INEQUALITY AND THE HUMAN DEVELOPMENT INDEX

A Dissertation Presented

by

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In memory of my mother, Kathleen J. Stanton.

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ABSTRACT

INEQUALITY AND THE HUMAN DEVELOPMENT INDEX

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The United Nations Development Program's (UNDP) Human Development Index (HDI) is a country-level measure of social welfare based on national values for average life expectancy, rates of adult literacy and school enrollment, and gross domestic product (GDP) per capita. HDI is commonly used by scholars, policy-makers, and development professionals to compare levels of development among nations and to gauge each nation's progress in development. Since HDI is based entirely on national averages it lacks any information about the distribution of health, education, or income within countries. The distribution of access to key resources is an important determinant both of the effect of average levels of health, education, and income on absolute levels of deprivation, and – as effects of inequality on environmental degradation and health have been well-documented – of the aggregate well-being of a population as a whole. Absent some measure of inequality, HDI is severely hampered in its ability to depict accurately the levels and changes in social welfare. My dissertation, entitled "Inequality and the Human Development Index," examines the relationship between inequality and human well-being; reviews the history of the HDI and the literature attempting to include

distribution in measures of social welfare; critiques several existing measures of inequality related to HDI; and proposes alternative indices that would capture inequality in the measurement of human development.

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CHAPTER 1

INTRODUCTION

In measuring a country's level of well-being, the *distributions* of key components of human development like health, education, and income are just as important as their *average levels*. Measures of well-being that do not take into account information about distribution and likely to overrate the performance of countries with very unequal distributions, and underrate the performance of countries with more egalitarian distributions.

Gross domestic product (GDP) per capita, the most common measure of aggregate well-being, is a simple average. Critics have pointed out that GDP per capita does not measure even the income contributions to well-being very well, due to its failure to account for unequal distribution. The main alternative measure, the United Nations Development Program's (UNDP) Human Development Index (HDI), was created in an effort to improve the measurement of human well-being. HDI embodies Amartya Sen's "capabilities" approach to understanding human well-being, which emphasizes the importance of ends (like a decent standard of living) over means (like income per capita).[1] Like GDP per capita, HDI is based on national averages, albeit for a wider set of welfare indicators.

Key capabilities are instrumentalized in HDI by the inclusion of proxies for three important ends of development: access to health, access to education, and access to commodities. Component indices for life expectancy, literacy, school enrollment, and income are combined into a single index that is used to compare the level of human well-being among countries or to monitor an individual country's progress over time. HDI has been the centerpiece of the UNDP's *Human Development Reports (HDRs)* for 16 years. The latest edition, *HDR 2005*, includes HDI rankings for 177 countries.

The rationale behind HDI is that average health and education are not simply functions of average income per capita; if they were, then HDI would merely contain the same information as per capita national income. Instead, average levels of health and education contain information not available from average income alone. Health and education have a substantial public goods component; they are not pure private goods, distributed entirely according to income. In addition, if the privately obtainable components of health and education are concave in income – that is, an individual's ability to purchase health and education is subject to diminishing returns – then countries with the same average incomes but different income distributions will have different levels of average health and education. For the latter reason, HDI's inclusion of average health and education goes some way toward capturing the effects of income inequality on social welfare.

HDI fails, however, to account for other welfare-relevant effects of income inequality, as well as for welfare-relevant effects of inequalities in the distribution of health and education outcomes themselves. For example, inequalities in all three components of HDI may have corrosive effects on human well-being through their association with decreasing social cohesion, increasing violence, or increasing environmental degradation. Moreover, many, if not all, people place an intrinsic value on equality as an end in itself.

This dissertation was written with two goals in mind. First, to provide a critical analysis of the Human Development Index, and other UNDP measures of human well-being that are closely related to the HDI, especially with regard to their sensitivity to different distributions of health, education, and income. Second, to present a set of alternative indices that successfully incorporate inequality into the measurement of well-being. The dissertation contains five main chapters, each of which is described below.

1.1 The UNDP's Human Development Index: A History

This chapter recounts the story of the development of HDI, beginning with the early intellectual history of welfare economics and following this field through three successive revolutions in thought culminating in the notion of "human development". I trace this history from the origins of economic "utility" theory to Sen's human capabilities approach, and chronicle past and present measures of social welfare used in the fields of economics and development, including national income and various composite measures up to and including HDI. Since HDI's introduction in 1990, scholars have offered critiques of its underlying data and its method of calculation. I summarize these critiques and describe the UNDP's adjustments to HDI over time.

1.2 Accounting for Inequality: A Proposed Revision of the Human Development Index

In this chapter, I argue that it is both desirable and feasible to reformulate the Human Development Index to push the boundaries of social-welfare measurement beyond national averages. The chapter begins with a summary and critique of the UNDP's own efforts to measure inequality in its *Human Development Reports*. Next, I explore the impacts of inequality on social welfare in greater detail. I then propose a new

"Inequality-adjusted HDI," providing a detailed explanation of the necessary data and methodology, and discussing the theoretical underpinnings of this methodology. Finally, I calculate this new measure for 46 countries (those for which the necessary data are currently available), and compare the results to the current HDI.

1.3 Human Development and Horizontal Inequality in the United States: A Disaggregation of the HDI by Gender, Race/Ethnicity, and State

Another way to observe inequalities in human development is to disaggregate each country's HDI into separate HDIs for subnational groups. In this chapter, I disaggregate of the United States HDI by gender, race/ethnicity, race/ethnicity by gender, and state. The United States aggregate HDI, when calculated using national data sources on which this disaggregation is based, differs from the UNDP's measure, which is calculated using international data sources. I analyze the origins of the differences between the two measures of United States HDI, and discuss how these differences raise questions about the quality of the data currently used by the UNDP.

