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Abstract

Gender inequality remains a major barrier to human development. Girls and women have made major strides since 1990, but they have not yet gained gender equity. In this paper, we review ways to measure and monitor gender inequality, providing a critique of existing measures including the first global gender indices that were launched in the 1995 Human Development Report – the Gender-related Development Index and the Gender Empowerment Measure - and introduce a new index that is presented in the 2010 Human Development Report. The Gender Inequality Index, which addresses the key criticisms of previous measures, is unique in including critical issues of educational attainment, economic and political participation, and reproductive health issues and in accounting for overlapping inequalities at the national level. As such, it represents an important advance on existing global measures of gender equity. Measures of the disadvantages for women raise awareness of problems, permit monitoring of progress towards gender equity objectives and help keep governments accountable. In this light, the Gender Inequality Index is designed to reveal the extent to which the realization of a country's human development potential is curtailed by gender inequality, and provides empirical foundations for policy analysis and advocacy efforts. We also compare our results with the results of alternative gender inequality indices, finding significant variation in rankings across the various indices due largely to differences in the elements of gender inequality they seek to measure.

Keywords: Gender inequality, gender index, human development, measurement.

JEL classification: D63, O15, C8, J16

1. INTRODUCTION

Gender equity is an intrinsic dimension of human development. If girls and women are systematically denied freedoms and opportunities, this is not consistent with human development. Gender equality also has instrumental value for human development—there is much country level evidence showing how investments in women and girls can be a vehicle to promote long-term prospects for growth prospects and human development.[1]

Equity is enshrined in the UN Charter and the "promotion of gender equality and the empowerment of women" is the third Millennium Development Goal. Several major international agreements have urged governments to take steps to ensure that both women and men enjoy equal rights, opportunities and responsibilities – such as the Nairobi Forward Looking Strategy for Advancement of Women (1985) and the Beijing Platform for Action (1995).

Global, regional and national reports have investigated and exposed key dimensions of gender disparities. The 1995 global report on gender highlighted areas of progress, but also noted that women still outnumbered men two to one in terms of illiteracy in 1995, and girls constituted around 60 percent of those without access to primary school. According to the Report women's labour force participation was only around 40 percent, and women only occupied 10 percent of parliamentary seats. The Report also highlighted that of the 1.3 billion people in poverty, 70% were women. The recent regional report for Asia–Pacific, the 2005 Arab States Report and the 2007 Azerbaijan report are among recent human development reports that have examined gender differences in detail. The 2010 Asia Pacific Report for example, identifies women's lack of power and voice as the heart of gender inequality in the region and calls for economic, legal and political barriers facing women to be addressed simultaneously. The Azerbaijan report also noted that gender disparities in the labour market reflect the inequality of opportunities for men and women.[2]

In order to know whether progress is being made toward the policy objective of gender equality, relevant indicators and monitoring is needed. This is a difficult endeavour – in part because of conceptual complexities and deficient data, but also because some aspects do not readily lend themselves to quantitative measurement.

[1] (Permanyer, 2009).

[2] UNDP 2010a Asia-Pacific *HDR*; UNDP 2005a Arab States *HDR;* and UNDP 2007 Azerbaijan *National Human Development Report* (NHDR).

It is nonetheless clear that women and girls still fare badly on important fronts. Their labour force participation rate continues to hover around 51 percent, compared with around 83 percent for males. Women's reproductive health needs are too often neglected. Many developing countries do not provide qualified birth attendants, good prenatal or postnatal care or emergency care during deliveries. Maternal mortality averages 400 deaths per 100,000 births globally[3], but ranges as high as 822 deaths per 100,000 births in low human development countries. And the global average for women in parliament is still only 16 percent. These are examples of just a few domains where gender inequalities persist.

This paper reviews the challenge of measuring and monitoring gender inequality, and introduces the new index that is presented in the 2010 Human Development Report[4]. As highlighted below, the Gender Inequality Index (GII) is unique in its focus on critical issues of educational attainment, economic and political participation, and reproductive health issues and in accounting for overlapping inequalities at the national level. As such, it represents an important advance on existing global measures of gender equity. The GII is designed to reveal the extent to which the realization of a country's human development potential is curtailed by gender inequality, and provides empirical foundations for policy analysis and advocacy efforts.

This paper is structured as follows. The next section examines the limitations of the Gender-related Development Index and the Gender Empowerment Measure which were introduced by the 1995 Human Development Report, as well as the strengths and weaknesses of other post-1995 gender indices. In this light, Section 3 proposes a new approach, called the Gender Inequality Index (GII). Section 4 highlights some of the key results and insights from the GII, while section 5 compares those results and the elements of gender inequality that the GII seeks to measure with alternative gender inequality indices. The final section concludes.

2. A REVIEW OF EXISTING MEASURES OF GENDER DISPARITIES

Measures of the disadvantages affecting women have played an important role in raising awareness of problems, and helping to keep governments accountable. As a result of broad collective efforts – including on the part of the International Labour Organization, World Bank, the OECD and World Economic Forum, the amount of data that incorporates a gender perspective has increased considerably

[3] (UNICEF 2008)
[4] (UNDP 2010b)

since the early 1990s. The extent to which basic indicators are systematically available on a gender disaggregated basis has improved enormously -- for example school enrolments, most health data, and employment in different sectors of the economy. Much better information is also available for specific issues, such as reproductive health[5] and violence against women,[6] although as we see below, there are still large gaps.

One of the key challenges in evaluating progress in gender equality has been quantifying important dimensions. For example, the notion of women's empowerment is difficult to evaluate and measure.[7] Time-use is another area which may in principle be easier to measure, but in practice is very difficult. The same is true for asset ownership (see below).

A number of composite measures of gender disparities are now available. The potential advantages of a composite index are that it provides a good summary of a complex multidimensional problem that is easily interpretable. This can help to understand the complexities of gender relations, and facilitate comparisons across time and countries. This in turn can attract public interest and capture the attention of policy makers. Single summary numbers also allow for national and subnational rankings, which are useful for advocacy purposes and to motivate government policy responses.

The first global indices designed to reflect gender disparities were the Gender-related Development Index (GDI) and Gender Empowerment Measure (GEM) that were launched in the 1995 HDR.[8] Since their introduction, the two measures have been used as advocacy and monitoring tools by UNDP and other developmental partners. In Korea for example the GEM has been used for lobbying purposes, which reportedly led to government actions to address the low representation of women in political and economic sectors.[9]

The GDI was developed to capture gender inequalities in an overall assessment of well-being. The HDI – which is a composite measure of well being comprising achievements in health, education and incomes -- is penalised if gender inequality exists in any of the three dimensions. Thus an advantage of the GDI is its clarity of purpose. The index's overarching concept, development, is well theorized and measured in much the same terms as the UNDP's HDI.[10] The more the GDI differs from the HDI, the larger the

[5] (Abdullah, 2000) (Ransom & Yinger, 2002)
[6] (Kelly, Kennedy, & Horvath, 2008)
[7] (Beneria & Permanyer, 2010)
[8] (UNDP HDR, 1995) This report was released prior to the Beijing conference on women and development.
[9] Schuler, 2006 and UNDP 2005b.
[10] (Anand and Sen, 1995)

measured inequality.[11] But because the GDI cannot be interpreted independently of the HDI, it cannot be interpreted on its own as an indicator of gender gaps in well-being. Because of this some critics have called the GDI a "false start" because it is not a true measure of gender inequality.[12]

The GEM was introduced as a complementary measure of gender equality in political, economic and decision making power. The three dimensions included are (i) control over economic resources, measured by men and women's earned income; (ii) economic participation and decision making, measured by women and men's share of administrative, professional, managerial, and technical positions; and (iii) political participation and decision making, measured by male and female shares of parliamentary seats. The measure usefully captures some aspects of female empowerment,[13] although it has been criticised as having an unclear conceptual basis and questioned as to the appropriateness of the indicators.[14]

These pioneering efforts gained some public visibility, supported by annual updates in the Human Development Report, and signalled the importance of collecting and disaggregating data by gender in country level analysis, including in National HDRs.[15] A number of later indices have actually used aspects of the GDI and GEM, as we shall see below. But both indices also attracted critical debate about how to construct a valid and reliable index with gender-differentiated data. Overall, the GDI and GEM have not had nearly as much success as the HDI in academic or policy circles. The GDI has frequently been misunderstood as a direct measure of gender inequality (which it is not). Both had conceptual problems in the underlying components as well as empirical problems relating to data availability.

These measures have also been criticized for their conceptual and methodological limitations and they have been frequently misinterpreted.[16] The key drawbacks can be summarised as follows:

a. The measures combine absolute achievements alongside relative aspects. This means, among other things, that countries with low absolute levels of income cannot approach gender equity, even if there is total parity in incomes. The GDI is very strongly correlated with the level of GDP, while the gap in education and health indicators is not as well reflected. Because of this the

[11] (Klasen, 2006)
[12] (Dijkstra, 2006)
[13] There are generally four dimensions of women's empowerment identified in the literature: economic, human and social, political and cultural. For useful discussion see (Ibrahim & Alkire, 2007), (Kabeer, 2005) and (Luttrell, Quiroz, & Scrutton, 2009)
[14] (Klasen, 2006)
[15] Including the UNDP 2005c Korea NHDR, the UNDP 2004 Jordan NHDR and UNDP 2003 Bolivia NHDR.
[16] See Dijkstra, 2006, Hawken and Munck 2009, Klasen, 2006 and Schuler, 2006 for good overviews of the critiques.

