Inequality of opportunities among children: how much does gender matter?

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Abstract

We apply a decomposition method to a measure of inequality of opportunities among children (the Human Opportunity Index) to examine the question of how much does gender of a child contribute to inequality in access to critical services that should be available as basic minimum opportunities to all children. We use a database of 47 countries for which DHS data is available during 2003-2010, four indicators for opportunities and a limited set of circumstances or characteristics of the child. On the average and for most countries, the contribution of gender of the child to inequality of opportunity in two measures of school attendance and immunization tends to be low and much below the contribution of household factors such as economic status and urban/rural location. In a few countries, however, gender still plays a more substantial role in influencing a child's access to a particular service. Preliminary evidence also suggests that inequalities and contributions of gender to inequality across opportunities are correlated, particularly for opportunities in the same sector.

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I. Introduction

The attempt to universalize access to a set of basic goods and services, such as clean water, sanitation, and education lies at the core of the pursuit of development. A person's ability to pursue a productive life of her choosing depends to a large degree on her ability to access such primary goods and services. Access to a basic set of goods and services provides a person the *opportunity* to advance, although they may or may not achieve this advancement. The World Bank's emphasis on equity has been highlighted in the 2006 World Development Report, *Equity and Development*. The report argues that inequality of opportunity sustains extreme deprivation, results in wasted human potential and often weakens prospects for overall prosperity. Regardless of the choice a society makes about *how* to universalize access to opportunities, there is a need for systematic ways for a country to *measure* its progress towards providing opportunities to all its citizens, beyond commonly used measures of overall coverage of or access to goods or services. The empirical work being conducted by the World Bank seeks to address this need at the country level.

The approach adopted by the Bank aims to measure how opportunities are distributed among *children* in a country. The focus is on goods and services that constitute investments in children, which in turn have a major impact on achievements in adult life. Equality of opportunity would imply that a child's access to basic services not be related to *circumstances*, namely the individual, family or community characteristics that s/he has no control over (exogenous). A principle of equality of opportunity would require that a child's likelihood of accessing such opportunities is independent of his/her exogenous circumstances, such as gender, ethnicity, location and economic status.[1] Based on this framework, the objective of this note is to measure to what extent *gender* of a child influences his/her access to basic opportunities, relative to other exogenous circumstances that also influence access to the same opportunities.

The basic building block of the analysis is an index that has been developed by Bank staff in collaboration with external researchers (see Barros et al., 2009). The Human Opportunity Index (HOI) is a simple and effective measure of society's progress in equitably providing opportunities for all children. HOI takes into account how the personal "circumstances" for which a child cannot be held accountable, like location, gender, household composition or parental wealth, affect his/her probability of accessing basic services that are necessary to succeed in life, like timely education, vaccination, running water or electricity.[2]

[1] Perhaps most important for the proposed work are the contributions of John Roemer, whose 1998 work Equality of Opportunity was the first to formalize an equality of opportunity principle.

[2] A 2009 report for Latin America and its updated 2010 version examined five indicators (access to clean water, sanitation and electricity, completing sixth grade on time, and attending school from age 10-14) for 19 LAC countries, exploring both changes over time within countries and comparisons between countries. In addition, in-depth country reports for Brazil, Colombia, Peru and Uruguay have explored a much richer variety of indicators, including vaccination, micronutrient intake, access to telephone, internet and other basic goods and services. Beyond analyzing an expanded set of indicators, country-level analysis can also help explore how public policies can influence the pattern of opportunity distribution.

II. Human Opportunity Index: a brief description[3]

In its simplest interpretation, the HOI measures the average availability of basic services, discounted by how inequitably the services are distributed among the population. This is done by measuring the coverage rate of a particular service and then adjusting it according to how equitably the available services are distributed among circumstance groups. The construction of the HOI involves aggregating circumstance-specific coverage rates in a scalar measure that increases with overall coverage and decreases with the differences in coverage among groups with different sets of circumstances. This implies that two societies that have identical coverage or average access rate of a particular service may have different HOI if the access to the service on one country is more concentrated among children of a certain set of circumstances.[4]

Specifically, HOI (H) for a particular opportunity is the average coverage rate of access ($\bar{C}$) discounted by a penalty (P) due to inequality in coverage between children of different sets of circumstances.

$$H = \bar{C} - P \qquad (1)$$

The penalty is defined according to the set of circumstances considered. It means that the penalty will change if we change the set of circumstances, and will be zero if no circumstances are considered. It also implies that the maximum value of HOI for a particular opportunity is the average coverage rate for that service, given by $\bar{C}$. It also implies that an HOI of 100 would be possible only when access is universal ($\bar{C}$ is equal to 100 and P is equal to 0). Alternatively, HOI can be expressed as the coverage rate multiplied by a factor of equality.

$$H = \bar{C}\left(1 - \frac{P}{\bar{C}}\right) = \bar{C}(1 - D) \qquad (2)$$

Where $(1 - D)$ is the equality factor that is equal to one if access to the opportunity is independent of the circumstances, in which case HOI is equal to the average coverage rate. D can be interpreted as share of the total number of opportunities that needs to be reallocated between circumstance groups to ensure equality of opportunities, which we refer to as the dissimilarity index or the inequality of opportunity index. With disjoint circumstance groups, one can compute D as follows:

$$D = \frac{1}{2\bar{C}} \sum_{k=1}^{m} \alpha_k \, |\bar{C} - C_k| \qquad (3)$$

Where k denotes a circumstance group (group of children with a specific set of circumstances); $\bar{C}$ the average coverage rate; C_k the specific coverage rate of group k; α_k the share of group k in total

[3] This section is a much shortened version of the concepts discussed in detail in Barros et al. (2009, 2011). For a complete description of the measure, its rationale, properties and limitations, see Barros et al. (2011).

[4] The HOI can take a value between 0 and 100. A society that has achieved universal coverage in a particular opportunity (e.g. primary school enrollment) would score 100, with no penalty imposed since universal coverage implies that personal circumstances are irrelevant. On the other hand, a society that has average primary enrollment of 50 percent and enrollment is skewed towards unequally distributed in favor of children of certain circumstances (say, urban children with high parental wealth), will have an HOI below 50 in primary enrollment, with the exact value of HOI depending on how unequal enrollment is among children of different circumstances.

population of children; and m the numbers of disjoint groups defined by circumstances. D is equal to zero when $C_k = \bar{C}$ for all *k* circumstance groups, in which case HOI is equal to the coverage rate $\bar{C}$. It can also be shown that D is equal to the *share* of total opportunities that are "misallocated" in favor of (against) circumstance groups that have coverage rates higher (lower) than $\bar{C}$. This also implies that any reallocation of opportunities to "vulnerable" groups (those with coverage less than $\bar{C}$) from "non-vulnerable groups (with coverage more than $\bar{C}$) will reduce D and increase HOI. Thus HOI is an inequality sensitive coverage rate in the sense that it improves when inequality between circumstance groups decreases with a fixed number of opportunities in a society, or when the number of opportunities increase and inequality among circumstance groups stays constant.

Properties and computation of the Human Opportunity Index

The important properties of HOI are as follows: (a) *range*: the value of HOI lies between $\bar{C}^2$ and $\bar{C}$; (b) *sensitivity to scale*: if coverage for all groups changes additively or multiplicatively by k, HOI also changes (additively or multiplicatively) by the same factor k; (c) *sensitivity to Pareto improvements*: if coverage for one circumstance group increases without decreasing the coverage rates of the remaining groups, HOI increases; and (d) *sensitivity to redistribution*: if coverage rate of a vulnerable group increases holding the overall coverage rate constant, HOI also increases.[5]

A notable feature about the dissimilarity or D-index (and therefore HOI) is that the index is a function of the set of circumstances considered, and can change as circumstances change. This is a result of the fact that HOI is by design sensitive only to inequality *between* circumstance groups, which would naturally vary with the number of groups considered. More formally, $D = D(x)$, where x is the vector of circumstances. The problem that there is no *unique* D-index or HOI for a particular opportunity in any population is mitigated somewhat by another property of the index: D-index for a particular opportunity will only increase (i.e. HOI will only decrease in value) if more circumstances are added to an existing set of circumstances. More formally, $D(x) \leq D(x, z)$ for any set of circumstances z.[6] This implies that the D-index cannot be lower, even if hitherto missing circumstances were to be added to the initial set of circumstances.[7] This is a useful property, given that it is impossible to consider *all* relevant circumstances for any population and opportunity, since the selection of circumstances, which are exogenous to individuals while being relevant for society to consider, is a matter of subjective judgment *and* depends on what the data allows.

[5] Another important algebraic property is that changes in HOI over time can be decomposed into three components: (i) composition effect, which refers to the contribution of changes in the distribution of circumstances to the change in HOI; (ii) scale effect, which refers to the contribution of a proportional change in the coverage rate of all groups; and (iii) equalization effect, which refers to the contribution of the change in the coverage of vulnerable groups keeping the average coverage rate unchanged.

[6] See Barros et al. (2011) for more details and formal proof of this property.

[7] Note however that this property may not hold for change in the *definition* of a circumstance, as opposed to increase in the no. of circumstances. In other words, if the same circumstance were to defined in a different way, for example by changing the categories within a circumstance like education of a household head or location, there is no guarantee that HOI will always move in the same direction.

