water or air pollution—are not fully observed. The fact that Morocco for example has high total inequality but low inequality of opportunity shares suggests that the circumstances we account for do a relatively poorer job in capturing variations in child health and nutrition in Morocco than in the other countries. Conversely, the larger share of inequality of opportunity we capture for Turkey given its intermediate level of total inequality suggests that these circumstance do a relatively better job in getting at inequality of opportunity there. The shares of inequality of opportunity that we estimate must therefore be interpreted as lower bound estimates, with the unobserved dimensions absorbed into the unexplained component that also include natural variations across children.

Figure 6 Country Comparison: Estimated Share of Inequality of Opportunity



7.5 The contribution of inequality of opportunity to total inequality: Countries over time

We now move to a comparison of the trends over time in inequality and inequality of opportunity across countries. The issues we are most interested in are the time trend, if any, and whether the trend in the inequality of opportunity share is similar to that in total inequality. First we note the contrasting trends in total inequality of height and weight-for-height shown in **Figure** 7 and **Figure** 8. Although fluctuating, the trend in Egypt for both standardized height and for weight-for-height is upward. Morocco is also exhibiting an upward trend, especially from 1992 to 2004. In contrast, the trend in Jordan and Turkey is downward, with the exception of 2007, which was an unsually high year in Jordan.

Moving on to the share of inequality of opportunity, shown in the right panel of Figure 7and Figure 8, we first note that the direct and residual parametric methods produce very similar results for both estimates and confidence intervals. Leaving Egypt aside for the moment, we can conclude that, for standardized height, the share of inequality of opportunity in Jordan was relatively flat throughout the period of 1990 to 2009, increased in Morocco from 1987 to 1992 and then declined from 1992 to 2004, and fell throughout the period under study in Turkey, although the changes there remain within the confidence intervals for the various individual year estimates (see Figure 7). The stability in Jordan is surprising given the sharp increase in inequality in 2007. If anything the share of inequality of opportunity seems to have fallen in 2007 rather than increased, as we would have expected. We therefore remain fairly ignorant as to what caused the big increase in inequality in Jordan in 2007. The reversal of the trend between 1992 and 2004 in Morocco is also somewhat surprising giving the increase in total inequality in that period. Again, that increase in inequality appears to be poorly explained by the circumstances we observe there. The declining trend in Turkey is consistent with the decline in total inequaliy over time.

In terms of weight-for-height, the trend is also flat, if not slightly increasing in Jordan, declining throughout the period in Morocco and declining in Turkey, especially in the 1998-2003 period. The decline in the share of inequality of opportunity in Morocco contrasts even more sharply with the increase in total inequality during the 1992-2004 period.

We return to the case of Egypt, which seems to exhibit fluctuating trends in both total inequality and inequality of opportunity. Interestingly, in the case of standardized height, total inequality and the share of inequality of opportunity show opposing trends in the early part of the period, but a similar upward trend since 2003. In the case of weight-for-height, the trends in the two indicators appear to roughly coincide throughout the period. In our earlier discussion, we attributed the big increase in stunting and wasting we observed for Egypt in 2008 to the possible impact of the culling of domestic poultry in 2007 as a meams to combat the avian influenza epidemic that hit Egypt in 2006. This had a geographically differentiated effect on child nutrition, depending on the extent to which families depended on domestic poultry as a source of protein for their children. In particular, rural households in Lower Egypt appear to have been more adversely affected due to their larger initial flock sizes amd possibly more consistent enforcement of the ban on domestic birds there. This sort of geographic diversity is captured in our regression by means of governorate and urban rural dummies and therefore shows up as an increase in the share of inequality of opportunity in 2008. The standardized height results show that both total inequality and the share of inequality of opportunity were rising steadily since 2003. The weight-for-height results, which highlight short-term nutritional stress show a much steeper rise in both indicators from 2005 to 2008, the period in which the poutlry culling intervention was implemented.