GDI is also not clearly differentiated from the HDI. Similarly the GEM uses income levels (adjusted by gender gaps) rather than gender gaps in income. Because income levels tend to dominate the GEM, high income countries are generally on top of the classification, regardless of the extent to which women achieve equally in the included dimensions.

b. The GDI is often misinterpreted as a measure of gender inequality – whereas it is actually a measure of how much (assuming a specific level of aversion to gender inequality) gender inequality reduces a given country's level of human development. While this shows the human development costs of gender inequalities in basic human development, it does not really measure the position of women as compared to men in society.

c. The indicators do not always correspond to the underlying concept. For example, "Legislators, Senior Officials and Managers" is used in the GEM to measure *Economic* Participation and Decision-making instead of political participation and decision-making.

d. Other issues have been raised around the selection of indicators. For example, the health component of the GDI – life expectancy at birth – raises issues of whether women's biological advantage in longevity should be considered as a gender gap, and whether the measure should consider the 'potentially alive' – in order to take into account 'missing girls.'[17]

e. Each of the indicators in the GEM arguably suffers from urban, elite bias. For example, the economic component is measured by female share of economic decision-making positions, which does not include agricultural or informal work (in which most women around the world labour), or work in the lower levels of the formal economy, nor does it measure the unpaid labour of care work. Therefore work-related aspects of empowerment are not measured for a broad part of the female population. Similar criticisms exist for other indicators in the GEM.

f. Over-reliance on imputations for missing data. In particular, for the estimated income shares, data is frequently unavailable and thus ultimately required imputations for over three quarters of the countries in the sample. Because the income component was the most important driver of the wedge between the HDI and the GDI, the overall measure was significantly weakened by these data shortcomings.

[17] (Klasen, 2004)

Partly as a result of these problems, a whole range of other gender-related well-being indices have proliferated. These tackle important aspects of gender inequality in different ways, although, as we argue below, none have been able to provide a comprehensive picture of the levels of gender inequality experienced within and across countries.[18]

For example, Social Watch introduced a Gender Equity Index (GEI) which measures gender equity in education, participation in the economy, and empowerment. It has been published annually since 2004 - it was estimated for 104 countries in 2004 and expanded to 156 countries by 2009. Its key conceptual innovation was the inclusion of the dimensions presented separately in the GDI and GEM. The education dimension is measured by adult literacy rate and primary, secondary and tertiary level enrolments. The economic participation dimension uses two indicators—percentage of women in non-agricultural paid jobs and gaps in estimated female and male incomes (taken from HDRO estimates). And the empowerment dimension uses shares in professional and technical positions, administrative and managerial positions, as well as the share of parliamentary seats and ministerial positions held by women.

The GEI is constructed by first identifying gender gaps in each dimension—ratio of female to male scores on each indicator. For each country, the weight of the reference female population in relation to the male population is also calculated. The gap in each dimension is weighted by the inverse of the weight of the reference female population. For each dimension, the average of the indicators of the gaps is calculated. The values of the dimensions are categorised from 1 to 4. The index itself is the arithmetic average of the three dimensions. While the approach has the advantage of being simple and easy to understand, it only allows for comparison of the degree of inequality between countries without reflecting the absolute levels of gender inequality at the country level. This means that the GEI is basically a ranking exercise, and is less useful for tracking changes over time at the country level. Moreover, the averaging of categorical variables can be problematic as the rankings that arise are sensitive to the specific numbers used to label each of the categories.

The World Economic Forum's Gender Gap Index (GGI), introduced in 2006, includes five dimensions of gender inequality – economic participation, economic opportunity, political empowerment, educational attainment and health and well being. These are measured using 14 indicators-- the same indicators used in the GDI, GEM, and GEI, to which the sex ratio at birth is added. The GGI is calculated for 154 countries and is published annually. The index is calculated by converting data into male/female ratios, which are then truncated according to an "equality benchmark" and a somewhat elaborate weighting

[18] (Hawken & Munck, 2009); (Agarwal, 1994); (Agarwal, 2003) and (Permanyer, 2009) provide excellent critiques.

procedure,[19] which makes interpretation of the index and comparisons over time difficult. The index originally used gender gaps as well as female-specific measures, like the number of years a woman has been head of state. It has been revised over time to address criticisms – for example, so that the GGI now only takes into account the ratios of achievement between women and men and no longer includes women specific measures. This index also relies on HDRO's estimated earned incomes which suffer various limitations as discussed above.

In 2000, Dijkstra and Hammer developed the Relative Status of Women Index (RSWI). This index focuses only on the relative scores between men and women by taking their arithmetic mean in the three components of health, education and income (the same three as the HDI). Beneria and Permanyer (2010) describe the RSWI as one of the "simplest and most appealing" indexes presented in the literature so far.[20] It has the advantage of measuring gender gaps without taking into account countries overall development levels. The values of RSWI are also only weakly related to income levels – thus addressing one of the criticisms of the GDI. However, because the index allows for "full compensation," higher achievement in one dimension can fully offset lower achievement in another – which may not be desirable if the different dimensions have intrinsic value. Use of the arithmetic mean for the ratios of men's and women's achievements can also lead to non-intuitive results – because it is an additive function while the ratios are multiplicative. And, because the gender gaps favouring men and women are all combined in a single formula, it is not possible to identify the level of contribution of each of the three subcomponents to the overall levels of gender inequality.[21]

The OECD's Social Institutions and Gender Index (SIGI), published in 2009, takes a different tack, focussing on critical societal norms and institutions which affect how women fare -- using family code**,** physical integrity**,** son preference**,** civil liberties and ownership rights. It has been applied to 102 non-OECD countries. The SIGI is built around the overarching concept of social institutions, and therefore is focused not on gendered outcomes but rather on gendered institutions and processes. Because of this it encompass a range of issues largely ignored by other indices. A key criticism of the index, similar to the GEI, is that confusion in interpretation can occur due to the combination of different sorts of indicators –

[19] For example, the GGI's data driven weighting scheme assigns higher weights to indicators with lower standard deviations relative to those of other indicators of the same conceptual dimension, and the weighting scheme calculated for the 2006 index is used in subsequent versions of the index. But it is unclear, for example, why a ban on women holding seats in parliament in a certain country should be considered less of a problem simply because many other countries also have a similar ban. When the weighting of indicators thus derived is combined with the theory-driven weights at the level of the conceptual dimensions, the result is a weighting scheme that is complex and open to many questions. See (Hawken & Munck, 2009)

[20] (Beneria & Permanyer, 2010) and (Permanyer, 2009)

[21] (Permanyer, 2009)

some reflect a comparison of the positions of women and men, and others focus on the restriction of the rights of girls and women while making no contrast to the situations of boys and men.

New in 2010 is the Economist Intelligence Unit's Women's Economic Opportunity Index (WEOPI). The index involves both quantitative and qualitative indicators that measure specific attributes of the economic environment for women employees and entrepreneurs in 113 countries. There are five dimensions - labour policy and practice, women's economic opportunity, access to finance, education and training, women's legal and social status and the general business environment - which are made up of a total of 26 indicators. The overall results are the average of the scores across the five categories. As with the SIGI, the WEOPI seeks to show the extent to which underlying institutions affect women's equality of access to opportunities.

Each of these gender indices makes valuable contributions to the understanding of gender disparities around the world. However, as described above, each suffers from inherent shortcomings in their empirical scope, methodology or execution. It is in this light that we have designed the new GII measure.

3. INTRODUCING THE GENDER INEQUALITY INDEX

For an index to serve as a synthetic measure of gender disparities, the point of departure must be conceptual clarity and meeting of basic methodological standards. Building on recent reviews that helpfully summarized and clarified the key critiques, we propose a new way forward.

The Gender Inequality Index is designed to capture women's disadvantage in three dimensions - empowerment, economic activity and reproductive health - for as many countries as data of reasonable quality allow. The GII shows the loss in human development due to inequality between female and male achievements in these dimensions. It was designed taking as basis the association-sensitive welfare indices studied in Seth (2009). Specifically, the proposed Gender Inequality Index is based on the aggregation of achievements in society by using a general mean of general means of different orders—the first aggregation is by a geometric mean across dimensions; these means, calculated separately for women and men, are then aggregated using a harmonic mean across genders. This specific form of the index, as a harmonic mean (across genders) of geometric means (across indicators), was first proposed in Zambrano (2010a) and further studied, axiomatically, in Zambrano (2010b).

In 2010, the global Human Development Report estimated the GII for 138 countries. The GII captures aspects that were traditionally measured using separate empowerment and development indices. We argue however, that the issues should be considered using a more holistic approach, and for this reason we propose one synthetic measure.[22]

The GII usefully highlights the country's performance in the dimensions of reproductive health, empowerment and economic participation. The norms, or ideals, are set at zero for the adverse reproductive health outcomes of adolescent fertility[23] and maternal mortality rates, and at parity with male achievements on the education, economic, and political fronts. The score can thus be interpreted as characterizing where a country lies in reference to normative ideals for key indicators of women's health, empowerment, and economic status. We now turn to explain the dimensions and indicators chosen for inclusion.

3.1 SELECTION OF DIMENSIONS AND INDICATORS

Amartya Sen, among others, has noted that women's ability to find employment outside the home, earn an independent income, be literate, and to be educated participants in decisions that affect them both inside and outside the home, are critical. But well into the 21st century, the choice of dimensions for a global measure of how women and girls fare still faces huge data limitations.

We carefully reviewed candidates for inclusion, bearing in mind some basic criteria for indicator selection (OECD, 2008):

- Conceptual relevance: strongly related to human development definitions and theory, so that the indicators measure what they are supposed to measure.
- Non-ambiguity: simple to interpret and monotonic such that higher (lower) values of the indicator suggest better (worse) outcomes in the respective dimension.
- Reliability: based on data that have been standardized in terms of definitions, statistical quality, and processing, ideally by a single reputable organization.
- Value added: each indicator should clearly add new information not captured by the remaining indicators (i.e. not redundant).

[22] Various other gender indices have also adopted this approach – including Social Watch, Gender Equity Index and the World Economic Forum's Global Gender Gap Index.
[23] Defined as the number of births per 1,000 women ages 15-19.

- Power of discrimination: the distribution of each indicator should differentiate well between countries, especially to avoid bunching amongst those at the top or bottom of the distribution.