There is also a *limitation* to the sensitivity of the index to inequality between groups – the D-index does not change with redistribution of opportunities *among* vulnerable (or non-vulnerable) groups, namely among groups that have below (or above) average coverage rate. To illustrate what this means, consider a country where the average school enrollment rate for 12-15 year olds is 50 percent and enrollment rates for circumstance groups A and B are 40 percent and 30 percent respectively. A shift of enrollment in favor of the more vulnerable group (group B) that results in an enrollment rate of 35 percent for both groups will leave the D-index and HOI unchanged. A third caveat about the index is that it is not sub-group consistent. This implies that the D-index (and HOI) for a population cannot be decomposed into similar measures for sub-groups of the population; it also means that the change in HOI for a particular opportunity over time for the whole population may not be consistent with the change in HOI for sub-groups of the same population.

To allow computation of HOI for education and health opportunities, a household survey is essential and the survey must have a minimum set of information, at the individual (child) or household level, as appropriate. Examples of these would be whether the child is attending school or not and has been immunized against certain diseases or not. With regard to circumstances, the minimum information needed to make the analysis meaningful would be gender and location (urban/rural and/or regional) of the child, characteristics of parents (such as gender) and some measure of household economic status (income, consumption or wealth). Other circumstances can be added as available from the survey.

In practical terms, computing HOI for a particular opportunity when the number of circumstances is relatively large requires an econometric exercise,[8] which involves obtaining a prediction of the D-index from observed access to opportunities and circumstances among children. In simple terms, the exercise consists of running a logistic regression model to estimate the relationship between access to a particular opportunity and circumstances of the child, on the full sample of children for whom the HOI measure will be constructed. The estimated coefficients of the regression are used to obtain for each child his/her predicted probability of access to the opportunity; which is then used to estimate the D-index, the coverage rate and eventually the HOI (see Section III for more details).

III. Identifying the role of gender using the HOI framework

Before we go about addressing the question of how important is the gender of a child in determining his/her access to basic opportunities in education or health, it is important to identify the exact question we would be analyzing. The way we frame the question is as follows: what is the "contribution" of gender to inequality of opportunities that we observe among children, among the key set of circumstances (e.g. gender of child, household wealth, location and gender of parents) that are likely to be important drivers of such inequality? The contribution of gender here essentially refers to the extent to which gender, when it is considered a circumstance, contributes to the total extent of inequality

[8] It is easy to see that the number of circumstance groups multiplies rapidly as the number of circumstances (and the number of categories within each circumstance) increases. When the number of circumstance groups becomes large, the non-parametric method of computing the index, which will require computing D as given by equation (3), becomes unwieldy and runs into problems due to extremely small sample sizes for some of the groups.

(measured by the D-index) that is attributable to (or "explained by") differences in all the circumstances considered here.

Shapley decomposition of inequality of opportunities

The approach we use to address the question posed above involves applying the decomposition proposed by Shorrocks (1999), which is based on the Shapley value concept in cooperative games to distribute among the players the surplus produced by a coalition of cooperating players.[9] The idea behind applying Shapley decomposition would be to identify how much the measure of inequality of opportunities would change when we add a circumstance to different pre-existing sets of circumstances. The change in inequality as a result of adding a circumstance appears to be a reasonable indicator of the "contribution" of a circumstance to inequality of opportunities.

Implementing this idea however needs to take into account the fact that since the circumstances are correlated to each other, the change in the measure obtained by "adding" a circumstance depends on the initial set or subset of circumstances to which it is added. Thus to identify the unique impact of adding a circumstance to the measure, we would need to consider all the changes that occur when the circumstance of interest is added to all possible subsets of pre-existing circumstances, and take the average of all these possible changes. This intuitive explanation will become clearer in the formal description that follows and the hypothetical example found in the Appendix.

Following Barros et al. (2009, 2011) we can measure inequality of opportunities by the penalty (P) or by the dissimilarity index (D), as defined in expressions (1) and (3) above. The value of these two measures – where P is just a scalar transformation of D – is dependent on the set of circumstances considered. Moreover, they have the important property that adding more circumstances always increases the value of P and D. If we have two sets of circumstances A and B, and set A and B do not overlap, then $HOI(A,B) \leq HOI(A)$; and alternatively, $D(A,B) \geq D(A)$. The impact of adding a circumstance A is given by:

$$D_A = \sum_{S \subseteq N \setminus \{A\}} \frac{|s|!\,(n-|s|-1)!}{n!} \left[D(S \cup \{A\}) - D(S)\right] \qquad (4)$$

Where *N* is the set of all circumstances, which includes *n* circumstances in total; *S* is a subset of *N* (containing *s* circumstances) that does not contain the particular circumstance *A*. *D(S)* is the dissimilarity index estimated with the set of circumstances *S*. $D(S \cup \{A\})$ is the dissimilarity index calculated with set of circumstances *S and* the circumstance *A*.

[9] The Shapley value solution concept in cooperative game theory generates a unique distribution (among the players) of the total surplus generated by a coalition of players participating in a cooperative game. Shapley value solution provides a unique answer to the following question. In a setup where a coalition of players produces certain overall surplus (where some players may contribute more to the coalition than others or may possess different bargaining power), how important is each player to the overall cooperation and what payoff can s/he reasonably expect? This unique solution satisfies a number of desirable axioms, including: individual fairness in the sense that every player in the coalition gets at least as much as s/he would have got if s/he had not cooperated at all; efficiency, which implies that the total gain is distributed; and symmetry, which implies that two actors who are equivalent receive the same allocation.

We can define the contribution of circumstance A to the dissimilarity index as:

$$M_A = \frac{D_A}{D(N)} \qquad (5)$$

$$where \sum_{i \in N} M_i = 1$$

In other words, the sum of the contributions of all circumstances to the dissimilarity index adds up to 100 percent – a critical property satisfied by the Shapley decomposition. To illustrate how the decomposition works in practice, we use a hypothetical example, where the HOI is estimated on the basis of three circumstances (see Appendix).

Applying the decomposition: how much does gender contribute to inequality?

To identify the contribution of gender in inequality of access to an opportunity, we apply a decomposition method on the component of the HOI termed as the dissimilarity index, for a few selected opportunities. The selected opportunities are immunization against polio, *immunization against measles* (both at age 1 year) and *school attendance* among children of age 6-11 years and 12-15 years (separately). The set of circumstances we consider includes *gender* of the child, *location* of the child (urban/rural), *wealth quintile* of the household of the child belongs to and *gender of the household head*. The data used for the analysis is Demographic and Health Survey (DHS), for the latest year available for all countries. Forty-seven countries are used for the analysis, based on the availability of DHS data for recent years (between 2003 and 2010).

The choice of opportunities is driven by the need to focus on a few key indicators that are considered critical by the WDR 2012 team, in terms of their impact on a child's welfare and potential as well as the inequities (across children of different circumstances) that are likely to exist in how these opportunities are distributed. Another factor that played an important role in the selection is whether the indicator is available from DHS surveys for the maximum number of countries and measured in a comparable manner across surveys. Needless to say, similar analysis can be done for an expanded set of opportunities selected on the basis of other criteria.

The choice of circumstances, which essentially determines how "inequality of opportunity" is defined for the analysis, was another important decision to be made. Given the way HOI is defined, it is only the inequality between (and not within) circumstance groups that matters, and exactly which circumstance groups are considered in turn depends entirely on the choice of circumstances. A parsimonious set of circumstances was chosen for this analysis for two main reasons. Firstly, the parsimonious set ensures that the same set of circumstances, similarly defined, can be used across all countries. Secondly, using a small number of circumstances also implies that the relative "contribution" of gender in inequality of opportunities, as measured here, is likely to be an "upper bound" of the contribution of gender, regardless of the number of circumstances used in the analysis. To see why this is the case, recall the property (discussed earlier) that D-index cannot be lower, even if hitherto missing circumstances were to be added to the initial set of circumstances. As more circumstances are added to the parsimonious

set and the value of the D-index increases, the contribution of gender to the D-index is likely to fall. In other words, the contribution of gender to inequality estimated with the parsimonious set of circumstances is likely to be an upper bound of the contribution even if more circumstances were to be added.

Using harmonized DHS data for 47 countries, the Shapley decomposition of the D-index is conducted for the opportunities listed above, using the four circumstances as mentioned. To explain how this is done, it is first useful to describe how the D-index and HOI are estimated econometrically, along the lines of what was described in Section II earlier.

Consider any opportunity (e.g. attending school) in a country, defined as a discrete (0-1) variable, with "1" denoting "yes" and "0" denoting "no". Our objective is to obtain the conditional probabilities of access to this opportunity for each child based on his/her circumstances. In order to do so, a logistic model is estimated, linear in the parameters β, where the event I corresponds to accessing the opportunity and X the set of circumstances. The following logistic regression is fitted using survey data:

$$\ln\left(\frac{P\{I=1|X=(x_1,\dots\dots,x_n)\}}{1-P\{I=1|X=(x_1,\dots\dots,x_n)\}}\right)=\sum_{k=1}^{n}x_k\beta_k \qquad (6)$$

Where x_k denotes the row vector of variables representing n circumstances and β_k a corresponding column vector of parameters.[10] From the estimation of (6) regression one obtains estimates of the parameters $\{\beta_k\}$, denoted as $\{\hat{\beta}_{k,m}\}$, where m denotes the sample size.