1.4 Engendering Human Development: A Critique of the UNDP's GDI

This chapter concerns the UNDP's Gender-related Development Index (GDI), which is a measure of overall well-being that takes into account the negative effects of gender inequality on a society as a whole. I question whether or not GDI, as currently constructed, achieves the best possible gender-inequality-sensitive measure of human development. In GDI, health, education, and income indices are assigned penalties for the extent of gender inequalities using a formula that includes female and male population shares, the gender-specific component indices, and a parameter representing society's aversion to gender inequality. I examine GDI's underlying data, techniques for calculating its component indices and assessing levels of gender inequality, and the resulting GDI values.

1.5 Alternative Measures of Gender Inequality in Human Development

GDI is little known, seldom referenced, and poorly understood. In this chapter, I argue that the cause of this disregard is GDI's failures in the realm of common-sense or intuitive explanatory power. I then demonstrate a series of alternatives to GDI as currently formulated. These alternatives aim: first, to measure what the "woman in the street" would expect needs to be measured; second; to measure this using a method that makes immediate, intuitive sense; and finally, to produce results that more credibly depict our common understanding of the state of gender equity within and among countries.

1.6 Conclusion: Inequality and the Human Development Index

The UNDP's path-breaking work in bringing quantitative measures of human development to scholars, development professionals, policy-makers, and the general public has changed the field of international development for the better. Yet its original vision of human development included distribution of capabilities within each nation. The UNDP's early *Human Development Reports* ignored distribution in the original operationalization of HDI, but they did so only for a lack of data.

For some aspects of distribution – notably gender-based inequality and income inequality – the necessary data now exist. For other aspects, such as the distribution of education and health, the data have yet to be fully developed, but enough is now available to incorporate this information for a substantial subset of countries. Moreover, to the extent that demand drives supply in measurement tools, the absence of such data it is not a good reason for continuing to exclude measures of inequality from HDI. The existence of inequality in well-being can be addressed either by changes to the UNDP's existing measures, like HDI and GDI, or by the addition of new inequality-related companion measures to HDI. This dissertation provides a roadmap that can assist the UNDP in better fulfilling its original, inequality-sensitive vision of the measurement of human development.

Notes

[1] See Sen 1985.

CHAPTER 2

THE UNDP'S HUMAN DEVELOPMENT INDEX: A HISTORY

In 1990, the United Nations Development Program (UNDP) transformed the landscape of development theory, measurement, and policy with the publication of its first annual *Human Development Report* (*HDR*) and the introduction of the Human Development Index. *HDR 1990* presented the concept of "human development" as progress towards greater human well-being, and provided country-level data for a wide range of well-being indicators. The UNDP's establishment of the *HDR* expanded both the availability of measurement and comparison tools used by governments, NGOs, and researchers, and our common understanding of development itself.

The Human Development Index, or HDI, embodies Amartya Sen's "capabilities" approach to understanding human well-being, which emphasizes the importance of ends (like a decent standard of living) over means (like income per capita) (Sen 1985). Key capabilities are instrumentalized in HDI by the inclusion of proxies for three important ends of development: access to health, education, and goods. Empowered by these, and other, capabilities, individuals can achieve their desired state of being.

HDI has been the centerpiece of the *HDR*s for 15 years, and the latest edition, *HDR 2005*, includes HDI rankings for 177 countries. In HDI, component indices for life expectancy, literacy, school enrollment, and income are combined together into a single index that can be used to compare the level of human well-being among countries or to monitor one country's progress over time. HDI provides an alternative to the still common practice of evaluating a country's progress in development based on per capita national income.

What follows is the story of the development of the HDI, beginning with the early intellectual history of welfare economics and following this field through three successive revolutions in thought culminating in the theory of human development. In the first section, I trace this history from the origins of economic "utility" theory to Sen's human capabilities approach. The second section is a chronicle of past and present measures of social welfare used in the fields of economics and development, including national income and a variety of composite measures up to and including HDI. Since HDI's first introduction in 1990, many scholars have offered critiques of its underlying data and its method of calculation. In many cases, the UNDP has responded by improving HDI based on these critiques. In the third, and final, section of this chapter I summarize these critiques and the UNDP's adjustments to HDI over time.

2.1 Human Well-Being: A History of Thought

In neo-classical economics "utility" is a term that has come to mean an individual's mental state of satisfaction, with the proviso that levels of satisfaction or utility cannot be compared across individuals. It is a concept that is simultaneously too broad and too narrow. Almost anything can be seen to have and give utility, albeit with diminishing returns. While its reach is broad, the usefulness of the "utility" concept as deployed in neo-classical thought suffers from some severe limitations. In the absence of inter-personal comparability, the utility of individuals cannot be aggregated in order to consider social welfare, nor can it be compared in order to consider distribution.

While a theory of well-being that can address neither aggregate welfare nor inequality seems of little practical or conceptual use, this modern definition of utility has nonetheless been the dominant measure of human welfare used in mainstream economic theory since the 1930s. As measurement has become increasingly central to the field of economics, the accepted metric for social or aggregate welfare has been defined implicitly (and sometimes explicitly) in terms of money, or, more specifically, as national income per capita (ironically, a practice that violates neo-classical utility theory, as will be explored below). Yet modern theorists including Martha Nussbaum, John Rawls, and Amartya Sen have opened our eyes to a world of concepts of social welfare unbound by the rules of neo-classical economics. The history of thought leading up to Sen's capabilities approach to human welfare is the topic of this section.

2.1.1 The origins of welfare economics

The Western thought that provides the basis for most modern economists' understanding of human well-being can be traced back as far as Aristotle, who viewed well-being as something generated by our actions and not our belongings:

> Another belief which harmonizes with our account is that the happy man lives well and does well; for we have practically defined happiness as a sort of good life and good action. The characteristics that are looked for in happiness seem also, all of them, to belong to what we have defined happiness as being. For some identify happiness with virtue, some with practical wisdom, others with a kind of philosophic wisdom, others with these, or one of these, accompanied by pleasure or not without pleasure; while others include also external prosperity. (Aristotle, 350 B.C.E.)

Dominant European concepts of well-being changed over time from this Aristolean idea to the medieval metric of heavenly rewards and punishments determining our earthly well-being, to Calvinist predetermination, and finally to the scientific aestheticism of the

Renaissance, which lasted until the dawn of Utilitarian philsopophy in the 18th century (Segal 1991).