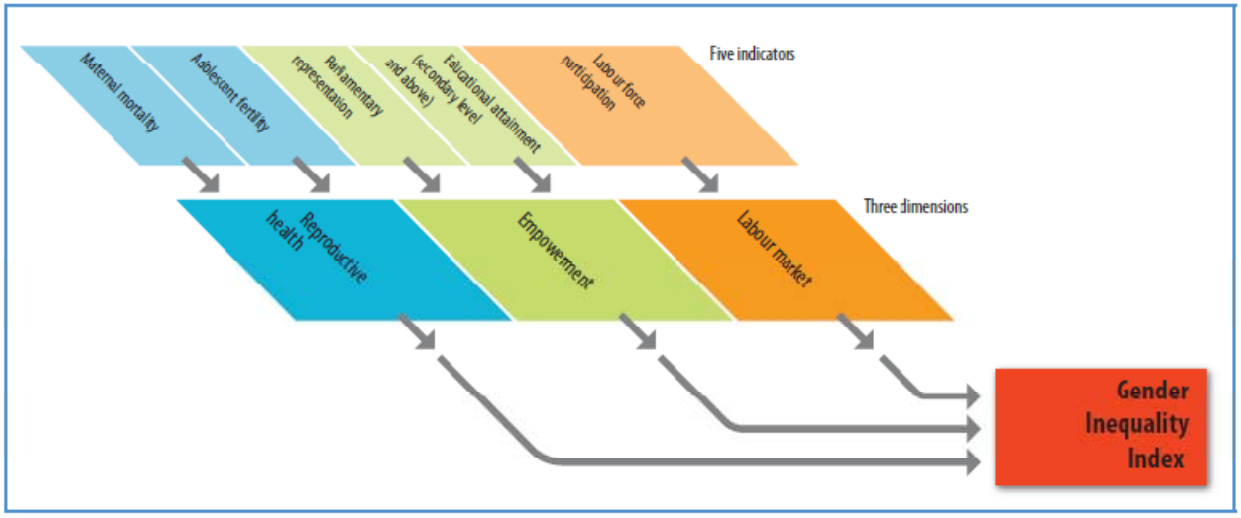
For the global Human Development Report, an additional but critical concern is data availability – we want to cover as many countries in the world as possible. For a small number (fewer than 3 percent of the total), missing values can be modelled and imputed. There should be a reasonable expectation that the indicators will be updated on a regular basis in the future and, if possible, several past time points should be available

Data availability and reliability remains a major constraint. In particular, while we have a better understanding of the importance of time use in thinking about well-being, and valuable data relating to this for some countries, this information is not generally available or regularly collected. The same is true of ownership of economic assets by women, despite its crucial importance.[24] Another key dimension that is sadly both prevalent but not well documented is domestic violence. For participation in decision-making, some community level indicators would be valuable, but nothing comparable is available. Likewise, a gender breakdown of electoral turnout is available for only a handful of countries. Hence it remains very difficult to capture the political, economic and social freedoms that are inherent in women's human development.[25]

We sought to capture key aspects of women's experience related to empowerment, the labour market and reproductive health. We selected indicators on the basis of their conceptual and practical relevance, the data reliability, international comparability, reasonable country coverage and frequency of availability. (Figure 1) summarizes the dimensions and indicators, all of which have reasonable country coverage. Data sources are largely international data agencies – that is, maternal mortality ratio (MMR) estimates are from UNICEF's 2010 State of the World Children's Report, adolescent fertility rate data are from the 2008 revision of the World Population Prospects produced by United Nations' Department for Economic and Social Affairs (UNDESA), female and male shares of parliamentary seats are from the Inter-parliamentary Union's (IPU) database and labour force participation rates are from the International Labour Organization. Educational attainment at secondary or higher education levels come from Barro and Lee.[26]

[24] (Agarwal, 1994) (Agarwal, 2003)
[25] (Sen, 1999: 3-53) and (UNDP, 1990: 10)
[26] (Barro & Lee, 2010)

Figure 1– Components of the Gender Inequality Index



Note: the size of the boxes reflects the relative weights of the indicators and dimensions.
Source: HDR 2010, p 91

The choice of dimensions and indicators can be justified as follows:

Reproductive Health

Two indicators are used to capture countries reproductive health situations. The maternal mortality ratio, which reflects the priority put on the well-being of women during childbirth, is a clear signal of women's status in the society. Current global estimates of maternal mortality – more than 500,000 women die each year because of complications related to childbirth – remain unacceptably high.[27] The risk of death in childbirth, appallingly high in many countries around the world, could be reduced through the provision of basic education, access to contraceptives, the provision of antenatal health services, and skilled attendance of births. But such services are denied to too many women in the 21st century. Many interventions that can decrease maternal mortality, such as providing women in childbirth with a trained birth attendant, are inexpensive. Some interventions, such as bans on female genital mutilation and discouraging teenage fertility and other harmful traditional practices, are less about spending and more about leadership in changing social norms.

There is enormous variation in maternal mortality rates across societies, even at similar income levels. For example, Costa Rica and Iran both have a GNI (PPP) of approximately $11,000, yet Iran's MMR is more than four times that of Costa Rica's. Indonesia's GNI (PPP) of $3,936 is slightly above that of Mongolia's ($3,594), yet Indonesia's MMR of 420 is more than 9 times that of Mongolia's. Maternal

[27](UNICEF 2008)

mortality in the US is similar to Bulgaria and Lithuania and 11 times that of Ireland, the best country on this front. It is important to note that the maternal mortality ratio is a model-based estimate for the majority of developing countries where the vital registration system either is nonexistent or is in the process of developing.

The other indicator utilised is the adolescent fertility rate for 15-19 year olds.[28] This indicator highlights that reproduction is not only risky, it often begins too early. Many girls have children at such a young age that their health is compromised and future opportunities are limited. For example, research in Mexico among poor women suggests that early childbearing is associated with poor living conditions, lower monthly earnings, and decreased child nutrition.[29] Bearing a child while very young may reflect a lack of meaningful options outside of taking on the role of mother. Premature pregnancy and motherhood pose considerable health, economic, and social risks to teenage girls. Early childbearing tends to prevent them from achieving a higher level of education, and often destines them to low-skilled jobs at best. The younger a girl is when she becomes pregnant, the greater the health risks for herself and her baby. Maternal deaths related to pregnancy and childbirth are an important cause of mortality for girls aged 15–19 worldwide, accounting for nearly 70,000 deaths each year. The risk of death during child birth is five times higher in teenage births, in part because their bodies are not yet fully developed.[30]

Empowerment

Education, especially higher levels of attainment, brings empowerment because it strengthens people's capacity to question, reflect and act on one's condition and increases access to the information needed to do so. Educated women are more likely to enjoy satisfying work, to use their voices in public debate, to be able to care for their own health and that of their family, and to take other initiatives. In this light education is particularly important in strengthening the agency of women. Women's education also has instrumental importance for economic growth and children's health[31] by fostering the capacity to absorb new information on health, nutrition, and hygiene and to stimulate and facilitate children's learning. For example, a study in rural Zimbabwe revealed that education and paid work positively affected the likelihood that a woman will access contraception and antenatal care.[32] The degree to which families

[28] We would have preferred to examine fertility only for girls below 18 years of age, but these data are not readily available. Age-specific fertility rates are usually presented in 5-year age groupings, with the youngest of reasonable quality being 15-19 years. Considering when the pregnancy under normal gestation would have started, for all but those births in the last 15 months of the interval, the pregnancies are to teenagers below 18 years of age.
[29] (Greene and Merrick, 2008) and (Buvinic, 1998)
[30] (Rowbottom, 2007)
[31] (Desai, 2010)
[32] (Becker, 1997)

decide to assure that girls receive as much education as boys is affected by their perception of future job opportunities available for educated versus non-educated offspring.[33]

Our second indicator is the share of female and male seats in parliament. Women have traditionally been disadvantaged throughout the world in the political arena, at all levels of government. Unfortunately the measures available in this area are sparse. Estimates for parliamentary representation at the national level reflect women's visibility in political leadership and society more generally, and the extent to which women can hold high offices. While this measure has the broadest country coverage, it excludes political participation at the community and local levels.

There are other crucial elements of empowerment, but internationally comparable measures do not exist. For example, violence against women, both inside and outside the home, is an important and revealing issue, but it is not internationally measured with consistency and comparability. General insecurity - including strife - can also pose particular risks to women's physical safety as well as their participation in society, but here too we do not have the data.

Labour market

In measuring economic activity, we decided to rely on female and male labour force participation rates. While some women choose not to participate in the formal labour market, or drop out to attend to unpaid family care responsibilities (care of children and/or elderly family members),[34] relative labour force participation can be taken to reflect the degree of economic activity of women versus men. However, we know that much of women's work, especially in the home and in family businesses, is unpaid, and that women's informal work is undercounted, thus labour force participation does not accurately reflect women's work efforts.

Further, it is well known that there are significant barriers to women's full participation in the economy. We also know, for example, that the gender wage gap persists at around 17 percent in OECD countries – ranging from 38 percent in South Korea to 9 percent in Belgium.[35] Sex segregation in the workforce remains a daunting barrier to equality. For example, women's representation in occupations that have decision-making responsibilities—managers and analysts—falls well below that of men's. Women are

[33] (Clemens, 2004)
[34] In a capabilities framework we are concerned about the expansion of choices – which would also include people choosing not to work, but who prefer to engage in other activities, like child raising,
[35] (OECD , 2009)

more likely to work in the service industry than men—in Latin America, 80 percent of women versus 45 percent of men work in services.[36]

Labour force participation, as traditionally measured, ignores the important contributions of women in unpaid work and may perpetuate the undervaluing of these critical activities. Yet, unfortunately data are too scarce to remedy these issues. Data on earned incomes and consumption are especially weak at the global level. Per capita consumption data, when available, do not account for inequalities in intra-household distribution of resources. The unemployment rate was considered but was ultimately dismissed due to the fact that this is not well-measured and, in poor countries, is largely an urban phenomenon. Few rural women tended to be counted among the unemployed and the urban informal sector also tends to be excluded.

Finally we do recognise that some of the indicators will not have much inter-temporal variation, in part due to infrequent measurement. In particular this is the case for the education indicators and maternal mortality ratios.