Figure 7 Trend in Total Inequality and Share of Inequality of Opportunity in Standardized Height over Time in Selected Countries (estimates and 95 percent confidence intervals)

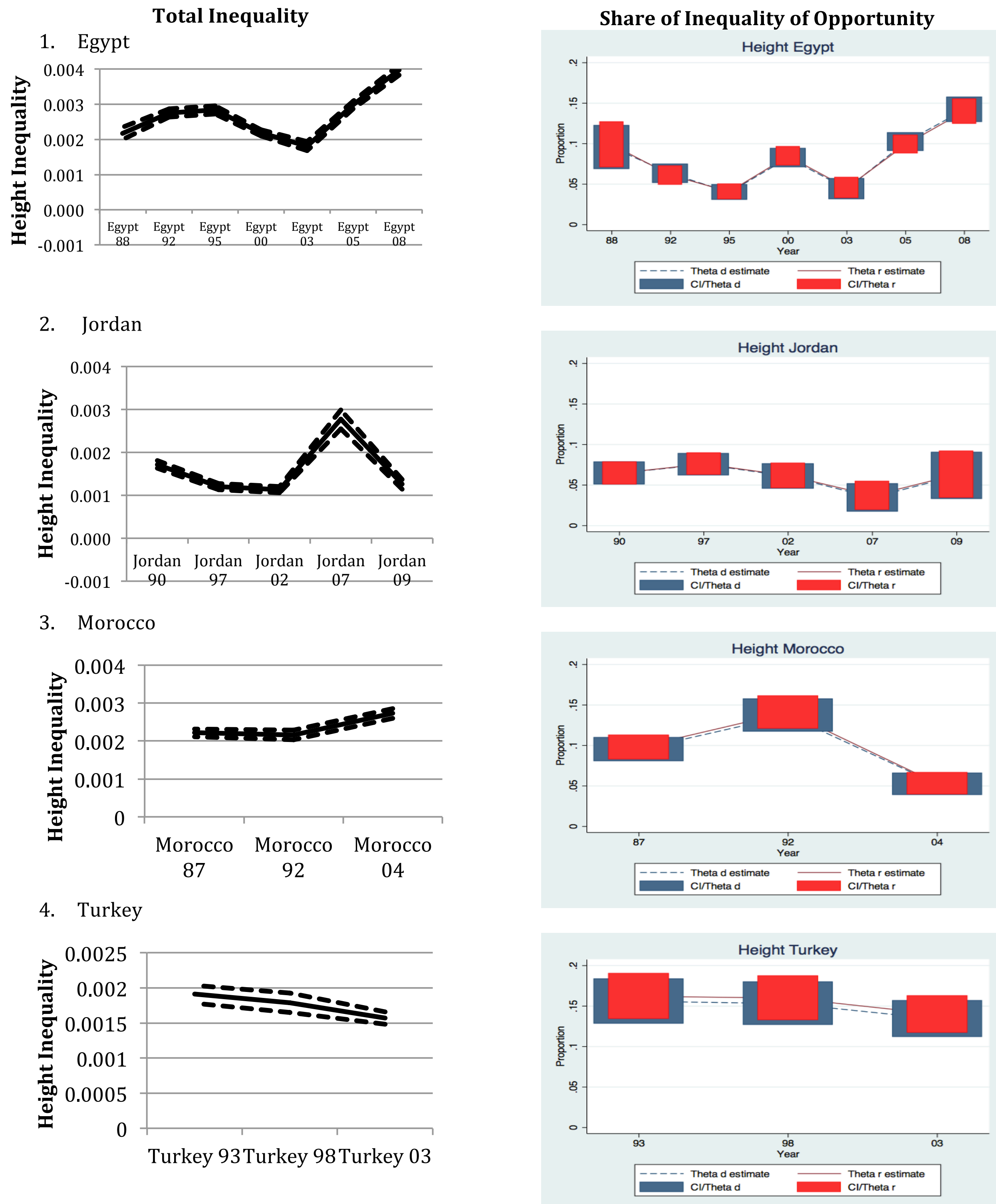
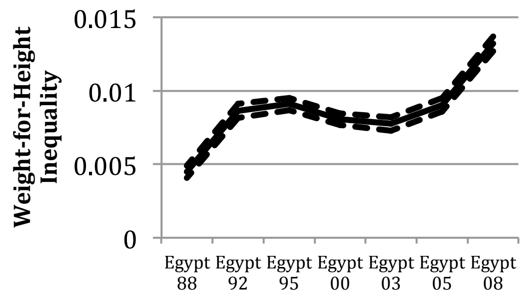
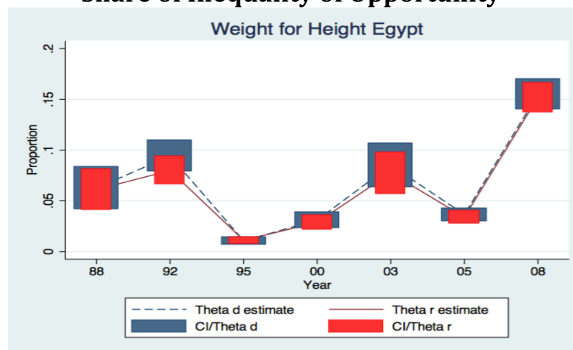