Given the estimated coefficients, one can obtain for each individual in the sample his/her predicted probability of access to the opportunity in consideration:

$$\hat{p}_{i,m}=\frac{Exp(x_i\hat{\beta}_m)}{1+Exp(x_i\hat{\beta}_m)} \qquad (7)$$

Using the predicted probabilities ($\hat{p}$) and sample weights (w_i), we find the predicted overall coverage rate ($\hat{\bar{C}}$) and D-index ($\widehat{D}$) as:

$$\hat{\bar{C}}=\sum_{i=1}^{m}w_i\hat{p}_{i,m} \qquad (8)$$

[10] Notably, the circumstances enter the regression singly, without any interaction terms between them. This is a simplifying assumption in the estimation model, to avoid the problems that can arise with large number of independent variables. The assumption implies that the estimated $\widehat{D}$ and $\widehat{H}$ with n circumstances can be quite different from the analytical D and HOI computed using a direct application of equations (2) and (3), if the missing interaction terms are important in the estimation of the logistic regression. That said, the missing interaction terms are only likely to bias $\widehat{D}$ downward (and $\widehat{H}$ upward), given the point made earlier that addition of circumstances can only increase (or reduce) the value of D (or HOI). This would also mean that in most cases, the contribution of gender to the estimated D-index will be lower if interaction terms were to be introduced. Exceptions to this however cannot be ruled out, and will depend on the direction and size of the effect of the interaction terms (of gender with other circumstances) in the estimation of the logistic regression.

$$\widehat{D} = \frac{1}{2\hat{\bar{C}}} \sum_{i=1}^{m} w_i \left| \hat{p}_{i,m} - \hat{\bar{C}} \right| \qquad (9)$$

Using (8), (9) and equation (2) in Section II, the predicted HOI ($\widehat{H}$) is estimated as:

$$\widehat{H} = \hat{\bar{C}}\left(1 - \widehat{D}\right) \qquad (10)$$

The *contribution* of circumstance *k* to the D-index for a particular opportunity is estimated using the relationships given by (4) and (5) above, with two qualifications: (i) $\widehat{D}$ substitutes for D, and (ii) the set of circumstances N is now given by the set of circumstances considered here – gender, location, wealth quintile and gender of the household head.

To describe intuitively, as mentioned earlier, the Shapley decomposition seeks to identify how much the estimated D-index for a certain opportunity in a population would change when an additional circumstance is added to different pre-existing sets of circumstances, and this is taken as the "contribution" of that circumstance to inequality of opportunities. To illustrate through an example, consider the following question: how much does gender (of the child) contribute to inequality of opportunities in school attendance among 12-15 year olds? The Shapley decomposition method would answer this question by measuring the impact of adding gender of the child as a circumstance on the predicted D-index ($\widehat{D}$), which involves taking the average of *all* impacts on $\widehat{D}$ when gender is added to all possible subsets of the three other circumstances. This is done by estimating the logistic regression given by (6) for a number of different configurations of covariates (circumstances) – all possible subsets of the three circumstances and then with gender added to each configuration; obtaining $\widehat{D}$ from all these estimations and then using the relationships given by (4) and (5). The contribution of each circumstance to the D-index calculated this way adds up to 100 percent. For a more detailed description of how this would work, see Appendix.

Results from the analysis

The detailed results of the exercise for the four opportunities specified earlier are shown in Appendix, Tables A-1 to A-4. Figure 1 below shows the coverage rate, HOI and Inequality of opportunity (measured by D-index) for all four opportunities, averaged across all 47 countries in the sample. Since these are just simple averages, unweighted by population, they should not be interpreted as average measures for the whole set of countries, but rather used as rough indicators for comparing between opportunities. An important feature from this graph is that while average coverage and HOI are both higher for school attendance than immunization, inequality (as measured by the D-index) is lower in case of immunization.

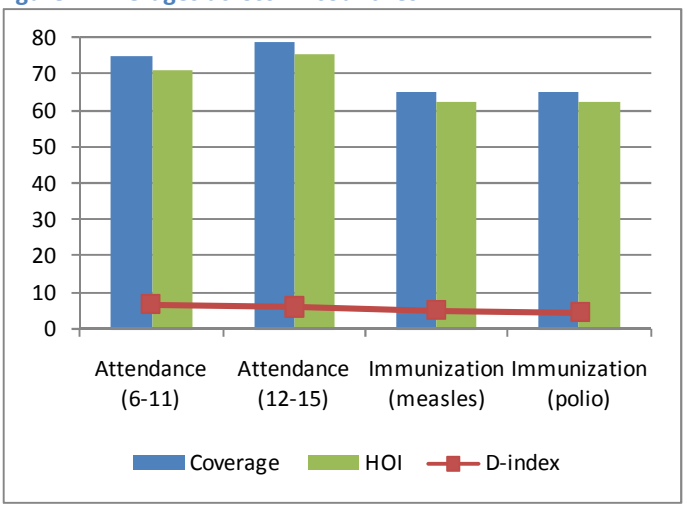
Looking across countries and opportunities, the following patterns stand out as far as the overall inequality of opportunity (measured by the D-index) is concerned.[11] Firstly, on average inequality of opportunity tends to be higher for school attendance (between 6 and 7 percent) than for immunization (between 4 and 5 percent). Secondly, the variation in inequality across countries for the same

[11] Refer to Appendix, Tables A-1 to A-4.

opportunity is higher for school attendance than for immunization. For example, while the average D-index for school attendance among 12-15 years is 6.1 percent, the index ranges from less than 0.5 percent for Maldives and Ukraine to 21 and 27 percent in Chad and Burkina Faso respectively. For immunization against measles, the D-index has an average of 5.1 percent and goes from a low of 1 in Jordan to highs of 12 and 10 percent in Ethiopia and India respectively. Thus inequality of opportunity is higher on the average *and* varies more across countries for school attendance than immunization.

To interpret the numbers quoted above, it is useful to recall here the definition of D-index. D-index or the inequality of opportunity index is the share of total opportunities (e.g. attendance) that would need to be "reallocated" from circumstance groups with higher than average coverage rate to those with lower than average coverage rate to achieve equality of opportunities. This would also imply that as overall coverage rate increases, the D-index will tend to be lower. Empirically, this is what we see on the average from the results, but there are also many exceptions, where country A with a higher coverage rate for a certain opportunity than country B also has the higher D-index.[12] An example of such an exception is also that D-index is lower for immunization than school attendance, even though coverage rate is higher for the latter (Figure 1).

Figure 1: Averages across 47 countries



Note: These are simple averages across countries, unweighted by population

Figures 2 to 5 summarize the information in the Appendix tables, showing clearly the contribution of different circumstances to inequality of opportunity. For example, Figure 2 does this for school attendance among children of age 6-11 years. For each country, it shows the contributions of gender of the child, wealth of the household and other circumstances (gender of household head and location) to the D-index, where the contributions of all circumstances add up to 100 percent. To measure the role of gender in inequality of opportunities, along with the contribution of gender to inequality it is equally important to consider the *extent* of inequality that exists in the first place. To take this factor into account, the countries in Figure 2 are divided into three groups by their D-index: "low" inequality, "moderate" inequality and "high" inequality.[13] The bounds for each group are chosen such that the three groups are of roughly equal size. Countries within each group are sorted by the contribution of gender to inequality of opportunity, in increasing order of magnitude.

[12] To cite one among many examples, coverage rate for school attendance among 6-11 year olds is 67 percent in Nigeria, compared to 64 percent in Sierra Leone and 57 percent in Mozambique. But the D-index for Nigeria, at 16 percent, is higher than the 13 and 9 percent for Mozambique and Sierra Leone, respectively.

[13] "Low" inequality refers to those with D-index between 0.3 and 2.0 percent, "moderate" inequality to those with D-index between 2.4 and 7.6 percent and "high" inequality to those with D-index between 8.2 and 24.4 percent.

Figures 3 to 5 are analogous to Figure 2, showing the contribution of different circumstances (including gender of the child) to inequality of opportunities in school attendance among 12-15 year olds, immunization against measles and immunization against polio for children one year olds. The bounds (in terms of the value of the D-index) for the low, moderate and high inequality countries vary across the figures, reflecting the fact that the D-index varies a lot across opportunities and countries alike.

In a vast majority of cases, gender is not the most significant contributor to inequality of opportunities among children, even among the short list of circumstances considered here. For school attendance of children of 6 to 11 years and 12 to 15 years, gender explains around 10 and 14 percent, respectively, of the D-index on average.[14] Focusing on attendance for 12-15 year olds, gender of the child contributes 20 percent or more to inequality in 12 out of 47 countries for which the analysis is done. For the same opportunity, out of 32 countries where inequality is moderate or high (D-index in the upper two-third of the sample), gender contributes one-fifth or more of the total inequality in only eight. Household wealth, which is by far the most consistently important contributor across countries, contributes at least 50 percent to the D-index in 29 out of 47 countries. In general, gender of the child contributes more to inequality in attendance among older children (12-15 year olds) than among younger ones (6-11 year olds), even as the average inequality of opportunity (D-index) in attendance is quite similar for both age groups.

For immunization against measles and polio, the results are broadly similar. The average contribution of gender to inequality of opportunities in immunization against measles and polio is 11 percent and 13 percent respectively. It is only for the group of countries with moderate inequality in immunization against measles that one sees some contribution of gender to inequality, with seven out of 16 countries showing gender contribution of 20 percent and above. A similar pattern is seen for immunization against polio, although the average contribution of gender in inequality for polio immunization is higher than that for measles. For immunization, when inequality is relatively high, the contribution of gender tends to be particularly low. Out of the 32 cases where inequality is high in immunization against measles or polio, gender contributes to more than 20 percent of the D-index in only a *single* case (Figures 2 and 3). Consider the following for comparison: gender contributes 20 percent or more to inequality in 11 out of 32 cases when inequality in immunization is *moderate*, and in five out of 16 cases when inequality is high in the case of *school attendance for 12-15 year olds*. For countries where inequality in access to immunization is on the high side (relative to other countries), differences in the household's economic status explain the most of the inequality and gender plays a very small role. In general, gender of the child contributes more to inequality in polio immunization than measles immunization, even as the average D-index is quite similar for both types of immunization.