3.2 METHODOLOGY

Building on the approach established by the Human Development Index, we followed the basic normative approach which says that all dimensions are of equal importance. Another basic principle is that women and men should fare equally irrespective of the level of human development achieved by a given country. The methodology integrates this normative approach with statistical principles to produce a composite index that captures the disparity between women and men, as well as the association between disparities across dimensions.

The GII is based on the general mean of general means of different orders. The combination of means, the harmonic mean of geometric means, makes the GII to be both distribution and association-sensitive, essentially meaning that the GII captures the inequality between women and men and is sensitive to changes in association between indicators. It penalises more those countries where one gender performs badly on all the indicators. This was achieved by first aggregating by the geometric mean across dimensions separately for women and men, and then by aggregating by the harmonic mean across genders. Appendix 1 provides details of the method, which is summarised here in terms of five steps.

[36] (Desai, 2010)

Step 1. Treatment of zeros and extreme values. Two of the indicators required adjustment in order to be able to compute the index:

- The maternal mortality ratio is truncated symmetrically at 10 (minimum) and at 1,000 (maximum). This is partly a normative judgement that conditions in countries at each extreme of the distribution are effectively very similar, but also due to a practical concern about the accuracy and precision of these rates. It is true that reproductive health indicators used in the Gender Inequality Index do not have equivalent indicators for males. So in this dimension, the reproductive health of girls and women is compared to assumed norms of no maternal death, and no adolescent pregnancy.

- The female parliamentary representation of countries reporting 0% is coded as 0.1% because it seems reasonable to assume that there is some very minimal level of political influence of women in all countries.[37]

Step 2. Aggregating across dimensions within each gender group, using geometric means. Aggregating first across dimensions for women and men by the geometric mean makes the GII association sensitive (see Zambrano 2010b).

For females, the formula for aggregating is

$$G_F = \sqrt[3]{\left(\frac{1}{MMR}\cdot\frac{1}{AFR}\right)^{1/2}\cdot(PR_F\cdot SE_F)^{1/2}\cdot LFPR_F}\ ,$$

and for males the formula is

$$G_M = \sqrt[3]{1\cdot(PR_M\cdot SE_M)^{1/2}\cdot LFPR_M}\ .$$

Step 3. Aggregating across gender groups, using a harmonic mean. The female and male indices are aggregated by the harmonic mean:

$$HARM(G_F, G_M) = \left[\frac{(G_F)^{-1}+(G_M)^{-1}}{2}\right]^{-1}.$$

[37] This affects the value of the GII of only two countries in 2010 – Qatar and Saudi Arabia, but has an impact on the ranks of countries with similar or higher value of the GII. Results of some preliminary sensitivity analysis are given in appendix 2.

Using the harmonic mean of geometric means within groups captures the inequality between women and men and accounts for association – or overlap -- across dimensions.

Step 4. Calculating the geometric mean of the arithmetic means for each indicator. The reference standard for computation of inequality is obtained by aggregating female and male indices using equal weights and then aggregating the indices across dimensions:

$$G_{F,M} = \sqrt[3]{\overline{Health} \cdot \overline{Empowerment} \cdot \overline{LFPR}}$$

where $\overline{Health} = \left(\sqrt{\frac{1}{MMR} \cdot \frac{1}{AFR}} + 1 \right) / 2$, $\overline{Empowerment} = \left(\sqrt{PR_F \cdot SE_F} + \sqrt{PR_M \cdot SE_M} \right) / 2$, and

$$\overline{LFPR} = \frac{LFPR_F + LFPR_M}{2}.$$

Note that $\overline{Health}$ should not be interpreted as an average of corresponding female and male indices but as half the distance from the norms established for the reproductive health indicators—fewer maternal deaths and fewer adolescent pregnancies.

Step 5. Calculating the Gender Inequality Index. Comparing the equally distributed gender index to the reference standard yields the Gender Inequality Index, $1 - \frac{Harm(G_F, G_M)}{G_{\overline{F},\overline{M}}}$, which ranges from 0 (no gender inequality across dimensions) to 1 (total gender inequality across dimensions).

The application of the method is illustrated by computation of the Gender inequality index for Brazil. Brazil's performance on the relevant indicators, as given in 2010 HDR (Statistics Annex, Table 4), is as follows: maternal mortality ratio is 110 deaths per 100,000 births, which is below the world's average of 273, while the adolescent fertility rate of 75.6 percent is above the world average (53.7). The parliamentary representation of women at 9.4 percent of seats is well below the world average of 16.2 percent. At the same time the gap in attainment at secondary and higher education is in favour of women (2.5 percentage points higher for women relative to men), in contrast to the world gap of about 10 percentage points in favour of men. Finally, although the Brazil's gap in labour force participation

between women and men is smaller than the world average, it is still over 20 percentage points. The values are presented in Table 1 below.

Table 1 Brazil – GII Indicators

	Health		Empowerment		Labour market
	Maternal mortality ratio	Adolescent fertility rate	Parliamentary representation (%)	Attainment at secondary and higher education (%)	Labour market participation rate (%)
Female	110	75.6	9.4	48.8	64.0
Male	na	na	90.6	46.3	85.2

Note: na is not applicable.

First, we calculate the geometric mean of the indicators for women and men separately:

$$G_F : 0.115 = \sqrt[3]{\sqrt{\left(\frac{1}{110}\cdot\frac{1}{75.6}\right)}\cdot\sqrt{0.094\cdot 0.488}\cdot 0.640}$$

$$G_M : 0.820 = \sqrt[3]{1\cdot\sqrt{0.906\cdot 0.463}\cdot 0.852}$$

Even a cursory glance reveals large differences, with the mean for men being seven times higher than that for women. The next step is to compute a notional level of development in three dimensions that could have been achieved if women and men fared equally in each dimension (but not necessarily on each indicator), by first computing the corresponding means in each dimension and then combining them by the geometric mean across the dimensions:

Reproductive health: $\left(\sqrt{(1/110)\cdot(1/75.6)}+1\right)/2 = 0.505$

Empowerment: $\left(\sqrt{0.094\cdot 0.488}+\sqrt{0.906\cdot 0.463}\right)/2 = 0.431$

Labour market: (0.640+0.852)/2=0.746

$$G_{\overline{F},\overline{M}} : \quad 0.546 = \sqrt[3]{0.505\cdot 0.431\cdot 0.746}$$

The next step is to average the two geometric means obtained for women and men separately by the harmonic mean, representing the average achievement of the country in the three dimensions – this accounts for differences between women and men as well as for association between dimensions:

$$Harm(G_F, G_M): \quad 0.201 = \left[\frac{1}{2}\left(\frac{1}{0.115} + \frac{1}{0.820}\right)\right]^{-1}$$

Finally, the Gender Inequality Index is obtained as a relative loss to human development due to uneven achievements for women and men:

$$GII = \left(G_{\overline{F},\overline{M}} - Harm(G_F, G_M)\right) / G_{\overline{F},\overline{M}} = 1 - 0.201 / 0.546 = 0.632$$

Brazil's GII score of 0.632 gives it a ranking of 80th overall out of the 138 countries for which we calculate the GII – putting it in the bottom half of countries in terms of gender equality as measured by the GII. As noted above, Brazil's GII score suffers due to a high adolescent fertility rate, very low representation of women in parliament and a relatively high gap in labour force participation between women and men.

4. RESULTS AND INSIGHTS

The GII is applied to 138 countries around the world, covering all regions and parts of the HDI spectrum. The results reveal that gender inequalities substantially erode human development achievements in all countries and regions, but with significant variation. Table 2 summarises the regional and world average losses due to gender inequality and the losses experienced in some of the key dimensions measured by the GII.[38] The estimated global loss due to gender inequality is 56 percent, with the largest losses concentrated in South Asia, sub-Saharan Africa and the Arab States. The group averages range from 32 percent in developed OECD countries, to 74 percent in South Asia.

[38] Country classifications are based on HDI quartiles. A country is in the very high group if its HDI is in the top quartile, in the high group if its HDI is in percentiles 51–75, in the medium group if its HDI is in percentiles 26–50 and in the low group if its HDI is in the bottom quartile.

Table 2 Regional Losses due to Gender Inequality

	GII Value	Maternal mortality ratio	Adolescent fertility rate	Seats in parliament (%)	Labour force participation rate (%)	
					Female	Male
Region	2008	2003–2008	1990–2008	2008	2008	2008
Developed						
OECD	0.317	8	19.4	20.6	65.5	80.1
Non-OECD	0.376	16	11.2	18.1	58.2	82.3
Developing						
Arab States	0.699	238	42.6	8.7	27.0	78.2
East Asia and the Pacific	0.467	126	18.1	19.8	70.1	84.5
Europe and Central Asia	0.498	41	28.2	12.5	58.6	75.0
Latin America and the Caribbean	0.609	122	72.6	17.5	55.3	83.3
South Asia	0.739	454	65.0	10.4	37.2	84.2
Sub-Saharan Africa	0.735	881	122.3	17.3	63.8	82.3
2010 HDI Categories						
Very high human development	0.319	8	19.1	20.5	65.3	80.2
High human development	0.571	82	47.7	13.3	52.7	79.5
Medium human development	0.591	242	41.8	16.0	54.7	84.1
Low human development	0.748	822	108.9	14.4	61.3	83.4
Least developed countries	0.746	786	104.5	16.6	64.7	85.2
World	**0.560**	**273**	**53.7**	**16.2**	**56.8**	**82.6**

Source: HDRO Calculations

Notes: The maternal mortality ratio is defined as deaths per 100,000 live births. The Adolescent fertility rate is defined as the number of births per 1,000 women ages 15 to 19.

With an average loss due to gender inequality of 74 percent, South Asia has the worst losses of any region. Women lag behind men across each of the dimensions captured, and most notably in national parliamentary representation, education and labour force participation. Maternal mortality also tends to be high, with an average of 454 deaths per 100,000 live births. All the countries in the region perform poorly on the GII—most notably Afghanistan, Bangladesh, India and Nepal – each with GII scores above 70 percent. The Maldives and Sri Lanka and perform somewhat better, with respective losses of 54 percent and 60 percent.