Jeremy Bentham's (1789: Ch.1) *Introduction to the Principles of Morals* was not the first, but is the best remembered discussion of the philosophy of Utilitarianism, in which human behavior is described as motivated by pleasure and pain – their net satisfaction being "utility." Society's well-being was the sum of these utilities, such that an ethical course of action was that which led to "the greatest happiness for the greatest number." This formulation of social welfare was meant to be both egalitarian and individualistic: each person's utility was counted equally and each person got to determine what was his or her own level of satisfaction (Ackerman 1997a). In theory, utility could be summed across individuals to determine "social welfare," but utilitarianism did not offer any practical way to actually measure either individual or societal well-being. Bentham also posited what would eventually come to be known as the diminishing marginal utility of goods, and, by extension, income or wealth: the idea being that each new unit of anything adds to your utility a little bit less than the last one.

Amartya Sen (2000a) points to a fierce opposition to pluralism of ideas as a defining characteristic of Utilitarianism. Utilitarians insisted on the importance of having a single measure of human well-being, as opposed to different and non-commensurable elements. In contrast, in *The Standard of Living*, Sen (1987b: 1) defends a pluralistic understanding of well-being:

> There are many fundamentally different ways of seeing the quality of living, and quite a few of them have some immediate plausibility. You could be well off, without being well. You could be well, without being able to lead the life you wanted. You could have got the life you wanted, without being happy. You could be happy, without having much freedom. You could have a good deal of freedom, without achieving much. We can go on.

Sen (2000a) views Benthamite utilitarianism as a rhetorical tactic that successfully cleared the intellectual arena of any serious opponents to utility. If there could be only one measure of well-being, then the struggle to have that measure be net satisfaction was not a very difficult one.

Utilitarianism receded in the early 19th century, until its revival by John Stuart Mill's *Utilitarianism* (1861). Mill's vision of utilitarianism differed in some respects from that of Bentham and other early proponents. He allowed for a hierarchy of different qualities or types of pleasure, recognized the importance of social influences on individual attitudes, and acknowledged that individuals are not always the best judges of their own interests (Ackerman 1997a).

2.1.2 The Marginalist Revolution

The most direct antecedents of today's neo-classical economists were called the Material or Marginalist Welfare School; these theorists preserved the basic precepts of Utilitarianism, but used new mathematical tools to make their arguments. At the center of their economic theory were two related ideas. First, that the goal of individuals was to maximize utility, and, second, a formalization of Bentham's idea that utility was concave, or diminishing on the margin. Versions of these ideas were published independently by Willam Stanley Jevons, Carl Menger, Leon Walras, and Alfred Marshal in the 1870s (Ackerman 1997a; Cooter and Rappoport 1984). Of the marginalists, Marshall (1890, Book 3, Chapter 3) is the best known for promoting the idea of "satiable wants":

> There is an endless variety of wants, but there is a limit to each separate want. This familiar and fundamental tendency of human nature may be stated in the law of satiable wants or of diminishing utility thus: The total utility of a thing to anyone (that is, the total pleasure or other benefit it yields him) increases with every increase in his stock of it, but not as fast as his stock increases. If his stock of it increases at a uniform rate the

> benefit derived from it increases at a diminishing rate. In other words, the additional benefit which a person derives from a given increase of his stock of a thing, diminishes with every increase in the stock that he already has.

By the 1890s the marginalists dominated British economic thought. This school of thought, perhaps envious of the new mathematical models developed in the field of physics in the 1860s, is responsible for increasing the mathematical complexity of economic analysis. Its members also changed the focus of economics, away from the centrality of economic growth emphasized by Adam Smith (and by future 20th century macroeconomists) and the distribution among classes emphasized by David Ricardo and Karl Marx, and towards the analysis of constrained maximization or allocation problems that necessitated the assumption of fixed resources (Ackerman 1997a).[1] Interestingly, interpersonal comparisons were assumed to be impossible by proponents of the Marginalist Welfare School, but these comparisons were conducted nonetheless between large groups, like the rich and the poor (Cooter and Rappoport 1984).

Following the work of Arthur Cecil Pigou, the marginalists restricted their analysis to the necessities of life, using money as a "measuring stick." Focusing on the most material aspects of welfare led to the insight that additional income was more useful to the poor than the rich. Pigou and Marshal, in particular, were explicitly in favor of income redistribution because it would lead to more material wants being satisfied. Vilfredo Pareto – who was against redistribution– clarified the by now murky waters of utility by pointing out that there were really two concepts of utility, not one. Usefulness was one form of utility. Ophelimity, or subjective desire, was the other. The Marginalist Welfare School was concerned only with the material wants of the former (Cooter and Rappoport 1984; Ackerman 1997b).

2.1.3 The Ordinalist Revolution

In 1932 the Marginalist Welfare School was attacked by British economist Lionel Robbins for having too narrow a focus on usefulness utility (e.g., bread) to the exclusion of ophelimity utility (e.g., opera tickets).[2] Unlike material necessities, ophelimity cannot be observed or compared either between individuals on average between groups of people. Robbins argued for the rejection of all interpersonal comparisons of utility. Robbins argued that cardinal measurement and interpersonal comparisons could never capture unobservable utility or satisfaction of others, and that it, therefore, could not be demonstrated or assumed that the marginal utility of income for the poor is greater than the marginal utility of income for the rich. The success of Robbins' rejection of cardinal measures of utility led to the so-called "Ordinalist Revolution" in economics, and the birth of neo-classical economics as we know it today (Robbins 1932; Cooter and Rappoport 1984).