Overall, the contribution of gender of the child to inequality of opportunities, in education (school attendance among 6-11 and 12-15 year olds, separately) or health (immunization against measles and polio, separately) alike tends to be low and far exceeded in most cases by the contribution of other circumstances. In particular, wealth and location play consistently more important roles than gender of

[14] This is obtained from a simple, unweighted average of the contribution of gender in inequality of opportunity across all countries in the sample.

the child in a large majority of countries and opportunities. While the average contribution of gender to the D-index (for each opportunity) ranges from 10 to 14 percent, the average contribution of wealth ranges from 52 to 62 percent and that of location from 21 to 24 percent. The average contribution of the gender of the household head is much lower and varies widely, ranging from 5 to 15 percent depending on the opportunity. For the D-index in school attendance, gender of the child has a higher contribution on the average than gender of the household head. But for immunization, the reverse is true, with the gender of the household head turning out to be a slightly larger contributor to inequality on the average than gender of the child.

There are some cases however where gender, while not the dominant factor, plays a key role in explaining unequal access to opportunities. In Nepal for example, gender of the child contributes 34 percent of the inequality in attendance among 6-11 year olds (a D-index of 2.5 percent), second only to the contribution of wealth. In Burkina Faso, gender of the child contributes as much as 32 percent to a moderate inequality (D-index of 5.2 percent) in immunization against measles among 2-year olds, which is just slightly lower than the contribution of wealth (37 percent).

Looking across opportunities and countries, two questions are useful to consider. Firstly, what is the correlation between inequalities of opportunities in different dimensions? In other words, is a country with high (relative to other countries) inequality in one opportunity is also likely to have high inequality in other opportunities? Secondly, what is the correlation between the contributions of gender to inequality for different opportunities? For example, if gender is a more important contributor to inequality in country A than country B for school attendance of 12-15 year olds, is it also likely to be a more important contributor to inequality in country A for any of the *other* opportunities? The first question is related to the issue of whether inequities in access to basic goods and services tend to be concentrated by country, while the second question is about whether inequality on the basis of gender is concentrated by country. A "yes" to both these questions can hint at systemic issues occurring in certain countries that result in high inequality (overall and what is attributable to gender) in access different types of basic services for children.

The correlations between D-indices across 47 countries for the four different opportunities are shown in Figure 6. There is strong correlation (greater than 0.8) between the D-index for opportunities that are similar, i.e. between school attendance of age 6-11 years and 12-15 years, and between immunization against measles and against polio. But the correlation across different types of opportunities, i.e. between any immunization indicator and any attendance indicator, is much lower (around 0.5 or below). Interestingly, D-index for school attendance among 6-11 year olds has a higher correlation with the D-indices for immunization indicators than does D-index for attendance among 12-15 year olds (see correlation matrix in Appendix, Table A5).

An important caveat however applies to these results. As mentioned earlier, because of the way it is defined, D-index is likely to be lower when coverage rate for an opportunity in a country is higher. Therefore the correlation in D-index may be, at least in part, due to correlation in the *coverage* rates of different opportunities. In other words, the high correlation coefficient between the D-indices for immunization against measles and against polio partly reflects the fact that countries with a high

average rate of immunization against measles are also likely to have the same for immunization against polio. This would necessarily imply that the correlation coefficients overstate the "true" correlation between *inequalities* in different opportunities. However, even if the interpretation of the *values* of the correlation coefficients is complex, the *comparison* of these coefficients across different pairs of opportunities is instructive. The results suggest that the correlations among inequalities of opportunity in the same sector, be that health or education, are much higher than correlations among inequalities in different sectors. That inequality in school attendance for the *lower* age group has higher correlation (than does attendance for the higher age group) with inequality in immunization may suggest that inequalities along different dimensions tend to be concentrated for young children in particular in certain countries.

Figure 7 shows the correlation between the contributions of gender to the D-index for different opportunities, in the sample of 47 countries. The caveat that applies to Figure 6 is not a concern here, since the correlation is that of the contribution of gender (as a share) in the D-index for different opportunities. As above, the correlations within the sector are higher than those across sectors (see correlation matrix in Appendix, Table A6).

IV. Conclusion

The analysis in this paper applies a decomposition method that has been used in the broader literature on inequality before, but not in the context of the Human Opportunity Index (HOI) – a concept that has been used in a number of countries by the World Bank to measure inequality of opportunities among children. The simple and intuitive properties and interpretations of HOI, combining the ideas of universality of coverage with inequality of access among children of different circumstances, make it particularly suitable to address the question of how far does gender contribute to inequality in access to critical basic services that are considered "opportunities". We use a database of 47 countries for which DHS data is available during the last decade, a limited set of four opportunities, and four types of circumstances that define the characteristics likely to influence a child's access to each opportunity. The Shapley decomposition method is used to decompose the "inequality of opportunity index" or D-index into the contributions of each of the four different circumstances to the index. The D-index, which is a component of HOI, can be interpreted as the share of total opportunities in a country that are not distributed in accordance with the equality of opportunity principle.

On the whole, the contribution of gender of the child to inequality of opportunities, in education (school attendance among 6-11 and 12-15 year olds, separately) or health (immunization against measles and polio, separately) alike tends to be low and far exceeded in most cases by the contribution of other circumstances taken together, which are the wealth quintile the household belong to, urban/rural location and gender of the household head. In particular, wealth and location play consistently more important roles than gender of the child for a large majority of countries and opportunities. That said, there are some cases where gender, even if it is not the dominant factor, plays an important role in influencing a child's access to opportunities.

Other interesting results emerge from the analysis as well. It turns out that inequality of opportunity is higher on the average *and* varies more across countries for school attendance than immunization. There is no clear pattern of gender playing a more important role in explaining inequalities in education or health opportunities. But on the average, gender of the child contributes a little more to inequality in attendance among older children (12-15 year olds) than younger ones (6-11 year olds), even as average inequality in attendance is similar for both age groups. On the average, gender of the child also contributes more to inequality in polio immunization than measles immunization, even as average inequality is quite similar for both types of immunization.

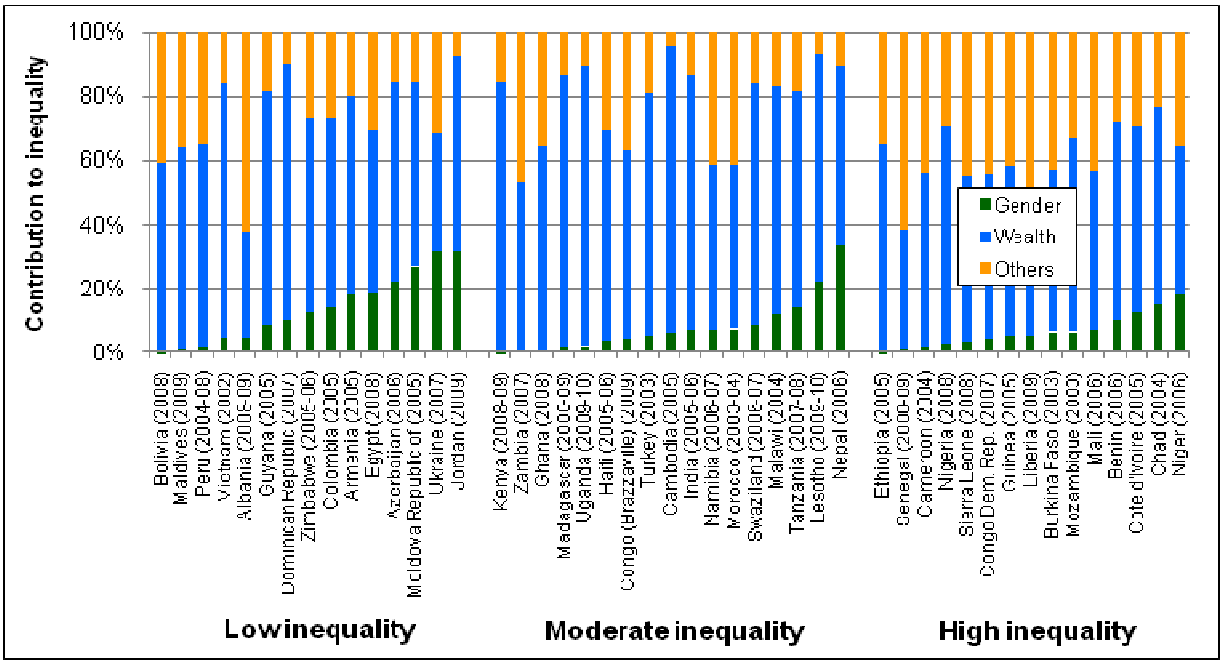
There is some evidence that across different opportunities, inequalities and the contributions of gender to inequality among different opportunities have some correlation, with the correlation being strong for services within the same sector and much weaker across sectors. In other words, countries with higher inequality and higher contribution of gender in inequality in attendance for one age group is also likely to exhibit similar patterns in attendance for the other age group; and the same goes for the two different types of immunization as well. These results are subject to important caveats that arise from the definition and interpretation of the inequality measure (D-index) used here. But they do suggest that inequalities, in terms of access to services in the same sector, are likely to be concentrated among children in certain countries.

A number of caveats to the analytical and empirical methods used here qualify these results. Most importantly, the measure of inequality used here, the inequality of opportunity or dissimilarity index (D-index) is a particular type of measure whose interpretation has been explained above. A different measure of inequality can of course yield different results about inequalities and the contribution of gender to that. The econometric estimation and prediction used to estimate and decompose the D-index are also subject to caveats, which may matter for the value of the D-index and the contribution of gender. Finally, the fact that the estimation of the index uses a relatively small set of circumstances also affects the extent of inequality of opportunities estimated and the contribution of gender to inequality. In that regard, however (and as argued earlier), adding more circumstances would very likely increase the extent of inequality estimated by the D-index and reduce the contribution of gender. This implies that in most cases, the contribution of gender to inequality would not be *higher* than what has been estimated here.