Figure 8 Trend in Total Inequality and Share of Inequality of Opportunity in Standardized Weight-for-Height over Time in Selected Countries (estimates and 95 percent confidence intervals)

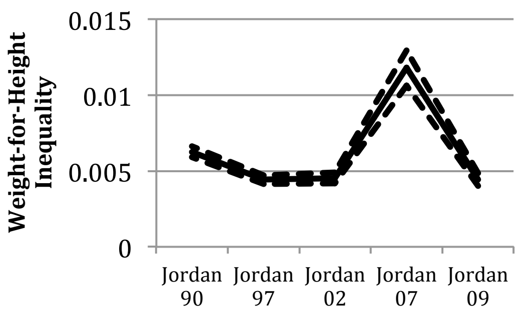
Total Inequality | **Share of Inequality of Opportunity**

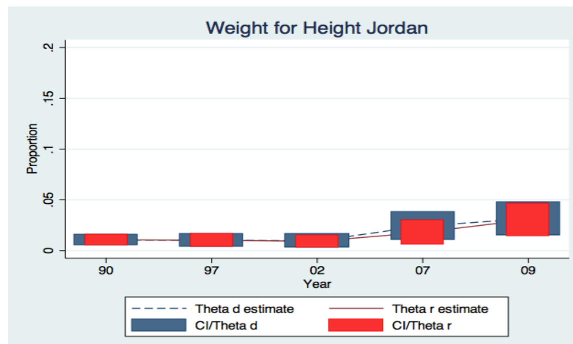
1. Egypt



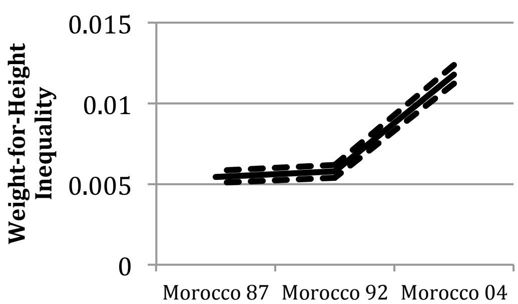


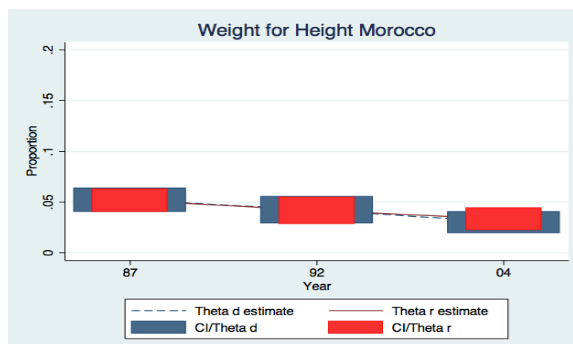
2. Jordan



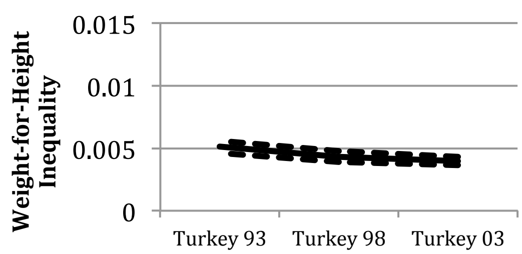


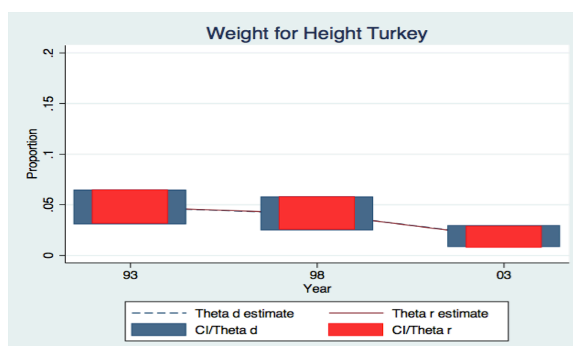
3. Morocco





4. Turkey





7.6 Partial effects: Which circumstances are most important in determining inequality of opportunity?

The partial effects are the shares of inequality due to the partial effect of a specific background characteristic, or a related set of background characteristics, relative to the total inequality of opportunity explained by all background characteristics. Therefore, they indicate how much of the inequality of opportunity is due to a particular set of circumstances, such as parental wealth, or parental education. Since the partial decompositions can only be calculated as a residual (see Equation 5.8), we limit ourselves to the residual method for this exercise. Because we use fewer DHS rounds per country in this part of the analysis, we are able to use a slightly richer parametric specification, one that includes as additional regressors father's occupation, two infrastructure variables relating to access to water and to a toilet in the home, and two additional demographic variables, mother's height and body mass index (BMI). We call this the "augmented specification." To limit the discussion, we group circumstance variables into several groups in discussing their partial contribution. The first group, which we label "region", includes the governorate and province dummies and the urban/rural dummy and thus captures geographic differences in conditions after correcting for other circumstances. The second group, labeled "infrastructure" includes access to piped water in the home and access to a toilet. The "demographic" group includes the child's sex and birth order, the mother's age and age squared when the child was born, and the mother's height and BMI. The "wealth" group includes the household wealth quintiles dummies and the final group "parents' education and occupation" includes father's and mother's education and father's occupation.