The ordinalists noticed that if one were to combine the utilitarian concept of social welfare (defined as the sum of individual welfares) with another important marginalist assumption, diminishing marginal utility of income, the logical outcome is a very subversive result: Social welfare reaches its maximum when income was distributed equally across the population. Robbins (1932: 137, 141) took pains to reject this conclusion:

> The Law of Diminishing Marginal Utility implies that the more one has of anything the less one values additional units thereof. Therefore, it is said, the more real income one has, the less one values additional units of income. Therefore, the marginal utility of a rich man's income is less than the marginal utility of a poor man's income. Therefore, if transfers are made, and these transfers do not appreciably affect productivity, total utility will be increased…[This claim] rests upon an extension of the conception of diminishing marginal utility into a field in which it is entirely illegitimate…[and] begs the great metaphysical question of the scientific comparability of different individual experiences…Hence the extension of the Law of Diminishing Marginal Utility,

> postulated in the propositions we are examining, is illegitimate. And the arguments based upon it therefore are lacking in scientific foundation. Recognition of this no doubt involves a substantial curtailment of the claims of much of what now assumes the status of scientific generalisation in current discussions of applied Economics. The conception of diminishing relative utility (the convexity downwards of the indifference curve) does not justify the inference that transferences from the rich to the poor will increase total satisfaction…Interesting as a development of an ethical postulate, it does not at all follow from the positive assumptions of pure theory. It is simply the accidental deposit of the historical association of English Economics with Utilitarianism: and both the utilitarian postulates from which it derives and the analytical Economics with which it has been associated will be the better and the more convincing if this is clearly recognised.

If income were both concave in welfare and unequally distributed, you could always increase social welfare by redistributing some income from the rich to the poor. Ian Little (1955: 11-14) elaborated on Robbins critique and argued that individual satisfactions cannot be summed up, that satisfaction is never comparable among different individuals, and that the field of welfare economics up until that time had been – to its detriment – entirely normative. The utilitarian definition of social welfare was gradually replaced in welfare economics by the idea of "Pareto optimality."

In the concept of Pareto optimality, individual welfare is still utility, but social welfare is defined by the absence or presence of Pareto optimality (a situation in which no one can be made better off without making someone else worse off). In reality, this is a somewhat empty concept of social welfare since a very wide array of distributional situations can be Pareto optimal, and the only real opportunities for "Pareto Improvements" – when someone is made better off while noone is made worse off – occur when there are unclaimed or wasted resources. In *On Ethics and Economics*, Amartya Sen (1987a: 33-34) calls this redefinition of social well-being the narrowing of welfare economics: "In the small box to which welfare economics got confined, with Pareto optimality as the only criterion of judgement, and self-seeking behaviour as the only basis of economic choice, the scope for saying something interesting in welfare economics became exceedingly small."

In modern usage, the applied economics of social welfare has taken the form of cost/benefit analysis (CBA), a common tool for making decisions about whether a project will improve social welfare (and should therefore be carried out) or will reduce social welfare (and should not be carried out). According to CBA, if the net present value of the future stream of costs and benefits of a project is positive, we should carry out the project, but if the net present value is negative we should not carry out the project. Abstracting from the vexing question of discount rates (by which future costs and benefits are translated into present values), this means that any addition to the size of the "economic pie" is good, regardless of the distribution of costs and benefits (in that changes that improve the welfare of some while diminishing that of others somehow qualify as social welfare improvements). This decision rule runs counter to that of Pareto optimality, but it is similar to Bentham's social welfare as the sum of all individual welfares, with the difference that what is being summed is money rather than utility. Thus in applied neo-classical welfare economics, inter-personal comparability re-enters through the back door, while the diminishing marginal utility of income drops out of sight. The practice of adding up costs and benefits, and concluding that any positive net present value is good overlooks problems of unequal distribution: who gets the benefits and who pays the costs?

Connecting CBA back to ordinalist economic theory takes a blind eye and a few, difficult to justify, conceptual leaps. The conceptual leap by which neo-classical economics bridges applied cost-benefit analysis to theoretical welfare economics is the "compensation test." If a project results in a positive net present value, then the economic pie has gotten bigger. With a bigger pie potentially we could make everyone better off, or at least we could make some people better off while making no one worse off: This is a "potential Pareto improvement."

The compensation test, introduced by Nicholas Kaldor and John Hicks, is a method for determining whether or not there has been a potential Pareto improvement (Cooter and Rappoport 1984; Jackson 1992). Those who receive net benefits (the winners) could in principle compensate those who bear net costs (the losers) and still be better off. When net present value is positive, if I get all of the benefits but I have to pay back everyone who suffers costs, I can pay all the losers and still have a positive benefit left for myself. Of course, this fails to bring solace to the losers unless they are compensated in practice. As Sen (2000b: 947) so devastatingly put it:

> If compensations are actually paid, then of course we do not need the comparison criterion since the actual outcome already includes the paid compensations and can be judged without reference to compensation tests…On the other hand if compensations are not paid, it is not at all clear in what sense it can be said that this is a social improvement ("Don't worry, my dear loser, we can compensate you fully, and the fact that we don't have the slightest intention of actually paying the compensation makes no difference; it is merely a difference in distribution"). The compensation tests are either redundant or unconvincing.

Winners do not actually have to compensate losers in CBA – there just has to be the potential. But when the costs accrue to one group and the benefits accrue to another, can it be said unequivocally that a positive net benefit is an increase to society's well-being?

CBA marries Pareto optimality to the compensation test at the micro-economic level. At macro-economic level, Pareto optimality combined with the compensation test leads to GDP per capita as a measure of development. The use of GDP per capita as a measure of social welfare requires the same conceptual leap that CBA makes on the micro-economic level. Unless one assumes that there is a constant marginal utility of income, maximizing the sum of dollars is not the same as maximizing the sum of utility. But with a bigger dollar pie, it would be possible to distribute the additional dollars such that no one has less – a potential Pareto improvement that evades the problem posed by diminishing marginal utility of income. The practice of conflating per capita GDP with social welfare is, of course, subject to the same criticism that Sen levels against CBA.[3]