A final word of caution in interpreting these results relates to the choice of indicators or "opportunities" for this analysis. The fact that gender is not the most important contributor to inequality in access to (and use of) four very basic types of services of course does not rule out the possibility that gender does matter for other, equally important opportunities for children, including the *quality* of education and health services that children have access to. Even in the context of the four indicators used here, the choice of countries and dataset are not intended to be representative for the whole developing world. Rather, the objective of this exercise with all its limitations has been to examine evidence across as many countries as possible, using similar datasets and a unified and intuitive methodology, to examine what the evidence can tell us about the contribution of gender to inequality of a certain type. We hope the preliminary evidence on this issue from a large number of countries we provide here serves as a motivation for future research, perhaps on a country-by-country basis. Such research would be

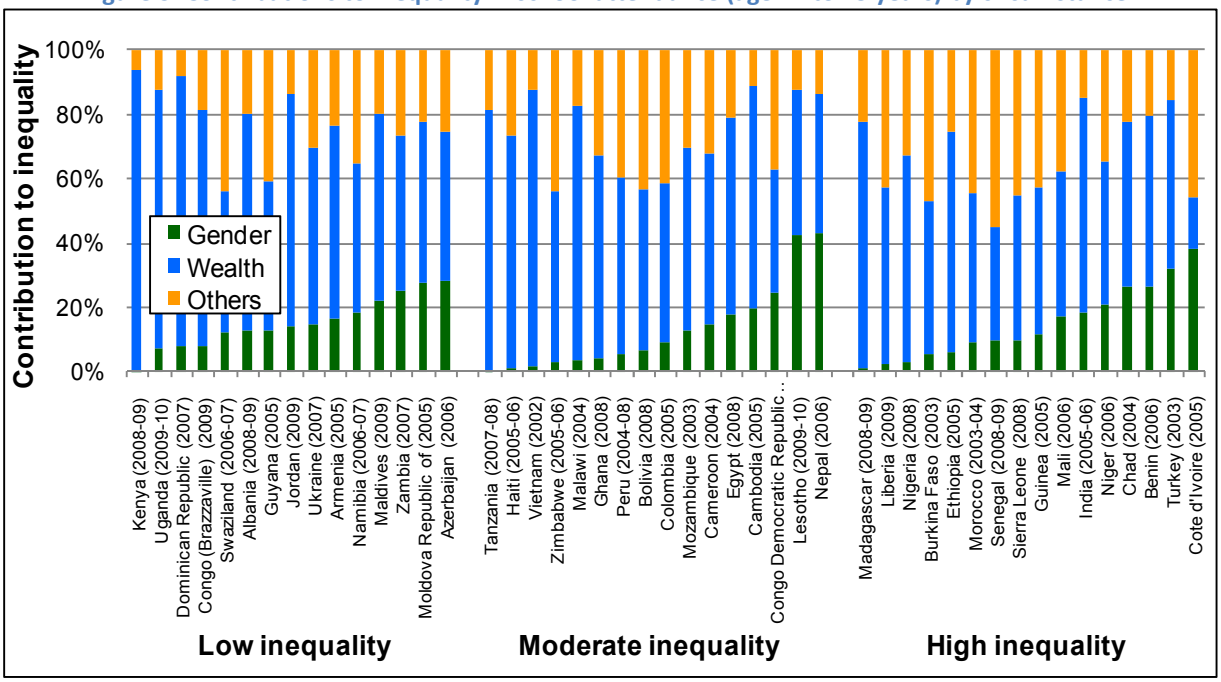
particularly useful in the context of the minority of countries in our sample where gender's role in determining unequal access to even opportunities as basic as school enrollment and immunization remains unacceptably high.

Figure 2: Contributions to inequality in school attendance (age 6 to 11 years) by circumstance



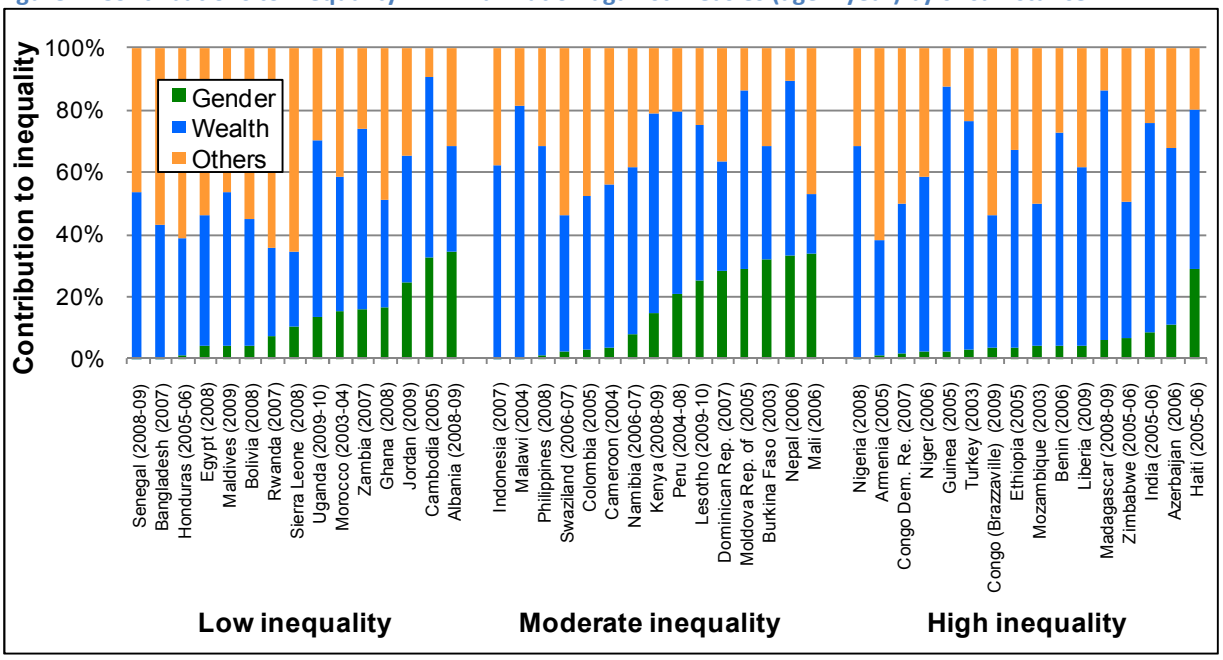
Note: The measure of inequality refers to the percentage of the total opportunities that must be reallocated to ensure that all the circumstances groups have the same average coverage rate. Low inequality is between 0.33% and 1.95%, Moderate inequality is between 2.38% and 7.58% and High Inequality is between 8.20% and 24.36%. Results are sorted by the gender contribution to inequality.

Figure 3: Contributions to inequality in school attendance (age 12 to 15 years) by circumstance



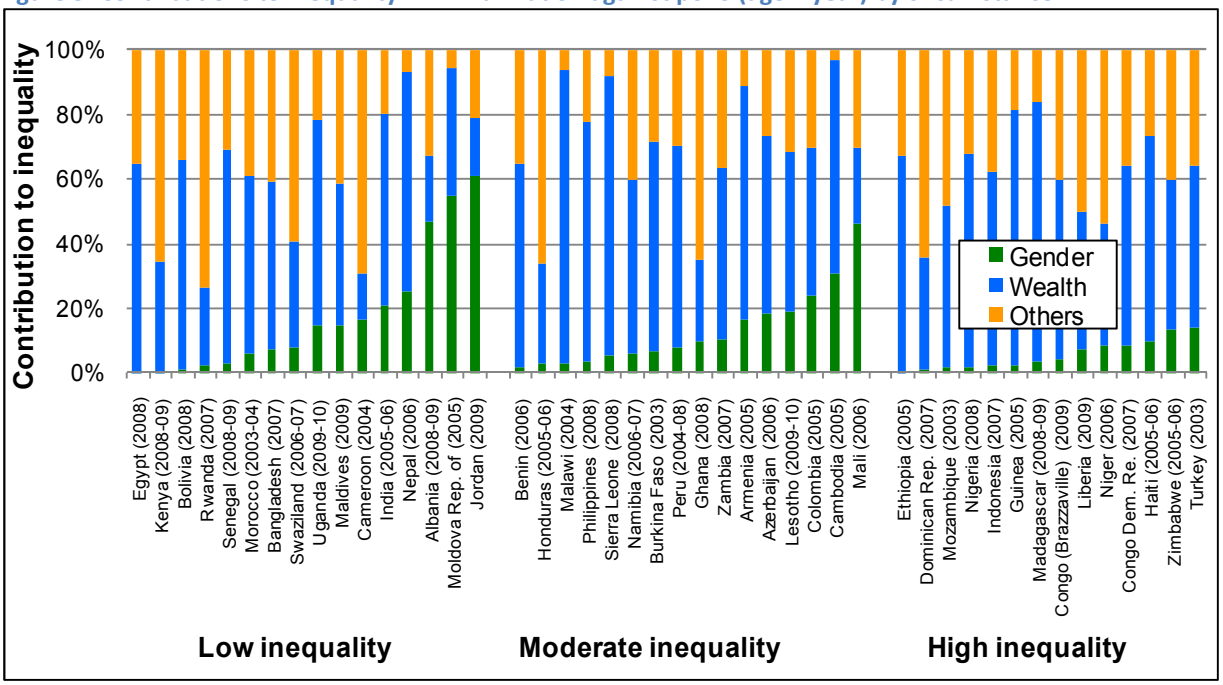
Note: The measure of inequality is the D-index; which is the percentage of total opportunities that must be reallocated to ensure that there is no inequality of opportunity. Low inequality is when the D-index is between 0.3% and 2.1%, Moderate inequality is between 2.3% and 6.4% and High Inequality is between 6.5% and 26.7%. Results are sorted by the gender contribution to inequality.