In theory, the partial effects of different sets of circumstances should all be positive and should add up to 100 percent of the inequality of opportunity due to all circumstances. However, given the way we calculate these partials (see Equations 5.7 and 5.8) it is possible in practice for some circumstances to contribute negatively under certain correlation structures between different sets of circumstances. This happened in our case with the partials for infrastructure in some years in Egypt and in Morocco. When they had negative partial effects, these variables were for the most part statistically insignificant determinants of child height and weight-for-height.

The results of the partial effects decompositions for the four comparator countries and over time are shown in Figure 9.[9] As shown in the figure, the "region" variables are the dominant drivers of inequality of opportunity in Egypt in both standardized height and weight-for-height. The partial share of "region" in inequality of opportunity in height in Egypt increased from 34 percent in 1992 to 92 percent in 2008. Its partial share in weight-for-height inequality of opportunity is also high, ranging from 37 percent in 1995 to 81 percent in 2008. "Region" appears to play an important role in inequality of opportunity in weight-for-height in Morocco and Turkey as well, where its relative contribution is over 60 percent. The relative importance of geography as a determinant of child health suggests that public goods that affect health and that are unequally distributed in space play an important role in children's access to health and nutrition. The increasing importance of geographic differences in Egypt also confirms the differential effects on children's nutrition of the poultry culling strategy we discussed above.