2.1.4 The Humanist Revolution

In *A Theory of Justice* (1971), philosopher John Rawls' definition of individual well-being was the possession of "social primary goods" or things that rational humans need or desire – a concept similar to utility – but his method of aggregating social well-being across individuals was revolutionary. Rawls' two principles of justice are, first, that, "Each person has an equal right to a fully adequate scheme of equal basic liberties which is compatible with a similar scheme of liberties for all." (Sen 1992: 75) This is not unlike Oliver Wendell Holmes' famous statement that, "The right to swing my fist ends where the other man's nose begins." Rawls' second principle is that, "Social and economic inequalities are to satisfy two conditions. First, they must be attached to offices and positions open to all under conditions of fair equality of opportunity; and second, they must be to the greatest benefit of the least advantaged members of society." (Sen 1992: 75; Rawls 1971)[4]

Rawls (1971: 152-3) went on to explain that these principles taken together form what he called the "maximin" rule for choice under uncertainty:

> [T]he two principles are those a person would choose for the design of a society in which his enemy is to assign him his place. The maximin rule tells us to rank alternatives by their worst possible outcomes: we are to adopt the alternative the worst

> outcome of which is superior to the worst outcome of the others. The persons in the original position do not, of course, assume that their initial place in society is decided by a malevolent opponent. As I note below, they should not reason from false premises. The veil of ignorance does not violate this idea, since an absence of information is not misinformation.

A Rawlsian notion of society's well-being, therefore, is one in which social welfare is said to be equal to the well-being of society's least well-off member.

Amartya Sen and Martha Nussbaum are together credited with the origination of the "capabilities" approach to human well-being based on Rawlsian philosophy (Pattanaik 1994). Like Aristotle, Sen and Nussbaum focused attention on what human beings can do, instead of on what they have. Moving the discussion away from utility and towards "capabilities" allowed Sen and Nussbaum to distinguish means (like money) from ends (like well-being or freedom) (Crocker 1992, 1995).

While Rawls limited his analysis of social welfare to the "social primary goods" that rational humans need or desire, and "negative freedoms" that involve the absence of interference, Sen and Nussbaum expanded on this base to include "positive freedoms" as well, like freedom from being constrained by poverty or a lack of education (Sen 1987a; Rawls 1971; Crocker 1992, 1995).[5] For neo-classical economists, well-being is individual utility, a mental state. For Sen and Nussbaum, both well-being and agency – or freedom – are important, and utility is not adequate as a measure of well-being (Crocker 1992, 1995). In *Inequality Reexamined*, Sen (1992: 6) makes this critique:

> Welfarism in general and utilitarianism in particular see value, ultimately, only in individual utility, which is defined in terms of some mental characteristics, such as pleasure, happiness, or desire. This is a restrictive approach to taking note of individual advantage in two distinctive ways: (1) it ignores freedom and concentrates only on achievements, and (2) it ignores achievements other than those reflected in one of these mental metrics.

Capabilities are the abilities to do certain things or to achieve desired states of being. They are empowerment, the power to obtain what you desire, utilize what you obtain in the way that you desire, and be who you want to be. Goods, on the other hand, are merely things that you possess. Capabilities allow you to use goods in ways that are meaningful to you. Sen uses a further term, “functionings,” to refer to the capabilities that a person actually uses or participates in. Capabilities, then, are the full set of functionings that are feasible for a given person. For example, with one capabilities set, fasting may be the only choice; with another set, fasting may be one of many choices. In addition, capabilities can have intrinsic value by adding worthwhile options or positive freedoms to one’s life (Sen 1999; Crocker 1992, 1995).

While Sen declines to list capabilities or functionings because of what he considers to be a need for a democratic process to determine such a list, Nussbaum (2000) has proposed a list of ten capabilities: (1) life; (2) bodily health; (3) bodily integrity; (4) senses, imagination, and thought; (5) emotions; (6) practical reason; (7) affiliation; (8) other species; (9) play; and (10) control over one’s environment.[6]

Nussbaum also discusses the ways in which our ability to convert a commodity into a capability depends on personal, social, and environmental conversion factors. Ingrid Robeyns (2005: 99) gives the example of access to a bicycle:

> If a person is disabled, or in a bad physical condition, or has never learned to cycle, then the bicycle will be of limited help to enable the functioning of mobility…If there are no paved roads or if a government or the dominant societal culture imposes a social or legal norm that women are not allowed to cycle without being accompanied by a male family member, then it becomes much more difficult or even impossible to use the good to enable the functioning.

The capabilities approach draws on a rich history of economic and philosophical thought regarding social welfare. Sen and Nussbaum’s work stands out from that of their predecessors because of inclusion of human beings' role as agents of their own well-being, and because of the centrality of human agency both as an end in itself, and as a means to other important capabilities or freedoms. Sen and Nussbaum's humanist revolution is a critique of theoretical neo-classical welfare economics, which goes beyond arguing that GDP per capita and CBA are inadequate measures of social welfare to refute Pareto optimality's standing as a basis of making value judgments. The UNDP's HDI is an attempt to build on the insights of the humanist revolution, in effect developing an applied measure of social welfare as a correlate to this new theoretical welfare economics. Just as GDP per capita and CBA were the progeny of the ordinalist revolution, HDI was born of the humanist revolution.

2.2 A History of the Measurement of Social Well-Being

In *India Economic Development and Social Opportunity*, Jean Drèze and Amartya Sen (1995: 9) describe the origins of the field development economics shortly after World War II and note that from its beginnings this field had "an overarching preoccupation with the growth of real income per capita." The most common measure of aggregate human well-being is now – as it has been for over 50 years – national income, usually expressed as per capita gross national product (GNP) or per capita gross domestic product (GDP). Criticisms of national income as a metric for social welfare have a long history and are by no means confined to economists:

> Too much and too long, we seem to have surrendered community excellence and community values in the mere accumulation of material things. Our gross national product [is the largest in the world], but that GNP – if we should judge [our nation] by that – counts air pollution and cigarette advertising, and ambulances to clear the highways of carnage. It counts special locks for our doors and jails for those who break them. It counts the destruction of our redwoods and the loss of our natural wonder in chaotic sprawl. It counts napalm and the cost of a nuclear warhead, and armored cars for police who fight riots in our streets…Yet the gross national product does not allow for

> the health of our children, the quality of their education, or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages; the intelligence of our public debate or the integrity of our public officials. It measures neither our wit nor our courage; neither our wisdom nor our learning; neither our compassion nor our devotion to country; it measures everything, in short, except that which makes life worthwhile. (Robert Kennedy, as quoted in Sánchez 2000: 13)

Measures of national income add up all of the goods and services exchanged on the market in a particular country in a given year. One of the principal architects of national income accounting was Nobel Laureate Simon Kuznets, who began work on the United States' income accounting in 1932. In 1947, a student of Kuznets, Milton Gilbert, then chief of the National Income Division of the United States' Department of Commerce, published the first description of the particular form of national income accounts called "gross national product" (Waring 1988).