Figure 4: Contributions to inequality in immunization against measles (age 1 year) by circumstance



Note: The measure of inequality is the D-index; which is the percentage of total opportunities that must be reallocated to ensure that there is no inequality of opportunity. Low inequality is between 1.0% and 3.2%, Moderate inequality is between 3.4% and 5.2% and High Inequality is between 5.2% and 22.0%. Results are sorted by the contribution of gender to inequality.

Figure 5: Contributions to inequality in immunization against polio (age 1 year) by circumstance



Note: The measure of inequality is the D-index; which is the percentage of total opportunities that must be reallocated to ensure that there is no inequality of opportunity. Low inequality is between 0.6% and 3.0%, Moderate inequality is between 3.1% and 5.0% and High Inequality is between 5.4% and 11.4%. Results are sorted by the gender contribution to inequality.

Figure 6: Correlation of D-index across opportunities

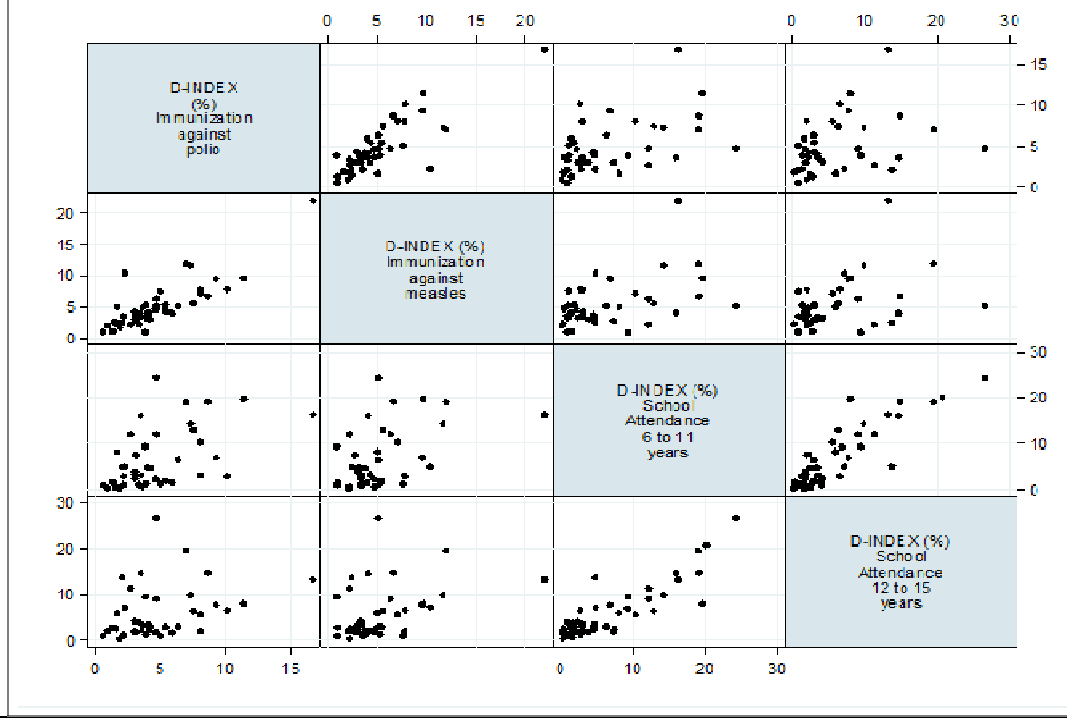
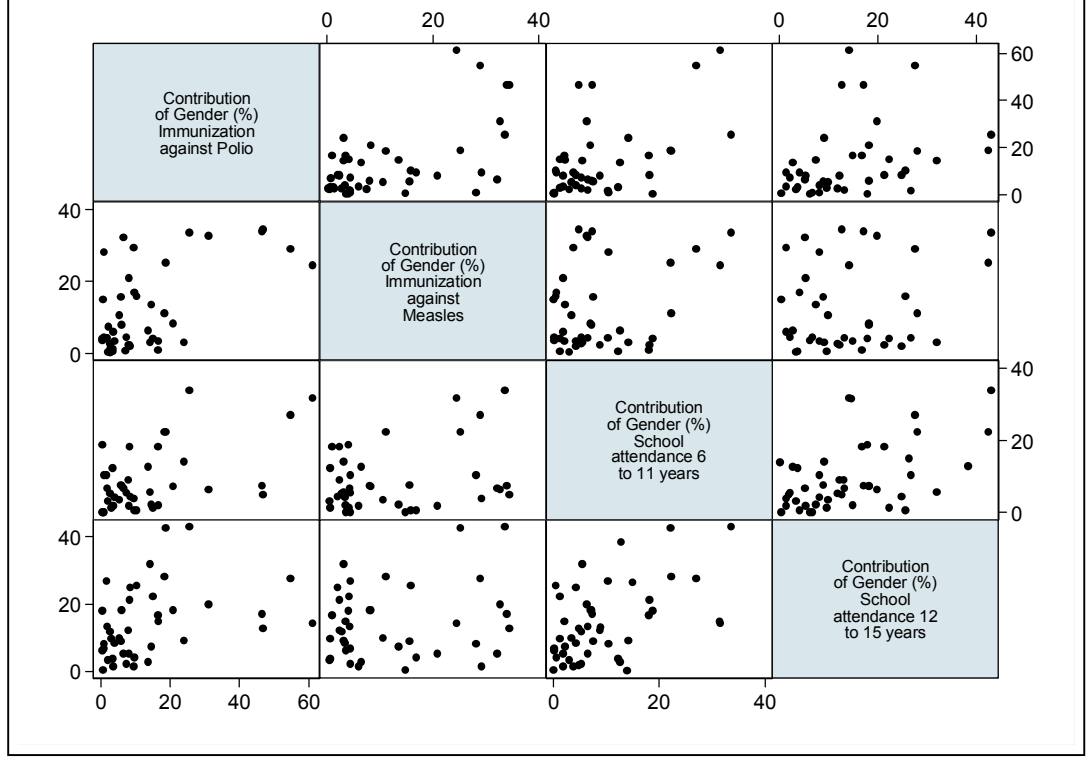


Figure 7: Correlation of the contribution of gender to D-index across opportunities



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Appendix

Hypothetical example to illustrate Shapley decomposition

Suppose the dissimilarity (D) index is estimated using 3 circumstances: A, B and C. Let D_j denote the contribution of circumstance A to the D-index, which is the same as the marginal impact of adding circumstance A on the D-index. Since the circumstances are correlated with each other, the marginal impact will differ depending on which set of pre-existing circumstances A is added to – for example, whether A is added to the set {B,C}, {B} or {C}. Therefore, to measure the "contribution" of A to the D-index, the Shapley decomposition method will take the average of all marginal impacts when A is added to all possible subsets of the set {B,C}. This is given by:

$$D_A = \frac{2}{6}[D(A,B,C) - D(B,C)] + \frac{1}{6}[D(A,B) - D(B)] + \frac{1}{6}[D(A,C) - D(C)] + \frac{2}{6}[D(A) - 0] \qquad (A)$$

Why are the weights for the different components of (A) the way they are? The idea is that we are taking the average of all the possible paths of addition of circumstances. In the figure below, the differences are represented by blue lines numbered as 1 to 4. There are six possible paths to go from zero (0) to D(A,B,C). It is easy to see that two of these paths use the blue line marked as (4), two use the blue line marked as (1), and one path uses the blue lines (2) and (3). The weights in the different components of (A) are allocated accordingly.

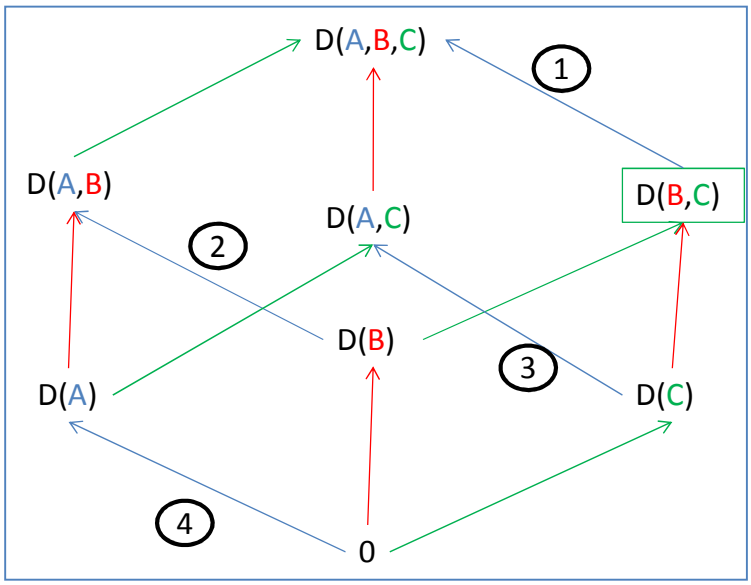

Table A1. Results for School Attendance (6 to 11 years)