In sub-Saharan Africa, significant gender disparities in education and high maternal mortality and adolescent fertility rates—which are the highest in the world—contribute to the region's 74 percent loss in potential human development due to gender inequality (only 0.4 percent less than the loss suffered in South Asia). The worst performing countries are Democratic Republic of the Congo, Mali and Niger (losses of 80-81 percent in each case) due to poor performance across each of the dimensions, most particularly reproductive health - Democratic Republic of the Congo has a maternal mortality ratio (MMR) of 1,100 deaths and adolescent fertility rate (AFR) of 201 births; Niger has a MMR of 1,800 deaths and AFR of 158 births; and Mali has a MMR of 970 deaths and AFR of 170 births, compared to

the regional average MMR of 881 deaths and AFR of 122 births. Mauritius and Burundi perform relatively better, with respective losses of 47 percent and 63 percent.

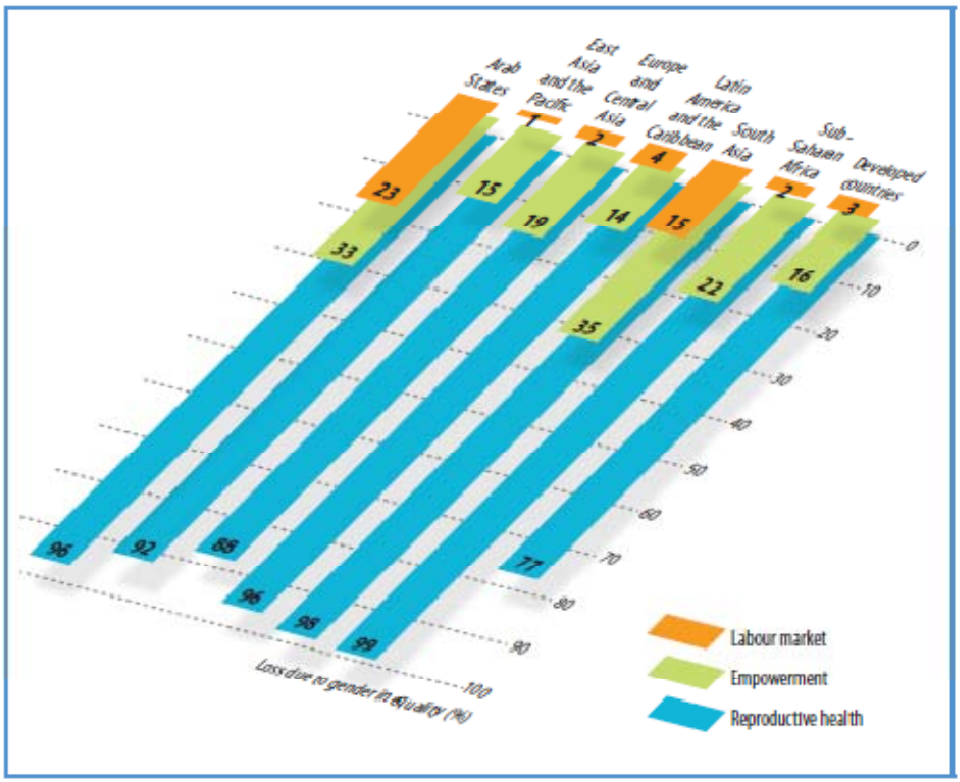
Women in the Arab States are affected by unequal labour force participation, which is only around half the global average, and poor educational attainment—less than one third of women over the age of 25 have completed secondary education. Tertiary enrolment for women is relatively high, however, and, with an increase of 45 percentage points since 1970, now exceeds that of men in the Arab States--there are 132 females for every 100 males in tertiary education.

At the other end of the spectrum, the developed OECD countries top the list as being closer to gender equality – with eight countries registering less than 25 percent loss in human development due to gender inequality: Netherlands, Denmark, Sweden, Switzerland, Norway, Belgium, Germany and Finland. The gap in labour force participation remains marked however – standing at about 66 percent for women as compared to 80 percent of men.

Countries in Europe and Central Asia have few women in parliament, though they are close to parity in educational attainment and employment, and they have low maternal mortality ratios. For example, in Lithuania, fewer than one in five parliamentarians are women, but the maternal mortality ratio -- of 11 deaths per 100,000 births – is low, secondary education rates are high and two thirds of women participate in the labour market compared with about three in four men.

Regional patterns reveal that reproductive health is the largest contributor to gender inequality around the world (Figure 2). Women in sub-Saharan Africa suffer the most in this dimension, followed by South Asia and the Arab States and Latin America and the Caribbean. The Arab States and South Asia also exhibit relatively weak female empowerment and unequal labour force participation.

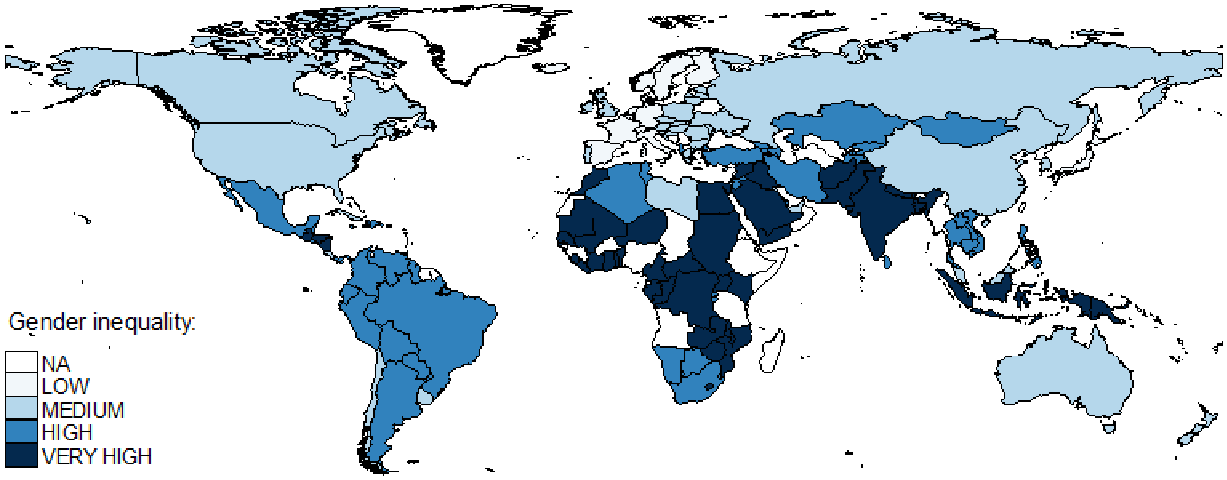
Figure 2 Loss due to Gender Inequality by region



Source: HDR 2010, P93

Map 1 shows the pattern of GII results at the country level, and reinforces the regional picture summarised above.

Map 1 Gender Inequality Index across 138 Countries



Note: Countries are categorized according to GII scores into four quartiles, reflecting a relative grouping with 34-35 countries in each. The associated threshold values of the GII are 0.280, 0.512, 0.674.
Source: HDRO, based on 2010 Human Development Report

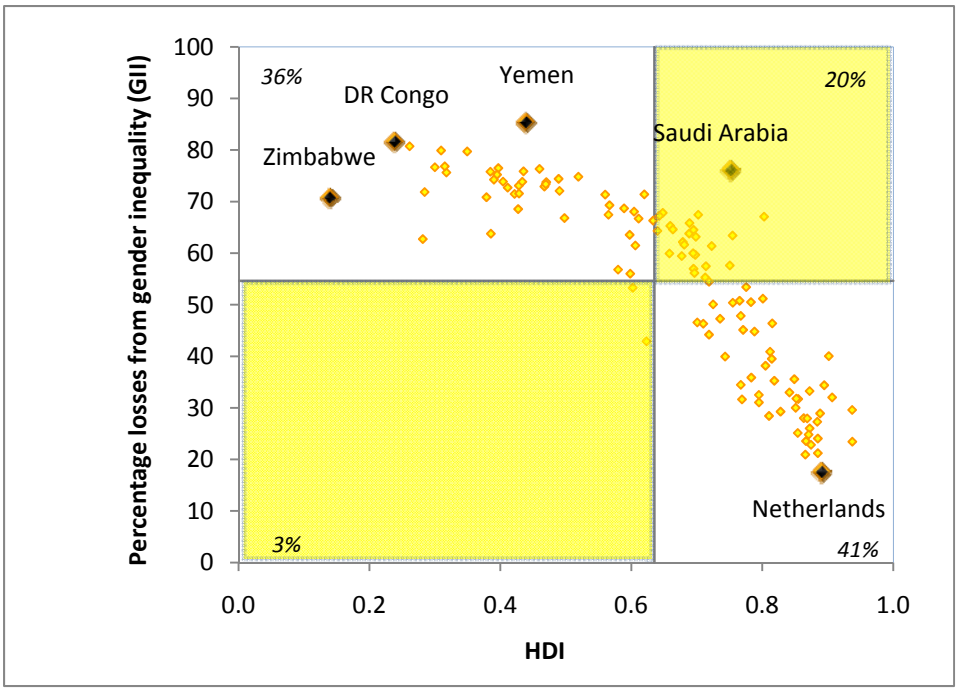
At the country level the GII ranges from 17 percent (Netherlands) to 85 percent (Yemen). But tremendous variation in gender inequality exists. With a GII of 17 percent, the Netherlands is the country which is closest to gender equality. The country has very low maternal mortality (6 deaths per 100,000 births), among the world's lowest adolescent fertility rate (3.8 births per 1,000 women ages 15-19) and is close to parity in educational attainment, political participation and employment. Yemen is the country at the other end of the spectrum, with a GII score of 85 percent. Only 20 percent of women in Yemen are in the labour force, women hold less than 1 percent of seats in parliament and only 8 percent of the female population has attended secondary school. The country also has a high maternal mortality ratio of 430 deaths per 100,000 births and an adolescent fertility rate of 68 births per 1,000 women.