GNP is the sum of all consumption, investment, and government spending by a country's nationals, whether within the national territory or not. In 1953, the United Nations published "A System of Statistical Tables" that gives clear, precise instructions for constructing national income accounts; these tables, with some modifications, are still the standard for national income accounts today (Waring 1988). Since the 1990s, GNP has been supplanted by GDP as the most common definition of national income (Ackerman *et al.* 1997: 347). GDP measures all consumption, investment, and government spending within a country, plus exports minus imports, regardless of the citizenship of the consumers or investors.

Many authors have noted conceptual problems with using GDP or GNP per capita as a measure of human well-being.[7] Briefly, national income accounts: 1) only register monetary exchanges; 2) equate goods with commodities that are not "goods" but "bads," like nuclear weapons, the production of which tends to lower social welfare; 3) count both addictions and cures, or "anti-bads," like the costs of cleaning up petroleum spills; 4) treat natural resources as free and limitless; 5) place no value on leisure-time; 6) ignore freedom and human rights; and (7) ignore the distribution of income within the society (Hicks and Streeten 1979; UNDP 1990).

2.2.1 Growth versus development

Closely associated with the use of national income accounts to measure well-being is the conflation of economic growth (as measured by the change in GDP) with development or progress. Hicks and Streeten (1979) point out two common assumptions made by proponents of this measure: First, economic growth will automatically "trickle-down" and spread its benefits across society; second, when economic growth fails to trickle-down and instead causes income disparities, governments will step in to remedy the situation. By one or both routes, growth in per capita national income will reduce poverty. As Hicks and Streeten (1979: 567) comment, neither assumption had, at the time of their writing, proved true: "Highly concentrated and unequal growth was observed in some countries for prolonged periods, so that there was no universal tendency for growth to spread. Nor did governments always show signs of correcting gross inequalities."

Ahluwalia and Chenery (1974: 38) state that:

> It is not sufficient that we should pay more attention to distribution or to the incomes of the poor within the existing framework of policy analysis. Rather, it is necessary to reformulate the framework itself so as to incorporate an explicit analysis of the processes by which the incomes of the poor are generated and the policy instruments by which these processes can be affected.

They distinguish between GDP growth and development, and propose an index of economic performance that sorts individuals into groups by their income or asset level, and then weights the importance of each group's economic growth before aggregating for a measure of social welfare. Ahluwalia and Chenery discuss several different potential weighting schefmes, from setting the weight of the poorest group at one and all other groups at zero (which would result in a measure consistent with Rawls' idea of social welfare), to giving each individual's income growth an equal weight (i.e., a one percent increase counts the same for all), to weighting the groups' importance to society's well-being by its share of total income. They point out that this last approach is equivalent to using GDP growth as a measure of the change in social welfare.

In *Hunger and Public Action*, Jean Drèze and Amartya Sen (1989: 183, 226) address this issue by distinguishing between growth-mediated and support-led government intervention. The growth-mediated strategy is, in some respects, a "trickle-down" policy. The idea is that greater affluence not only improves private incomes but also creates a better basis with which to pay for social services; the goal, then, is to increase GDP in order to increase the country's tax base and potential social service provision. In contrast, support-led strategies prioritize not increasing a country's GDP, but directly providing social services – including guarantees of income, income transfers, healthcare, and education – regardless of the level of GDP.

The strategies of growth-mediated and support-led development are contrasted to what Drèze and Sen (1989: 188) call "unaimed opulence" – an indiscriminate pursuit of economic expansion:

> A particularly crude version of [unaimed opulence], which is in fact not uncommon, consists of attempting to maximize economic growth without paying any direct attention to the transformation of greater opulence into better living conditions. Unaimed opulence, in general, is a roundabout, undependable, and wasteful way of improving the living standards of the poor.

In effect, unaimed opulence is a lack of any sort of public policy to address equity; the result of this lack can be rampant economic growth coupled with widespread poverty, illiteracy, ill health, child labor, crime, and starvation (Drèze and Sen 1995: 34). According to Drèze and Sen (1989: 180-1), there is no inevitable connection between GDP and the quality of life. The effect of GDP growth on poverty and inequality is always and everywhere mediated by public action.

The *HDR*s have carried this message – that national income is insufficient to measure human well-being for a wide variety of reasons – into the 1990s and beyond:

> People are the real wealth of a nation. The basic objective of development is to create an enabling environment for people to enjoy long, health and creative lives. This may appear to be a simple truth. But it is often forgotten in the immediate concern with the accumulation of commodities and financial wealth. (UNDP 1990: 9)

Some authors have disagreed with the UNDP's claim that estimates of national income have been the only measure of aggregate social welfare taken seriously since the 1950s or 1960s (UNDP 1990). For example, Srinivasan (1994: 238) states that, "In fact, income was never even the primary, let along the sole, measure of development, not only in the minds of economists but, more importantly, among policymakers." Srinivasan cites a variety of other measures that were in use in the 1950s. Similarly Rao (1991: 1453) calls the HDI "old wine in a new bottle," stating that before development was supplanted by economic growth in the 1960s, there was a more comprehensive view of human well-being.