Country (Year)	Coverage (%)	D-Index (%)	HOI (%)	Contribution (%): Gender	Wealth	Gender of the household head	Location (Urban/Rural)
Albania (2008-09)	95.0	0.3	94.7	4.9	32.9	58.3	3.9
Armenia (2005)	93.7	1.2	92.6	18.1	62.2	1.7	18.1
Azerbaijan (2006)	82.3	1.2	81.3	22.2	62.4	6.5	8.8
Benin (2006)	62.0	12.2	54.5	10.3	62.2	5.0	22.5
Bolivia (2008)	97.7	0.5	97.2	0.2	59.3	3.8	36.8
Burkina Faso (2003)	28.1	24.4	21.3	6.6	50.5	2.9	40.0
Cambodia (2005)	76.7	4.6	73.2	6.3	89.1	0.5	4.0
Cameroon (2004)	80.1	8.2	73.5	2.1	54.3	12.3	31.4
Chad (2004)	36.0	20.1	28.8	15.0	61.5	2.0	21.5
Colombia (2005)	95.4	1.1	94.4	14.2	59.3	0.3	26.3
Congo (Brazzaville) (2009)	86.4	3.1	83.7	4.2	58.9	2.4	34.4
Congo Democratic Republic (2007)	61.0	10.4	54.7	4.3	51.6	0.5	43.6
Cote d'Ivoire (2005)	54.3	9.3	49.2	12.8	57.8	6.8	22.6
Dominican Republic (2007)	92.9	1.6	91.4	10.4	79.9	7.0	2.7
Egypt (2008)	87.5	1.6	86.1	18.7	50.5	2.5	28.3
Ethiopia (2005)	33.3	14.3	28.5	0.1	64.9	3.4	31.7
Ghana (2008)	86.0	4.7	82.0	0.7	64.0	12.5	22.8
Guinea (2005)	45.1	19.2	36.5	5.3	53.2	1.4	40.1
Guyana (2005)	98.3	0.3	97.9	8.9	72.4	5.2	13.5
Haiti (2005-06)	80.8	6.4	75.7	3.8	65.4	1.6	29.2
India (2005-06)	77.9	5.0	74.1	7.1	79.1	0.1	13.7
Jordan (2009)	91.1	1.0	90.2	31.6	61.2	5.0	2.2
Kenya (2008-09)	91.8	3.3	88.8	0.1	84.6	3.8	11.6
Lesotho (2009-10)	83.1	3.1	80.5	22.2	70.8	4.1	2.9
Liberia (2009)	31.5	19.7	25.3	5.3	45.1	3.3	46.4
Madagascar (2008-09)	79.9	6.9	74.4	1.9	84.7	1.0	12.5
Malawi (2004)	80.6	4.5	76.9	12.3	70.9	1.4	15.5
Maldives (2009)	98.0	0.4	97.6	1.3	62.6	2.7	33.4
Mali (2006)	37.5	16.1	31.5	7.4	49.5	2.4	40.8
Moldova Republic of (2005)	94.7	1.0	93.8	27.0	57.7	3.7	11.6
Morocco (2003-04)	88.5	4.9	84.1	7.6	51.1	1.8	39.6
Mozambique (2003)	57.1	13.0	49.7	6.6	60.3	1.6	31.5
Namibia (2006-07)	86.9	2.4	84.8	7.3	51.3	30.1	11.3
Nepal (2006)	89.9	2.5	87.7	33.7	56.2	1.4	8.7
Niger (2006)	33.3	19.1	26.9	18.2	46.4	2.9	32.6
Nigeria (2008)	67.4	16.4	56.4	3.0	67.5	8.4	21.1
Peru (2004-08)	97.8	0.7	97.2	1.9	63.2	0.5	34.5
Senegal (2008-09)	52.1	12.2	45.8	1.3	37.3	8.3	53.1
Sierra Leone (2008)	63.7	9.4	57.7	3.4	52.1	2.6	41.9
Swaziland (2006-07)	83.4	2.9	81.0	8.9	75.3	9.5	6.3
Tanzania (2007-08)	69.9	7.6	64.6	14.0	67.6	0.7	17.7
Turkey (2003)	88.3	2.8	85.7	5.5	75.3	0.4	18.8
Uganda (2009-10)	84.6	3.9	81.3	2.2	87.7	0.0	10.1
Ukraine (2007)	81.8	1.7	80.4	31.5	36.8	8.4	23.3
Vietnam (2002)	96.1	1.7	94.5	4.8	79.2	7.2	8.7
Zambia (2007)	69.5	7.4	64.4	0.6	52.4	2.0	45.0
Zimbabwe (2005-06)	89.4	2.0	87.7	12.6	60.5	0.9	25.9
Average	***75.3***	***6.7***	***71.5***	***9.5***	***61.7***	***5.3***	***23.5***

Table A2. Results for School Attendance (12 to 15 years)

Country (Year)	Coverage (%)	D-Index (%)	HOI (%)	Contribution (%): Gender	Wealth	Gender of the household head	Location (Urban/Rural)
Albania (2008-09)	92.5	2.1	90.6	12.7	67.9	0.2	19.3
Armenia (2005)	96.0	1.4	94.7	16.7	59.8	6.8	16.7
Azerbaijan (2006)	96.7	0.9	95.9	28.1	46.4	13.9	11.6
Benin (2006)	65.5	9.1	59.5	26.7	53.0	5.8	14.6
Bolivia (2008)	92.5	2.6	90.1	6.8	49.8	0.3	43.1
Burkina Faso (2003)	27.9	26.7	20.4	5.2	47.8	6.2	40.7
Cambodia (2005)	85.7	3.0	83.1	19.9	69.2	8.3	2.6
Cameroon (2004)	82.8	6.0	77.8	14.9	53.2	10.3	21.7
Chad (2004)	45.7	20.7	36.2	26.3	51.5	5.0	17.2
Colombia (2005)	88.4	4.0	84.8	9.1	49.4	0.7	40.8
Congo (Brazzaville) (2009)	88.5	2.1	86.6	8.2	73.3	3.3	15.1
Congo Democratic Republic (2007)	77.0	5.6	72.7	24.8	38.1	3.9	33.2
Cote d'Ivoire (2005)	51.9	6.9	48.3	38.3	15.9	9.0	36.8
Dominican Republic (2007)	92.6	1.8	91.0	8.2	83.9	4.3	3.6
Egypt (2008)	86.7	2.8	84.3	17.9	61.0	0.7	20.4
Ethiopia (2005)	59.8	9.9	53.9	6.2	68.3	2.8	22.7
Ghana (2008)	85.7	3.4	82.8	4.1	63.1	22.4	10.4
Guinea (2005)	55.2	14.9	47.0	11.7	45.8	2.1	40.5
Guyana (2005)	92.6	1.6	91.2	13.1	45.8	5.7	35.4
Haiti (2005-06)	88.0	3.1	85.4	1.4	72.3	2.2	24.2
India (2005-06)	74.7	7.2	69.3	18.2	67.0	1.0	13.8
Jordan (2009)	96.6	0.9	95.8	14.2	72.5	11.6	1.8
Kenya (2008-09)	94.9	2.1	92.9	0.3	93.7	2.7	3.3
Lesotho (2009-10)	87.4	3.6	84.2	42.5	45.5	1.9	10.1
Liberia (2009)	75.0	8.0	69.0	2.2	54.9	2.4	40.5
Madagascar (2008-09)	69.1	7.7	63.8	1.4	76.5	2.5	19.6
Malawi (2004)	85.4	2.3	83.4	3.8	79.0	9.2	8.1
Maldives (2009)	98.3	0.3	98.0	22.3	57.7	1.6	18.3
Mali (2006)	44.5	14.6	38.0	17.1	44.9	1.0	36.9
Moldova Republic of (2005)	97.1	0.9	96.2	27.5	50.2	11.4	10.9
Morocco (2003-04)	68.4	13.7	59.0	9.0	46.8	1.7	42.6
Mozambique (2003)	74.9	6.4	70.1	13.2	56.2	0.6	29.9
Namibia (2006-07)	92.3	1.8	90.6	18.2	46.3	21.1	14.4
Nepal (2006)	81.6	4.2	78.2	43.0	43.2	9.0	4.8
Niger (2006)	32.3	19.5	26.0	21.2	44.2	2.3	32.3
Nigeria (2008)	73.5	13.3	63.7	3.3	64.1	10.7	21.8
Peru (2004-08)	93.4	2.4	91.2	5.3	55.1	1.7	38.0
Senegal (2008-09)	51.2	11.4	45.3	9.6	35.3	8.1	47.0
Sierra Leone (2008)	70.0	9.4	63.4	9.8	45.1	2.0	43.0
Swaziland (2006-07)	90.4	1.2	89.3	12.2	43.8	40.6	3.4
Tanzania (2007-08)	85.9	2.5	83.8	0.1	81.7	1.1	17.2
Turkey (2003)	82.6	6.5	77.2	31.9	52.8	0.2	15.1
Uganda (2009-10)	89.7	1.8	88.1	7.3	80.1	9.3	3.2
Ukraine (2007)	98.5	0.5	98.0	14.7	54.8	23.7	6.8
Vietnam (2002)	86.5	3.9	83.1	1.9	85.6	4.0	8.5
Zambia (2007)	89.8	2.0	88.0	25.5	47.9	3.0	23.6
Zimbabwe (2005-06)	85.1	3.0	82.5	2.8	53.3	12.0	31.9
Average	***79.2***	***6.0***	***75.4***	***14.4***	***57.3***	***6.6***	***21.6***