The bottom 10 countries (in descending order) are Cameroon, Côte d'Ivoire, Liberia, Central African Republic, Papua New Guinea, Afghanistan, Mali, Niger, the Democratic Republic of the Congo and Yemen, with an average GII of 0.79. Saudi Arabia is another country with high gender inequality, and which is an interesting case. The country shows high human development, with a global HDI ranking of 55, an HDI of 0.75 and income per capita of nearly $25,000. However, despite good female educational attainment, women are nearly absent from parliament, and female labour force participation rates are only one-fourth those for men, giving the country a GII value of 0.76, and a ranking of 128 out of 138 countries.

For the bottom 20 countries the average maternal mortality ratio is about 915 deaths per 100,000 live births and the adolescent fertility rate is 111 births per 1,000 women ages 15–19, both well above the global averages of 273 deaths and 54 births. Moreover, there is only one woman for every eight men in parliament.

More generally, all of the bottom ranked HDI countries have high levels of gender inequalities on multiple dimensions. This is shown in Figure 3. All 30 low HDI countries included in the 2010 GII have a GII score exceeding 50 percent; whereas among the high and very high HDI countries, only 26 out of the 74 included in the index have values that high. This suggests that gender equity is a key correlate of low HDI, and vice versa.

Figure 3 Large losses due to gender inequality, especially in low HDI countries

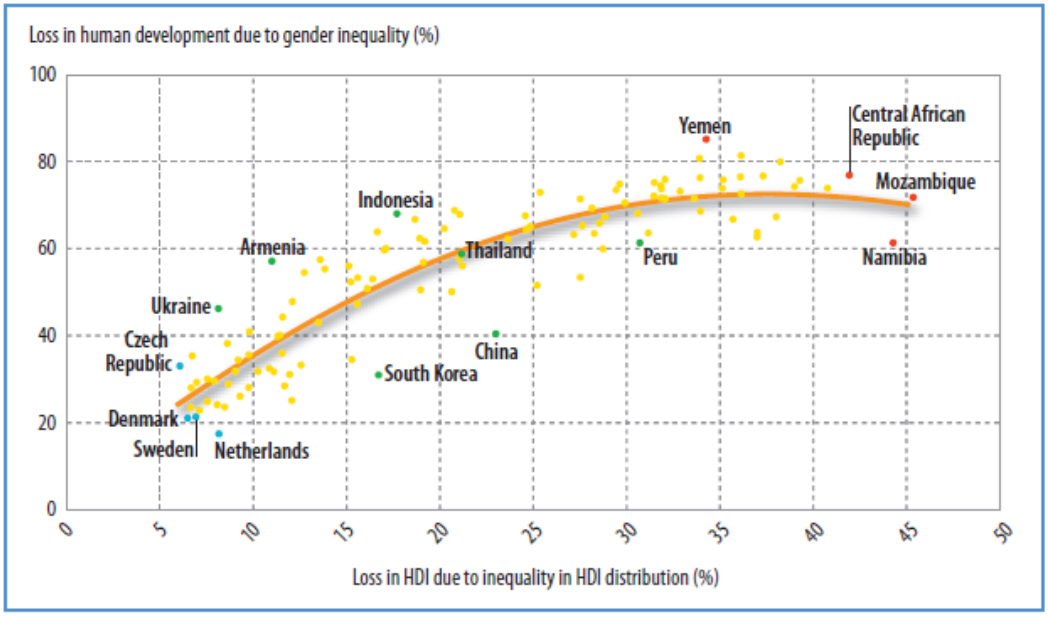


Source: HDRO calculations using data from the HDRO database

But there are important exceptions, and as evident in figure 2 around 20 percent of countries characterised as having high gender inequality are also in the high HDI category – for example Qatar has a high HDI value (0.803) and an HDI rank of 38, but also suffers high gender inequality (67 percent) and ranks poorly on this front (94th overall).

It is also interesting to compare the results to the inequality adjusted HDI. In doing so we find a strong correlation (0.87) between gender inequality and the loss due to inequality in the distribution of the HDI – suggesting that countries experiencing unequal distribution of human development also experience high inequality between men and women and vice versa (Figure 4).

Figure 4 Loss due to gender inequality compared to multidimensional inequality



Source: HDR 2010, P94

For example, Central African Republic, Democratic Republic of the Congo, Mali and Mozambique each experience losses in HDI due to inequality of greater than 55 percent and also have GII values above 70 percent (ranking them last in terms of loss due to inequality and in the bottom 30 countries in terms of gender inequality). In the middle of the spectrum we see Ghana, Egypt and Guatemala; each with loss due to gender inequality of around 72 percent and losses due to inequality of around 30 percent; and Paraguay, Columbia and the Dominican Republic each experience loss in human development due to gender inequality of around 65 percent and losses due to inequality of 20 percent. In addition, 8 of the 10 best performing countries in terms of gender equality are also among the 20 countries that experience the smallest losses in human development due to inequality.

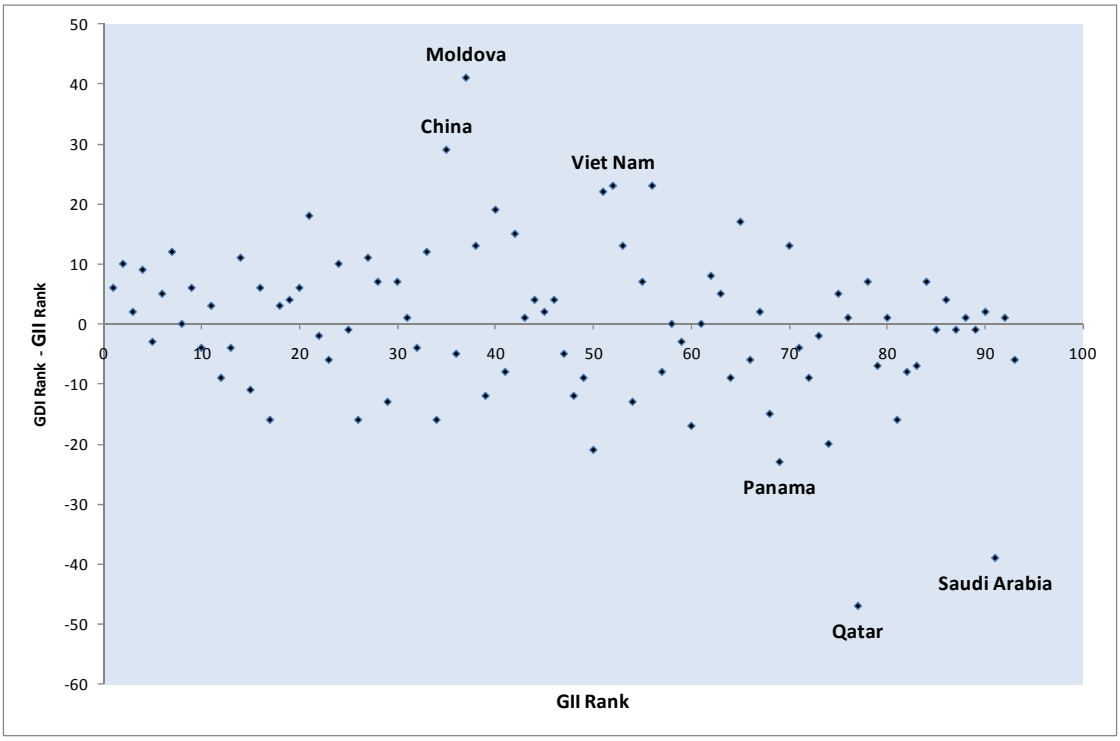
5. COMPARING RESULTS WITH OTHER GENDER INDICES

As noted in Section 2 above, the various gender indices measure gender inequality in different ways – and because the underlying conceptual frameworks differ, so too do the results. Still, given the commonality of objectives it is interesting to review and contrast the results and pictures which emerge. We do this for the GDI and GEM, GGI, GEI, SIGI and WEOI.

There are 93 countries for which the GII, GDI and GEM are calculated and we find very little rank order correlation between the three indices—only 0.4. The different method of aggregation, which reduces the extent to which a high achievement in one dimension can compensate for a low achievement in another, partly explains this lack of correlation.

The comparison of GDI rank and GII rank shows some interesting results (Figure 5). For example, the Republic of Moldova gains 41 places, China 29 places and Viet Nam 23 places on the GII as compared to the GDI. The gain results mainly from relatively low maternal mortality and adolescent fertility rates combined with high levels of female labour force participation. In additional Qatar and Saudi Arabia lose 47 and 39 places respectively. The huge lose is largely explained by relatively low female labour force participation rates and the absence of females in parliament. Absence of income from the measure also erodes advantages these countries had previously on the income dimension of the GDI.