It is not, however, the existence of other measures that is in dispute, but rather the overwhelming dominance of national income as a measure of well-being. An early United Nations (1954: 12) report gives further evidence both of this dominance, and of a long tradition of criticism of national income as a measure of development:

> The amount of money spent on consumption is often regarded as the measure of the level of living. The Committee did not agree with this view. Monetary expenditure to a large extent indicates personal wants and preferences. If an individual receives an increased income, and if prices, etc., remain the same, it must be assumed, according to

> the monetary approach, that his level of living has risen. But if he spends the additionally money on certain types of products or activities injurious to his health, we may…come to the conclusion that his level of living has not gone up or is even lower than before. Similarly, two persons expending the same amount of money on themselves may…have quite different levels of living.

2.2.2 Predecessors of the HDI

Many scholars and development agencies have attempted to create a broader measure of human well-being by combining indicators that shed light on both means and ends of social progress. Obstacles to the construction of such an index have included the lack of any objective standards both for what components should and should not be included, and for the appropriate way to combine the chosen indicators (Hicks and Streeten 1979).

One of the earliest of these attempts was conducted by the United Nations Research Institute for Social Development (UNRISD). In 1966, the UNRISD published a 20-country study of a “level of living index” that had categories for physical needs (nutrition, shelter, and health); cultural needs (education, leisure, and security); and higher needs (measured as income above a threshold). The UNRISD released a second study in 1972, this time of a “Development Index” with nine economic and nine social characteristics (McGranahan 1972; Hicks and Streeten 1979). In 1973, the Organization for Economic Cooperation and Development (OECD) published a report in which six social variables were used to form a “predicted GNP per capita index” for 82 developing countries. In 1975, the United Nations Economic and Social Council ranked 140 countries by adding the ranks together for seven indicators: two social (literacy and life expectancy) and five economic (energy, the manufacturing share of GDP, the manufacturing share of exports, employment outside of agriculture, and number of telephones) (OECD/DAC 1973; UN-ECOSOC 1975; Hicks and Streeten 1979).

Beginning in 1976, the International Labor Organization began publishing its work on the "basic needs" approach to development. Basic needs included an adequate level of both consumption and essential services, like health care or primary education. The specific indicators used to measure basic needs have varied over time, although in later studies by Paul Streeten (1981) and Frances Stewart (1985) an effort was made to reduce the number of variables by establishing which had the highest levels of correlation with one another. Both studies came to the conclusion that life expectancy could stand as a proxy for all basic needs.

In 1979, M.D. Morris of the Overseas Development Council released the Physical Quality of Life Index (PQLI) with the objective of measuring whether a minimum set of human needs was being met by the world's poorest people: "To the extent that development planners within poor countries and aid dispensers in donor countries now focus more directly on projects that emphasize distribution of benefits, they need not only new planning strategies but also additional measurement systems." (2) The PQLI combined infant mortality, life expectancy at age one year, and basic literacy, transforming each indicator into an index by comparing the level to a fixed range of possible levels, and then taking the average of the three components. Morris (1979: 49) explained that, "The extremes that define each index affect the placing of countries on that particular index as well as on the composite index." The PQLI also presented sub-national measures by gender and by region, where data were available.

Later attempts to construct a measure of social welfare include Camp and Speidel's (1987) *International Human Suffering Index*, which combined ten measures including income, infant mortality, nutrition, adult literacy, and personal freedom (Srinivasan 1994). Also Slottje's (1991) study of 130 countries, which appears to have been written before the release of the *HDR 1990,* drew on the capabilities approach by constructing a composite of 20 indicators, arguing that Morris' three components were insufficient to capture the quality of life.

2.2.3 Mahbub ul Haq and the HDI

> For the first time, we have begun to acknowledge – still with a curious reluctance – that in many societies GNP can increase while human lives shrivel. – Mahbub ul Haq (1999: 4)

Drawing heavily on the capabilities approach to human welfare, Mahbub ul Haq's "human development" project of the UNDP has been to define a new conceptualization of well-being and to make available measures of well-being based on that new idea. The first *HDR* (UNDP 1990: 9) declared that the means of development have obscured its ends because of two primary factors:

> First, national income figures, useful though they are for many purposes, do not reveal the composition of income or the real beneficiaries. Second, people often value achievements that do not show up at all, or not immediately, in higher measured income or growth figures: better nutrition and health services, greater access to knowledge, more secure livelihoods, better working conditions, security against crime and physical violence, satisfying leisure hours, and a sense of participating in the economic, cultural and political activities of their communities. Of course, people also want higher incomes as one of their options. But income is not the sum total of human life.

The human development process is one of enlarging people's choices. It focuses on three essential components: a long and healthy life, knowledge, and "access to resources needed for a decent standard of living" because, "If these essential choices are not available, many other opportunities remain inaccessible."(UNDP 1990) In the words of Paul Streeten (1994: 232):

> Human development puts people back at center stage, after decades in which a maze of technical concepts had obscured this fundamental vision. This is not to say that technical analysis should be abandoned. Far from it. But we should never lose sight of the ultimate purpose of the exercise, to treat men and women as ends, to improve the human condition, to enlarge people's choices.

Sen, who was one of the principal consultants on *HDR 1990*, wrote that at first he did not see the point of a crude composite index like the HDI, especially against the backdrop of the wealth of information that the UNDP was planning to include in the report. Haq replied, "We need a measure of the same level of vulgarity as GNP – just one number – but a measure that is not as blind to social aspects of human lives as GNP is."[8] Sen (2000a: 17) has since described human development as "an illuminating concept that serves to integrate a variety of concerns about the lives of people and their well-being and freedom," and affirmed that the *HDR* has served the increasing demands for pluralistic measures of development from both scholars and activists.