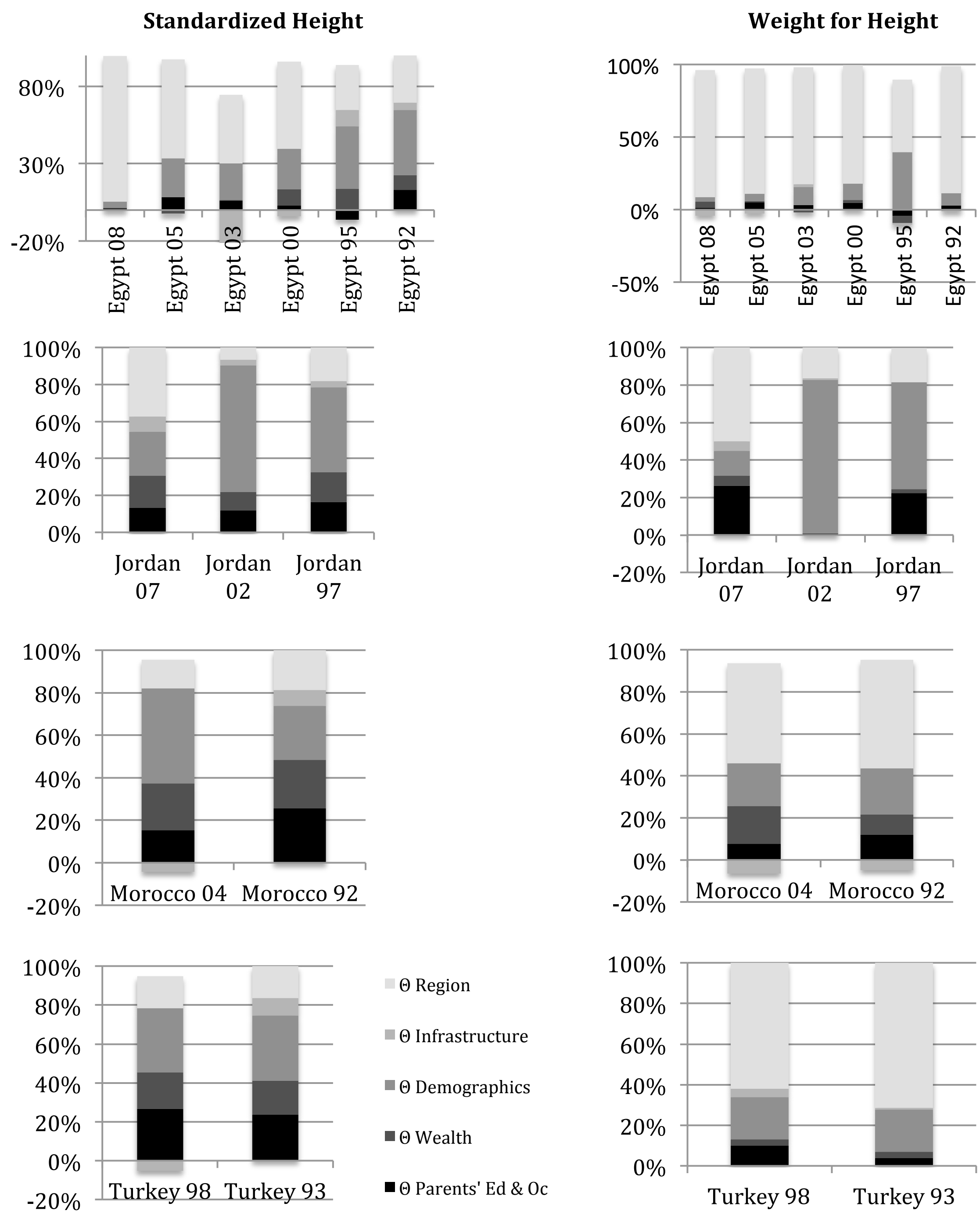
A child's demographic background tends to play the next most important role in inequality of opportunity. Demographics play a particularly important role in Jordan, in Morocco and in Turkey, especially with respect to standardized height. Although one can potentially target children by sex, it is harder and possibly undesirable to compensate through policy for other demographic variables such as mother's height, and BMI. However, the disadvantage that children with "short" mothers are experiencing could very well indicate multigenerational disadvantage in child nutrition.

Parental human capital, as measured by parental education and father's occupation, is surprisingly not very important relative to other sets of circumstances. Its contribution to inequality of opportunity in height ranges from zero to 15 percent in Egypt, from 14 to 22 percent in Jordan, from 21 to 33 percent in Morocco, and from 34 to 39 percent in Turkey. Its contribution to inequality of opportunity in weight-for-height is generally even lower than that.

[9] See the appendix tables in Assaad et al. 2012 for detailed results.

Parental wealth is the last set of circumstances we examine and it appears to have roughly the same magnitude as the parental education and father's occupation set of circumstances. Its contribution to inequality of opportunity in height ranges from zero to 21 percent in Egypt, from 12 to 21 percent in Jordan, from 29 to 30 percent in Morocco and from 25 to 27 percent in Turkey. Again its contribution to inequality of opportunity in weight-for-height is smaller than for height.

Figure 9 Partial Effects of the Contribution of Different Sets of Circumstances to Inequality of Opportunity in Standardized Height and in Weight-for-Height in Selected MENA Countries and Over Time



To ascertain the relative importance of different sets of circumstances in different countries, we summarize in **Table** 2 the frequency with which a particular set of circumstances shows up as most important, second most important, etc. in either the height or weight-for-height decompositions. As shown in the table, the primacy of "region" in Egypt is clear. In 10 out of 12 runs (six waves for height and six waves for weight-for-height) geographic differences show up as the most important set of circumstances in contributing to inequality of opportunity in Egypt. Demographics factors are second, coming out as the second most important set of circumstances 9 out of 12 times. Parents' human capital is the third most important set, coming out third 8 out of 12 times.