Figure 5 Difference in ranks - GII as compared to GDI

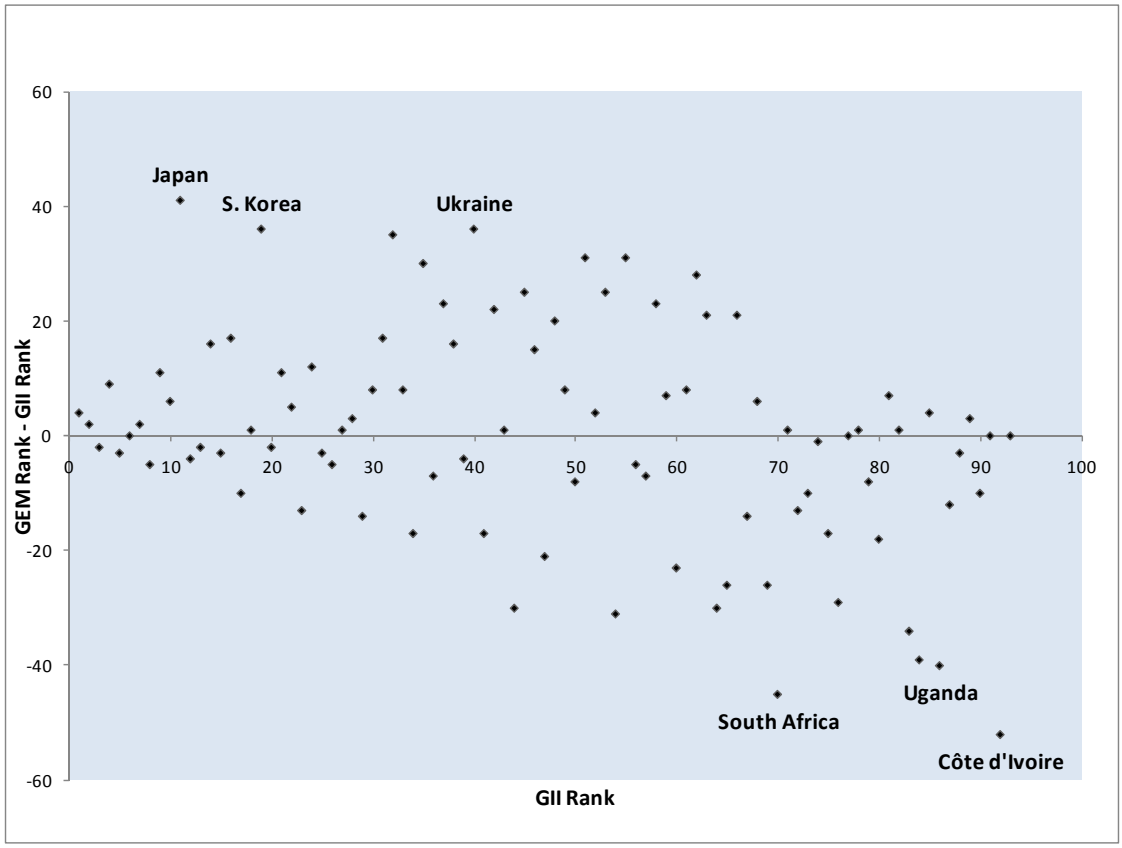


Source: Authors' computations based on data from 2010 HDR and 2009 HDR

In contrast, different rankings emerge relative to the GEM, as shown in Figure 6. Côte d'Ivoire, South Africa and Uganda fare poorly worse on the GII, losing 52, 45 and 40 places in rank respectively. While Japan gains 41 places and South Korea and Ukraine each gain 36 places in rank. Both Côte d'Ivoire and Uganda have relatively high maternal mortality and adolescent fertility ratios; and low female

achievements in higher education. The reverse is true for the countries gaining in rank. South Africa's loss in rank is mainly explained by the relatively high maternal mortality ratio.

Figure 6 Difference in ranks - GII as compared to GEM



Source: Author's computation based on data from 2010 HDR and 2009 HDR

In looking at other measures, we recall that the World Economic Forum's Global Gender Gap Index (GGI) differs from the GII in that it measures gender gaps but ignores the absolute achievements. This is useful – but can also be somewhat misleading. For example, on this index, Lesotho is in 8th position of 128 (as compared to 102nd on the GII), ahead of, among others, the United States, Switzerland and Spain – despite the fact that fewer than one-fourth of women have secondary education and almost one in ten women die in childbirth. Hence the picture revealed by the GGI would appear to be partial, at best. Similarly South Africa comes in at 12th (despite the fact that only half of women participate in the labour force and one in every 250 women will die in child birth) and Mozambique at 22nd (regardless of the fact that less than 2 percent of women have secondary education and almost 150 out of every 1,000 women aged 15-19 will give birth), as compared to 82nd and 111th respectively on the GII.

The Gender Equity Index (GEI) developed by Social Watch, provides a comparison of gender equity across countries, but as noted above the objective is to provide a ranking and not to capture the absolute

levels of gender inequality within countries. The top and bottom ranking countries on the GEI are similar to those identified by the GII – Sweden, Finland and Norway are all in the top 5, and Yemen, Benin and Cote d'Ivoire are all in the bottom 10. There are however some surprises: Rwanda ranks fifth on the GEI, but is 83rd on the GII. Other notable differences include the Philippines, which is ranked 13th on the GEI and 78th on the GII, and Colombia which is ranked 18th on the GEI and 95th on the GII. These differences appear to arise because of the inclusion of reproductive health on the GII –both countries perform relatively very poorly on this dimension as compared to their performance in the dimensions of empowerment and labour force participation. It is also useful to recall that the GII is association sensitive. This clearly highlights that the indexes are measuring different things – one showing the loss to potential human development caused by gender inequality, and the other the situation of women relative to men as compared across countries.

The SIGI, as noted above, is focused not on gendered outcomes, but rather on the institutions that influence such outcomes. By focusing on the root causes behind gender inequalities, SIGI is a useful complement to track reforms and social institutions affecting the gender based inequalities measured by the GII. In 2009 the top 5 countries (out of 102 non-OECD countries) suffering the lowest discrimination in social institutions based on SIGI rankings were Paraguay, Croatia, Kazakhstan, Argentina and Costa Rica. In contrast these countries rankings on the GII are 85, 30, 67, 60 and 51 respectively. These contrasting results underline the need to examine why countries making strong institutional and policy efforts to promote gender equity still experience significant losses in human development due to gender inequality. This may raise issues around implementation, cultural and other constraints, as well as questions about the time needed for reforms to take effect.

Finally, the recently released WEOI, like the SIGI, focuses on the institutions that affect women's participation - in this case in relation to women's economic opportunities. Specifically, the WEOI considers the laws, regulations, practices, customs and attitudes that allow women to participate in the workforce under conditions roughly equal to men, whether as wage-earning employees or as owners of a business. One data related constraint is that the focus is limited to the formal sector, which means that the measure likely provides better insights for developed countries and urban elites in developing countries than for developing countries more generally. Nonetheless it is notable that the top 5 ranked countries on the WEOI – Sweden, Belgium, Norway, Finland and Germany – are also in the top 10 on the GII. And 4

of the bottom 5 – Togo, Cote d'Ivoire, Yemen and Sudan[39] – also score poorly on the GII, with rankings of 115, 130, N/A, 138 and 106 respectively.

6. CONCLUSIONS

Significant progress has been made in measuring women's status and well-being. However, substantial challenges remain. First, there is a lack of gender disaggregated data for many important aspects of women's status and well-being. Second, even when there are measures available for many countries, they may not be available for those countries where gender is a particularly salient issue. Third, time series data for indicators measured consistently are usually not available. Finally, in order for international comparisons to be meaningful, consistent measures are needed. Thus, some of the more interesting aspects of gender – including property ownership, participation in community life and decision making, seats on boards, and gender based violence -- are not included in any of the indices.

The GII is unique in that it focuses on critical issues of educational attainment, economic and political participation, as well as female-specific health issues. None of the existing gender gap measures incorporate a reproductive health indicator, which is very pertinent to the other choices women can make. Adolescent fertility raises important questions of whether young women have access to contraceptives and to sex education to help them make informed choices. The method allows us to combine issues where women's status is considered in relation to men's with issues where a male counterpart does not exist, namely reproductive health.

In sum, the GII casts important light on gender disparities in health, empowerment and labour market participation across 138 countries in the world. It yields new and important insights on gender gaps in well-being and empowerment. It shows that some societies disadvantage women in critical dimensions, thereby pointing to the need for more proactive public policies. By looking at the component indicators, the GII give pointers to areas needing critical policy intervention.

[39] Chad is the 5th country in the bottom 5 on the SIGI, however no GII could be computed for this country due to insufficient data.

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APPENDIX 1. DESIGNING THE GENDER INEQUALITY INDEX[40]

First we introduce the notation. The achievements of women and men in three dimensions of a society's human development is measured by five indicators, and expressed by a 2x5 matrix X, where row i=1,2, contains the achievements x_{ij}, j=1,…,5 corresponding to the five indicators for gender i. The entries in X are *positive* numbers, with a high value of x_{ij} representing a high accomplishment of gender i in dimension j.

We are looking for a composite index of inequality between women and men across five indicators which satisfy some basic properties of a well defined inequality measure, such as scale invariance, gender symmetry, inequality aversion, and also the right kind of association sensitivity. Scale invariance means that if all indicators are multiplied by the same positive constant, the relative positions of both genders, and the relative position of all indicators for each gender, remain the same, and thus gender inequality remains the same. Gender symmetry refers to the index treating women and men the same, as all important differences between them are intended to be captured by X. The inequality aversion property means that the mean preserving spread of the achievements across indicators and genders increase inequality. Finally, the association sensitivity of the index we seek means that gender inequality increases under increasing association across indicators indicating that the more likely it is for a particular gender to have the relatively high achievement in all dimensions, the higher the gender inequality in that country.[41] A class of measures that satisfy these properties can be built from considering welfare indices defined through computing general mean of general means. We present a particular form for two gender groups, five indicators and the aggregation across indicators with elasticity of substitution of one which implies the use of the geometric mean across the indicators:

$$(1) \qquad I(x) = 1 - \left[\frac{1}{2}\left(\left(\frac{x_{11}}{\bar{x}_1}\right)^{\alpha_1} \dots \left(\frac{x_{15}}{\bar{x}_5}\right)^{\alpha_5}\right)^{\beta} + \frac{1}{2}\left(\left(\frac{x_{21}}{\bar{x}_1}\right)^{\alpha_1} \dots \left(\frac{x_{25}}{\bar{x}_5}\right)^{\alpha_5}\right)^{\beta}\right]^{1/\beta}$$

Since the geometric mean is the general mean of order 0, the order of the general mean across genders has to be smaller for inequality measure to be increasing under increasing association[42], thus implying that

[40] This text is based on Zambrano (2010a).
[41] Association sensitivity is studied in detail in the context of social welfare functions in Seth, S. (2010) and in the context of the gender inequality index discussed in this Appendix in Zambrano (2010b).
[42] C.f.., Seth (2010) and Zambrano (2010b).

$\beta < 0$. If $\beta = -1$ the aggregation across genders is by the harmonic mean. The $\alpha_1, \dots, \alpha_5$ are positive weights that sum up to one.