Table A3. Results for Immunization against measles

Country (Year)	Coverage (%)	D-Index (%)	HOI (%)	Contribution (%): Gender	Wealth	Gender of the household head	Location (Urban/Rural)
Albania (2008-09)	90.8	2.0	89.0	34.4	34.2	24.5	6.9
Armenia (2005)	72.0	5.3	68.2	1.0	37.4	13.4	48.3
Azerbaijan (2006)	56.5	7.6	52.2	11.2	56.5	12.1	20.3
Bangladesh (2007)	76.4	2.5	74.5	0.7	42.8	20.9	35.7
Benin (2006)	54.4	6.4	50.9	4.4	68.3	5.7	21.6
Bolivia (2008)	70.1	2.3	68.5	4.5	40.3	16.4	38.8
Burkina Faso (2003)	52.4	5.2	49.7	32.1	36.7	0.2	31.1
Cambodia (2005)	70.1	3.0	68.0	32.7	58.0	4.4	4.9
Cameroon (2004)	56.3	5.1	53.5	3.5	52.9	1.5	42.2
Colombia (2005)	73.5	3.4	71.1	3.1	49.2	26.7	21.0
Congo (Brazzaville) (2009)	58.8	7.7	54.3	3.4	42.6	20.6	33.4
Congo Dem. Re. (2007)	58.5	7.1	54.4	2.0	48.2	5.4	44.4
Dominican Rep. (2007)	62.9	4.0	60.4	28.1	35.3	35.5	1.1
Egypt (2008)	89.3	1.1	88.3	4.2	42.2	30.0	23.6
Ethiopia (2005)	31.5	11.7	27.8	3.6	63.8	2.4	30.2
Ghana (2008)	43.5	3.2	42.1	16.9	34.5	44.5	4.1
Guinea (2005)	47.5	6.7	44.3	2.7	85.1	6.4	5.7
Haiti (2005-06)	52.2	5.2	49.5	29.3	51.1	3.0	16.6
Honduras (2005-06)	78.2	2.2	76.5	1.4	37.5	40.1	21.0
India (2005-06)	51.5	10.4	46.2	8.4	67.5	4.4	19.7
Indonesia (2007)	69.9	4.4	66.8	0.2	62.2	3.0	34.5
Jordan (2009)	91.8	1.0	90.9	24.5	41.0	8.3	26.2
Kenya (2008-09)	78.5	4.3	75.2	14.9	64.0	6.4	14.7
Lesotho (2009-10)	64.2	3.5	61.9	25.3	50.3	22.0	2.4
Liberia (2009)	52.6	9.7	47.6	4.4	57.0	3.2	35.4
Madagascar (2008-09)	63.8	9.5	57.7	6.1	80.2	6.0	7.7
Malawi (2004)	73.2	3.7	70.5	0.7	81.1	5.7	12.5
Maldives (2009)	77.7	2.2	76.0	4.2	49.4	17.6	28.8
Mali (2006)	61.2	4.1	58.7	33.9	19.0	13.3	33.9
Moldova Rep. of (2005)	78.3	3.6	75.5	29.0	57.4	0.8	12.8
Morocco (2003-04)	84.0	2.4	82.0	15.6	42.8	22.9	18.6
Mozambique (2003)	69.1	5.6	65.3	4.4	45.5	16.4	33.7
Namibia (2006-07)	63.3	4.7	60.3	8.1	53.7	3.6	34.7
Nepal (2006)	78.0	3.3	75.4	33.6	55.8	3.3	7.4
Niger (2006)	43.2	12.0	38.0	2.4	56.2	8.3	33.1
Nigeria (2008)	38.3	22.0	29.9	0.5	67.9	2.5	29.1
Peru (2004-08)	57.6	4.8	54.8	20.9	58.7	4.8	15.6
Philippines (2008)	78.2	4.1	75.0	1.2	67.5	4.5	26.8
Rwanda (2007)	85.8	1.6	84.5	7.4	28.5	62.1	2.0
Senegal (2008-09)	65.5	2.2	64.0	0.6	52.9	17.0	29.6
Sierra Leone (2008)	47.4	0.9	47.0	10.7	23.9	51.7	13.7
Swaziland (2006-07)	73.1	3.5	70.5	2.4	43.8	22.8	31.0
Turkey (2003)	74.7	7.8	68.8	3.1	73.4	1.3	22.2
Uganda (2009-10)	60.2	3.0	58.4	13.5	56.8	5.2	24.4
Zambia (2007)	78.1	2.8	75.9	15.8	58.2	4.8	21.1
Zimbabwe (2005-06)	55.6	5.4	52.6	6.5	44.2	30.9	18.4
Average	***65.4***	***5.1***	***62.4***	***11.3***	***51.6***	***14.5***	***22.6***

Table A4. Results for Immunization against polio

Country (Year)	Coverage (%)	D-Index (%)	HOI (%)	Contribution (%): Gender	Wealth	Gender of the household head	Location (Urban/Rural)
Albania (2008-09)	95.4	1.0	94.4	46.7	20.6	21.2	11.4
Armenia (2005)	76.2	3.9	73.2	16.5	72.1	4.0	7.4
Azerbaijan (2006)	65.7	5.0	62.4	18.4	54.8	2.1	24.7
Bangladesh (2007)	83.2	1.5	81.9	7.2	52.2	16.0	24.7
Benin (2006)	57.5	4.7	54.9	1.7	63.1	1.2	33.9
Bolivia (2008)	80.6	1.6	79.3	0.9	64.9	22.7	11.4
Burkina Faso (2003)	55.0	4.7	52.4	6.5	65.1	4.7	23.6
Cambodia (2005)	70.2	4.2	67.2	31.1	65.7	0.9	2.3
Cameroon (2004)	60.2	1.7	59.2	16.7	14.4	5.3	63.5
Colombia (2005)	61.6	3.3	59.6	24.1	45.6	1.8	28.4
Congo (Brazzaville) (2009)	61.8	8.1	56.8	4.0	55.7	8.5	31.8
Congo Democratic Republic (2007)	42.0	8.1	38.6	8.6	55.8	6.2	29.4
Dominican Republic (2007)	61.0	5.9	57.4	1.0	35.1	58.3	5.7
Egypt (2008)	84.4	1.3	83.3	0.4	64.6	2.6	32.4
Ethiopia (2005)	40.9	7.3	37.9	0.4	67.1	1.9	30.6
Ghana (2008)	42.1	4.0	40.4	9.7	25.6	41.2	23.5
Guinea (2005)	47.7	8.7	43.6	2.7	79.0	5.3	13.0
Haiti (2005-06)	47.0	6.4	44.0	9.5	63.6	1.5	25.4
Honduras (2005-06)	77.8	3.4	75.1	2.9	31.3	41.2	24.6
India (2005-06)	68.7	2.3	67.2	21.0	59.5	0.0	19.5
Indonesia (2007)	68.7	5.4	65.0	2.7	59.9	0.1	37.4
Jordan (2009)	95.4	0.6	94.8	61.1	17.9	11.9	9.0
Kenya (2008-09)	71.6	3.0	69.5	0.6	34.0	1.5	63.9
Lesotho (2009-10)	61.2	3.5	59.1	18.8	49.8	29.3	2.1
Liberia (2009)	42.5	11.4	37.7	7.5	42.7	14.0	35.8
Madagascar (2008-09)	64.0	9.3	58.0	3.6	80.3	9.2	7.0
Malawi (2004)	72.0	4.2	69.0	3.4	90.3	1.9	4.5
Maldives (2009)	79.7	1.8	78.2	15.0	43.5	10.0	31.5
Mali (2006)	55.3	3.5	53.4	46.6	23.3	25.4	4.7
Moldova Republic of (2005)	83.4	2.2	81.6	54.7	39.9	2.1	3.4
Morocco (2003-04)	88.6	2.1	86.8	5.9	55.1	34.1	5.0
Mozambique (2003)	61.9	7.5	57.3	2.0	50.0	15.9	32.0
Namibia (2006-07)	61.3	4.6	58.5	6.1	53.7	2.1	38.2
Nepal (2006)	83.7	3.0	81.2	25.5	67.7	3.8	3.0
Niger (2006)	49.9	7.0	46.4	8.4	37.8	33.1	20.8
Nigeria (2008)	35.4	16.7	29.4	2.1	65.8	1.9	30.2
Peru (2004-08)	58.7	3.6	56.5	8.2	62.3	3.5	26.0
Philippines (2008)	78.5	4.1	75.3	3.4	74.1	4.3	18.2
Rwanda (2007)	81.7	1.9	80.1	2.4	24.0	72.2	1.5
Senegal (2008-09)	66.1	2.7	64.3	3.1	66.0	24.0	7.0
Sierra Leone (2008)	40.1	3.9	38.5	5.5	86.2	2.7	5.6
Swaziland (2006-07)	72.0	2.2	70.4	8.1	32.8	53.8	5.3
Turkey (2003)	64.6	10.2	58.0	14.4	49.9	1.0	34.7
Uganda (2009-10)	53.1	3.0	51.5	14.8	63.8	20.4	1.0
Zambia (2007)	71.0	3.1	68.9	10.4	53.2	0.1	36.2
Zimbabwe (2005-06)	55.3	5.4	52.3	13.7	46.3	13.1	26.8
Average (unweighted)	***65.1***	***4.6***	***62.4***	***12.6***	***52.7***	***13.9***	***20.8***

Table A5. Correlation matrix of D-index across opportunities

		D-Index			
		Immunization against polio	Immunization against measles	School Attendance 6 to 11 years	School Attendance 12 to 15 years
D-Index	Immunization against polio	1.00			
	Immunization against measles	0.83	1.00		
	School Attendance 6 to 11 years	0.52	0.48	1.00	
	School Attendance 12 to 15 years	0.34	0.39	0.86	1.00

Table A6. Correlation matrix of contribution of gender to D-index across opportunities

		Contribution of gender			
		Immunization against polio	Immunization against measles	School Attendance 6 to 11 years	School Attendance 12 to 15 years
Contribution of gender	Immunization against polio	1.00			
	Immunization against measles	0.58	1.00		
	School Attendance 6 to 11 years	0.52	0.28	1.00	
	School Attendance 12 to 15 years	0.35	0.19	0.56	1.00