In Jordan demographics dominate, coming out on top in four out of six runs. Region is next coming out on top in two out of six runs and as second most important in two out of six runs. Parents' education and occupation is third most important coming in second place in three out of six runs. In Morocco, region comes out on top in two out of four runs, followed by demographics which come out on top once in four runs and in second place three times. Parents' education and occupation is third in importance in Morocco. In Turkey, first place position in terms of importance is split between region, which seems to matter most for weight-for-height and demographics, which matter most for standardized height. Parents' education and occupation is third in importance there.

As a general rule, the two least important sets of circumstances in determining inequality of opportunity in child health and nutrition across all four countries are household wealth and household access to infrastructure. The lack of importance of household connection to infrastructure is somewhat surprising, but given the importance of region, it suggests that what seems to matter most for children's health is the general state of infrastructure in the community rather than the specific access the household itself has to infrastructural services.

Table 2 Circumstance Height and Weight-for-Height Inequality Relative Importance by Country

Height + Weight-for-Height	Most Important	2nd	3rd	4th	Least Important
Egypt					
Parents' Education & Occupation	0	0	8	3	1
Wealth	0	1	2	5	4
Demographics	2	9	1	0	0
Infrastructure	0	0	1	4	7
Region	10	2	0	0	0
Height + Weight-for-Height					
Jordan					
Parents' Education & Occupation	0	3	1	2	0
Wealth	0	0	2	3	1
Demographics	4	1	1	0	0
Infrastructure	0	0	1	0	5
Region	2	2	1	1	0
Height + Weight-for-Height					
Morocco					
Parents' Education & Occupation	1	0	2	1	0
Wealth	0	1	2	1	0
Demographics	1	3	0	0	0
Infrastructure	0	0	0	0	4
Region	2	0	0	2	0

Height + Weight-for-Height					
Turkey					
Parents' Education & Occupation	0	2	2	0	0
Wealth	0	0	2	1	1
Demographics	2	2	0	0	0
Infrastructure	0	0	0	1	3
Region	2	0	0	2	0

7.7 Most and least advantaged child simulations

As a final exercise, we look at the combined effect of all circumstances by examining the predicted outcomes for specific child profiles in terms of the circumstances we observe. We add to this analysis two more countries --Tunisia and Yemen-- for which there is only one DHS survey. We undertake the simulations using "base" specification of the regression of the two health outcomes on observed circumstances. We simulate the standardized height and weight-for-height outcomes for a "most advantaged" and a "least advantaged" child by setting the circumstances variables at their best and worst levels, respectively, depending on their coefficients in the regression for the relevant country-year combination. The most advantaged child in most cases is a child whose parents are university educated, who lives in an urban area in a household in the top wealth quintile, and who is the first-born child. The least advantaged child in most cases is a child whose parents have no education, who lives in a rural area in a household in the lowest wealth quintile, and who is of high parity (set at three for this exercise).[10] Child sex and mother's age did not have a regular relationship with advantage or disadvantage and were set at the level that produced the highest (lowest) predictions in the most (least) advantaged profile. Although being part of a multiple birth was a clear source of disadvantage in most cases, we assumed that both the most advantaged and least advantaged child were single births due to the rarity of multiple births events.