Equation (1) is a measure of inequality of the Dalton-Atkinson type, so that the assessment of inequality is based on the comparison between the aggregate accomplishment a society achieves to the one it would achieve had all inequality across genders been suppressed. Such an "equal" society, call it Y, is obtained from X as follows:

$$X = \begin{bmatrix} x_{11} & \dots & x_{15} \\ x_{21} & \dots & x_{25} \end{bmatrix} \quad \rightarrow \quad Y = \begin{bmatrix} \bar{x}_1 = \frac{x_{11}+x_{21}}{2} & \dots & \bar{x}_5 = \frac{x_{15}+x_{25}}{2} \\ \bar{x}_1 = \frac{x_{11}+x_{21}}{2} & \dots & \bar{x}_5 = \frac{x_{15}+x_{25}}{2} \end{bmatrix}$$

This requirement essentially implies that for the indicators for women and men to be comparable they have to be expressed in the same units and that whatever changes in units are done to the indicator of one gender must be applied to the indicator of the other gender. Otherwise, it would be hard to give a meaning to expressions like $\frac{x_{11}+x_{21}}{2}$ or even $x_{11} > x_{21}$.

Because of this, normalizing *the units* (common to both genders) in which the indicators are measured is irrelevant for the computation of an index of inequality based on a generalized mean across genders of the geometric means across indicators. This actually reveals that this inequality index has a normalization built in – since the indicators really enter the computation of the index as ratios of the indicators to the averages of these indicators across genders. Thus, a normalization of units that treats the genders the same will cancel out in the computation of this index. This is so because the index being proposed only cares about changes in the *orders of magnitude* of the data[43], which is invariant to any linear normalization of units. [44]

Equation (1) can also be written as

$$(2) \qquad I(x) = 1 - \frac{\left\{\frac{1}{2}[(x_{11})^{\alpha_1} \dots (x_{15})^{\alpha_5}]^{\beta} + \frac{1}{2}[(x_{21})^{\alpha_1} \dots (x_{25})^{\alpha_5}]^{\beta}\right\}^{1/\beta}}{(\bar{x}_1)^{\alpha_1} \dots (\bar{x}_5)^{\alpha_5}}$$

We would like to assign normatively the same weight to each of three dimensions, as well as to each indicator within a dimension, by keeping the weights $\alpha_1, \dots, \alpha_5$ equal to ½ within the dimension and 1/3

[43] Such a normalization is usually done by dividing with a constant say a maximum for the indicator for both women and men across all compared countries: $x_{11}/M, x_{21}/M$.

[44] An alternative normalization which includes a change of origin, for example $x_{ij} - \min_c\{x_{ij,c}\}$ has the capacity, in principle, to alter the rankings of the countries in a rather unintuitive way, unless the origin is set to 0, in which case such a normalization coincides with one that does rescaling of indicators by dividing with a constant.

between the dimensions. Noting that the first dimension - health, has two indicators, the second dimension - empowerment, has also two, and the third - labour market, has only one, the (2) becomes

$$(3) \qquad I(x) = 1 - \frac{\left\{\frac{1}{2}\left[\left((x_{11}x_{12})^{0.5}\right)^{\frac{1}{3}}\left((x_{13}x_{14})^{0.5}\right)^{\frac{1}{3}}(x_{15})^{\frac{1}{3}}\right]^{-1} + \frac{1}{2}\left[\left((x_{21}x_{22})^{0.5}\right)^{\frac{1}{3}}\left((x_{23}x_{24})^{0.5}\right)^{\frac{1}{3}}(x_{25})^{\frac{1}{3}}\right]^{-1}\right\}^{-1}}{(\bar{x}_1^*\bar{x}_2^*\bar{x}_3^*)^{1/3}}$$

where $\bar{x}_1^* = [(x_{11}x_{12})^{0.5} + (x_{21}x_{22})^{0.5}]/2$, $\bar{x}_2^* = [(x_{13}x_{14})^{0.5} + (x_{23}x_{24})^{0.5}]/2$, and $\bar{x}_3^* = (x_{15} + x_{25})/2$, represent the dimension means obtained under assumption of gender equality.

The Gender Inequality Index will be equal to 0 if women and men fare equally in each dimension. The Gender Inequality Index tends to 1 as the harmonic mean on the right hand side tends to zero which is the case if the gap between women's and men's achievements is increasing.

It is important to note that two indicators of health dimension, maternal mortality ratio (MMR) and adolescent fertility rate (AFR), have a different direction from the other indicators and have to be transformed in a way that is consistent with the functional form and the normalization. Such a transformation has to preserve the proportions in the data and to result in a transformed indicator of the same direction as others - that is an increase in the indicator corresponds to an improvement. Computing the inverse of MMR and AFR has exactly those two properties. Take for example Latvia with MMR equal to 10 and Tunisia with MMR equal to 100. The ratio of the two is 10, that is, Tunisia has a level of MMR that is 10 times higher than that of Latvia. Changing the direction of the indicator but preserving the factor of proportionality in the relative relationship we have to arrive to an indicator that will assign value to Latvia that is 10 times higher than the one assigned to Tunisia. We achieve this by taking the inverse of MMR - for Latvia it is 100,000/10=10,000 and for Tunisia it is 100,000/100=1000.

We arrive to a natural interpretation of the inverse of MMR by first observing that MMR/100,000 is the probability of the mother dying in a live birth. Then, 100,000/MMR is how many live births, on average, one has to witness before seeing the mother die during birth. The number for Latvia, 10,000, says that one has to witness, on average, 10,000 live births before seeing the mother die during birth. The number for Tunisia is 1,000, case in which one has to witness, on average, 1,000 live births before seeing the mother die during birth.

The same logic and equivalent interpretation holds for the AFR.

Finally, it also makes sense to calculate the loss due to inequality in each dimension. The loss due to inequality in the first dimension (expressed by two indicators) is given as

$$I_1(x) = 1 - \frac{\left\{\frac{1}{2}[(x_{11}x_{12})^{0.5}]^{-1} + \frac{1}{2}[(x_{21}x_{22})^{0.5}]^{-1}\right\}^{-1}}{\bar{x}_1^*}$$

where $\bar{x}_1^* = [(x_{11}x_{12})^{0.5} + (x_{21}x_{22})^{0.5}]/2$. The loss in other dimensions can be obtained in the same way. However, the GII is not a simple sum of these dimension losses, it also accounts for the association between dimensions.

APPENDIX 2: SUMMARY OF STATISTICAL AND SENSITIVITY ANALYSIS OF THE GII

HDRO undertook extensive statistical and sensitivity analyses of the Gender Inequality Index. These found that the reproductive health indicators are the most influential in determining the level of gender inequality, followed by the empowerment indicators – education and parliamentary representation.

The labour force participation rate appears to be a relatively weak indicator: its impact on country rankings is the smallest (it is weakly correlated to the GII). And if we exclude it we see that 50 percent countries would change their ranks by at most 2 places, and the next 45 percent of countries rank would change by 10 places or less. However no other options are available on the economic side for a sufficiently large number of countries.

We undertook sensitivity analysis of the rankings to three methodological judgments – replacement of zero parliamentary representation of women in Qatar and Saudi Arabia by 0.1%, truncation of maternal mortality ratio at 10 and 1000, and the choice of parameter β in the general form given by equation (1) of appendix 1.

It should be recalled that Qatar and Saudi Arabia have zero female parliamentary representation. We assumed a level of 0.1 percent. Their ranking could improve for up to 26 places if a higher value was used. However, the use of 0.1% has been justified on the ground that the smallest observed non-zero value of this indicator is 0.7 percent for Yemen (3 seats out of 412) or 0.2 percent for each seat held by women. Thus replacing zero percent of seats by any number over 0.1 percent would give an advantage to Qatar and Saudi Arabia over the actual achievements in other countries. On the other hand because only one seat held by a woman increases the value of the indicator to 2.6 and 0.7 in these countries respectively, it would be hard to justify a figure below 0.1 as a replacement.

The weaknesses in MMR estimates are well known. Truncation of the MMR at 10 and 1000, to exclude outliers, keeps about three-fourths of the countries in the sample at the same ranks as they would have if the original MMR was used; for the other 35 countries, the rank changed by at least one place, for about 5% or 7 countries, the rank changed by at least 7 places, and for two countries – Saudi Arabia and Qatar - the ranks changed by 9 and 23 places, respectively. The justification for truncation at 10 and 10,000 is to avoid the statistical uncertainty in relatively very small numbers – our judgment was that countries with 1 to 10 deaths per 100,000 are performing at effectively the same level of care in terms of reproductive health, and that differences among these countries are insignificant. Otherwise, a country with only one

maternal death per 100,000 women of fertile age could appear as performing twice as well as a country with 2 deaths, while the difference is likely due to the random fluctuation of events. Similarly, at the upper end of the MMR distribution for countries with MMR higher than 1000, an upper bound of 1000 was used. The reasoning is that countries where the MMR exceeds 1000 are likely to be equally weak in their capacity to create safe conditions and support for maternal health, alongside concerns about the accuracy of reported deaths. Thus a country with 1000 maternal deaths per 100,000 live births is not twice as superior as a country with 2000 deaths; we classify them to the same open ended group and count the deaths as being 1000.

The final area of interest relates to the choice of our inequality aversion parameter. Since we interpret the value of GII as the loss in human development due to inequality between women and men it is important to see how the values of GII change depending on the choice of β. We find that there is only a very small change in rankings due to different choices of beta parameter in the equation (1). When $\beta = -1/2$ the GII values are lower, indicating that the estimated inequality between women and men is lower. This is because of the lower sensitivity to association of inequalities in the three dimensions implied by $\beta = -1/2$. When $\beta = -2$ the GII values are larger, because the association between dimension inequalities is more heavily penalized. The $\beta = -1$ is the interim position, and the value that we adopted – also known as the harmonic mean.[45]

[45] A normative justification of $\beta = -1$ is undertaken in Zambrano (2010b).