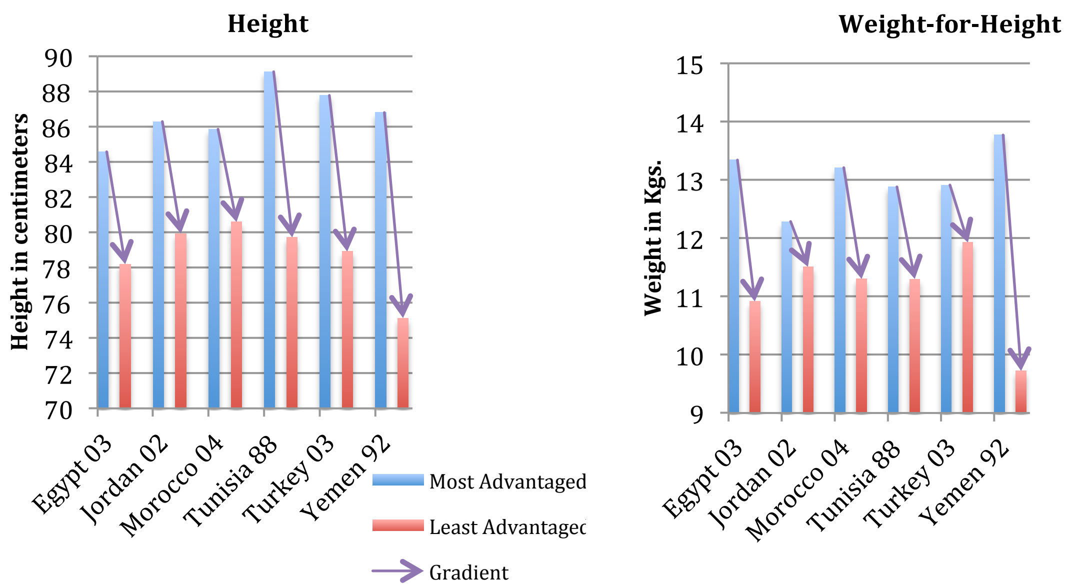
The predicted standardized height and weight-for-height for the most and least advantaged child profile in each country are shown in **Figure** 10. Both the levels of the predictions and the dispersion between the most and least advantaged children are noteworthy. The fact that Yemen has the shortest height and the lowest weight-for-height for the least advantaged child is no surprise, but what may be surprising is that the most advantaged child in Yemen is taller than the most advantaged child in either Egypt, Jordan or Morocco, and heavier for his/her height than the most advantaged child in any of the other six countries. This indicates a much larger range in Yemen and therefore greater inequality of opportunity there. Tunisia does relatively well in terms of the height of the most advantaged child, but is about average for the least advantaged child, making it among the worst performers on equality of opportunity in height in the region. Turkey, also a relatively rich country, exhibits a similar pattern. In contrast, Turkey and Tunisia exhibit relatively small gaps between the most and least advantaged child in weight-for-height. Egypt has relatively large gaps in both height and weight-for-height in 2003 and this is before the sharp worsening in both these indicators that occurred in the 2005-2008 period. Morocco in 2004 has the smallest gap in height but the third highest gap in weight-for-height.

While consistent for the most part with the results of the inequality decomposition above, the results of the opportunity gap between the most and least advantaged child profiles also provide some notable differences in results. The results are mostly consistent in terms of the relative ranking of Egypt, Morocco, Turkey and Jordan in the inequality of opportunity of weight-for-height, and in terms of the relative ranking of Turkey in the inequality of opportunity of height. However, they are inconsistent when it comes to the relative rank of Egypt along that same dimension. Egypt had the lowest share of inequality of opportunity in height among the four countries (see left panel of Figure 6), but the second highest gap after Turkey (see left panel of Figure

[10] There were a few exceptions in some country-year combinations where the most advantaged and least advantaged profiles were different from this, but this usually happened when the variable in question was not statistically significant in that country-year regression. Please refer to Tables A6 and A7 in Assaad et al. 2012 for the regression results on which the simulations were based.

10). We can conclude from this that when the differences in inequality of opportunity shares and gaps are relatively small, as is the case between Egypt, Jordan and Morocco on the height dimension, the two methods may produce seemingly contradictory rankings.

Figure 10 Simulations of Standardized Height and Weight-for-Height for Most and Least Advantaged Child Profiles, Based on All Circumstances in Base Specification



8 Conclusions

The early years of a child's life are key to successful physical and cognitive development. While a healthy childhood lays the groundwork for success later in life, health problems in childhood are both persistent and damaging to later outcomes. This paper has shown that children in the Arab world and Turkey face unequal opportunities to accumulate key dimensions of health, both height and weight, based on their circumstances. Circumstances entirely beyond the control of children determine their ability to develop healthily and succeed in life.

Using DHS data we examined the height and weight of children age five and younger in Egypt, Jordan, Morocco, and Turkey across a number of years to assess the inequality in health outcomes that is attributable to unequal circumstances. Total inequality in child health in Egypt has been rising slightly over time, while the share of inequality of opportunity has been oscillating. 2008 was a particularly bad year for Egypt's children, both in terms of inequality of child outcomes and inequality of opportunity, with geographic location explaining most of the variation in outcomes attributable to circumstances. We speculate that this is due to interventions used to curb the spread of avian influenza, which consisted of culling domestic birds, one of the main source of protein for children under 5 in certain parts of Egypt. Jordan is doing fairly well in terms of both low and slightly declining total inequality, with fairly stable shares of inequality of opportunity. Morocco is experiencing rising total inequality, but the share of inequality of opportunity has risen and then fallen, suggesting that factors other than the circumstances we observe are responsible for the rise in inequality of child health outcomes in Morocco. Turkey, despite having fairly high inequality and a high share of inequality of opportunity, has exhibited the most consistent declining trend in both. Comparing across countries around 2003, Morocco exhibited the highest total inequality, and Turkey the highest inequality of opportunity. Jordan demonstrated the lowest total inequality and inequality of opportunity.

A variety of different circumstances were shown to contribute significantly to the inequality of opportunity we measured. Familial characteristics, such as parental education, wealth, and occupation did not have as big a contribution as we expected. In no country-year combination did household wealth show up as the most important circumstance in determining inequality of child health and nutrition, and other parental characteristics showed up as most important in only one year in one country, Morocco. Demographic characteristics, including child gender and birth order, as well as mother's anthropometrics, often had a large role in determining inequality of opportunity. They tended to show up as the most important set of circumstances in countries that are doing well in terms of inequality and inequality of opportunity, like Jordan. In other words, when there is low inequality of opportunity, demographic variability becomes the main source of (explained) variability in child health outcomes.

The set of circumstances that was most likely to show up as the most important source of inequality of opportunity is geographic location. Where a child lives appears to strongly determine his/her health and nutrition outcomes, especially in countries with higher inequality of opportunity, such as Egypt, Morocco and Turkey. This result suggests that the unequal distribution of public goods, such as water and sewer infrastructure, health facilities, and possibly food distribution channels plays a critical role in child health outcomes. For example, rural Upper Egypt in Egypt and Eastern Turkey had a disproportionate number of the disadvantaged children in terms of health and nutrition and this disadvantage remained after correcting for parental characteristics and household wealth. It is notable that this geographic disadvantage in Egypt shifted dramatically to Lower Upper Egypt in 2008, a region that is likely to have been more strongly affected by the culling of household poultry in response to the avian influenza epidemic.

Surprisingly, household-specific connections to piped water and the availability of a toilet seemed to contribute little to inequality of opportunity. We conclude from this that what is important is the general level of sanitation in the community rather than the household's individual access to services. The apparent importance of community-level variable to inequality of opportunity in child health requires further research to elucidate which public good deficits are most critical to child outcomes.

To assess differences between children in the best and worst circumstances, we used the parametric estimates of the effects of circumstances on child health outcomes to simulate height and weight-for-height outcomes for a most and least advantaged child in each country. The difference between these two hypothetical children in a given context illustrates the extent to which circumstances matter and is therefore an alternative measure of the importance of inequality of opportunity. For this exercise, we added to the four countries examined above, Tunisia and Yemen, countries for which there is only one year of DHS data.

While some of the results on the levels of the predicted outcomes were not surprising, others were unexpected. Tunisia and Turkey, the richest countries in the group, had, as expected, the highest predicted height for the most advantaged child, but they fared poorer than Jordan and Morocco when it came to their least advantaged child. This essentially shows that these two countries have high inequality of opportunity in this particular outcome. The large gaps in both Tunisia and Turkey can be attributed in large part to the important geographic disparities observed in these two countries. Similarly, Yemen, the poorest country represented here, had the worst outcomes for the least advantaged child in both height and weight-for-height, but, surprisingly, the third best and best outcomes, respectively, for its most advantaged child; another indication of severe inequality of opportunity. The relative ranking of countries in terms of inequality of opportunity obtained by the most-least advantaged comparison proved to be consistent for the most part with that obtained using the much more complicated inequality decomposition method.

Unlike demographic contributors to inequality of opportunity, which depend on household behavior (such as son preference) and intergenerational transmission of disadvantage, geographic contributors can be directly addressed by policy. Such geographic disparities arise from unequal distribution of public goods and can be rectified by modifying the geographic distribution of public investment and expenditure strategies. The fact that Jordan fares well in terms of both the level of inequality and the share of inequality of opportunity suggests that the Jordanian government has done well in providing fairly equal access to public services and infrastructure to different parts of the country. However, it should also be noted that Jordan also stands out in terms of its achievements in improving the education of mothers, a dimension that both Egypt and Turkey are doing increasingly well on, but where Morocco is still lagging.

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