On the success of this mission to supplant GDP, Haq has said:

> Only 30 years ago, it would have been heresy to challenge the economic growth school's tacit assumption that the purpose of development is to increase national income. Today, it is widely accepted that the real purpose of development is to enlarge choices in all fields – economic, political and cultural. Seeking increases in income is one of the many choices people make, but it is not the only one. (Haq, as quoted in Sánchez 2000: 9)

In 2005, as in 1990, the HDI is the heart of the *HDR*s. HDI is a measure of human development that combines proxies for three important human capabilities: health, education, and a decent standard of living. Health (H) is represented by life expectancy (LE), education by literacy (LIT) and school enrollment (ENR) (the literacy and school enrollment indices are combined in weighted average as the education (E) index), and standard of living by GDP per capita (Y). The value for each these components is transformed into an index using a normalization formula in which the actual value is compared to a stylized range of values:

$$(1)\ \text{H-Index}_i = \frac{\text{LE}_i - 25\text{ years}}{85\text{ years} - 25\text{ years}}$$

$$(2)\ \text{LIT-Index}_i = \frac{\text{LIT}_i - 0\%}{100\% - 0\%}$$

$$(3)\ \text{ENR-Index}_i = \frac{\text{ENR}_i - 0\%}{100\% - 0\%}$$

$$(4)\ \text{E-Index}_i = 2/3(\text{LIT-Index}_i) + 1/3(\text{ENR-Index}_i)$$

$$(5)\text{Y-Index}_i = \frac{\ln(\text{Y}_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

The per capita GDPs used in the income index are in U.S. dollars and are purchasing power parity (PPP) adjusted to eliminate differences in national price levels. In addition, income is capped at $40,000, and natural logarithms are calculated for the actual, minimum, and maximum values in order to account for the diminishing marginal utility of income. The practical upshot of the logarithmic transformation is this: increasing GDP per capita by $100 in a country where the average income is only $500 has a much greater impact on the standard of living than the same $100 increase in a country where the average income is $5,000 or $50,000.

In the final step for calculating HDI, the health, education, and income indices are averaged together, with each one given an equal weight:

$$(6)\ \text{HDI}_i = (\text{H-Index}_i + \text{E-Index}_i + \text{Y-Index}_i)/3$$

The calculations used in the HDI have changed over the years and what is described above is the most recent formula, which has remained unchanged since 1999. Figure 2.1 below gives a history of HDI formulations.[9]

Year	Human Development Index
1990	• Component Index = (maximum-actual)/(maximum-minimum) • HDI = 1 - average of component indices • Ranked from worst (#1) to best (#130) • Maximum and minimum for current year • Education Index = adult literacy only • Income Index = $\log_{10}$(PPP GDP/capita); with the average poverty line for nine OECD countries as maximum
1991	• Ranked from best (#1) to worst (#160) • Education Index = adult literacy and mean years of school enrollment • Income Index = Atkinson formula = $y^* + 2(GDP_i - y^*)^{1/2} + 3(GDP_i - 2y^*)^{1/3}$ +…; threshold y* is the average poverty line for nine OECD countries
1994	• Component Index = (actual-min)/(max-min) • HDI = average of component indices • Fixed maximum and minimum (LE: 25/85 yrs; LIT: 0%/100%; ENR: 0%/100%; Y: $200/$40,000)
1995	• Education Index = adult literacy and combined gross school enrollment • Income minimum changed to $100
1999	• Income Index = natural log(PPP GDP/capita) up to $40,000

Source: UNDP 1990 to 2005.

Figure 2.1: History of Changes to the HDI

2.3 Critiques of HDI

Sen and Haq have not been the only ones to point out that one of the primary attributes of HDI is its ability to draw attention away from GDP and towards a wider concept of human development. Some scholars have derided the HDI on precisely these grounds. For example, Castles (1998: 832) writes that the *HDR*'s "dominant position in the global market for information on the social and economic world owes little to its intrinsic qualities and much to the packaging and promotional efforts of its multinational sponsor." Streeten (1994: 235), on the other hand, takes a positive view of these same qualities, “Yet, such indexes are useful in focusing attention and simplifying the problem. They have a stronger impact on the mind and draw public attention more powerfully than a long list of many indicators combined with a qualitative discussion.”

Over the years many economists and other scholars have critiqued the HDI for this among many other reasons. Srinivasan (1994: 241) sums up the viewpoints of several of his colleagues writing:

> [T]he HDI is conceptually weak and empirically unsound, involving serious problems of noncomparability over time and space, measurement errors, and biases. Meaningful inferences about the process of development and performance as well as policy implications could hardly be drawn from variations in HDI.

Srinivasan goes on to criticize the *HDR*s, in general, as being ill-informed and unsound.

This section summarizes the literature critiquing the HDI, changes in the HDI formula proposed by its critics, and the UNDP’s responses to these critiques. The critiques and proposed alternatives fall into five main categories: poor data, incorrect choice of indicators, various problems with the HDI’s formula in general, incorrect specification of income in particular, and redundancy.

2.3.1 Poor data

One category of critiques of the HDI addresses what some suggest is a poor quality of data, particularly in terms of the thoroughness of data collection and the frequency of measurement errors. Srinivasan (1994) and Ogwang (1994) point out that the census data used to calculate the HDI are unreliable because of the infrequency of census data collection, the possibility of inaccurate reporting, and a lack of complete coverage within countries. Srinivasan (1994) and Aturupane et al. (1994) each discuss a variety of concerns with measurement errors, including differing definitions – especially of literacy – from country to country, and the absence of a measure of school quality or length of school year in the school enrollment index. The UNDP has strived to improve the *HDR*'s data over the last 15 years, although more improvement is, of course, still possible. *HDR 1996* (UNDP 1996: 133) states that, "A major goal of the Report is to encourage national governments, international bodies and policy-makers to participate in improving statistical indicators of human development."

2.3.2 Wrong indicators

A second set of critiques concerns the selection of components included in the composite HDI. This critique takes two, closely related, forms: first, that important indicators are missing from the HDI, and second, that those indicators included in the HDI are the wrong ones. The latter critique will be discussed below in the section regarding overall misspecification of the index. The former critique – that variables important to explaining human well-being have been left out – refers to indicators related to four main areas: the extent of civil and political liberties; distribution of income, access to health care, and access to educational opportunities; environmental impacts on well-being and access to natural resources; and further educational measures to include both stocks and flows.[10]

While the UNDP has not added any new indices to the three original components, it has responded to the first three of these concerns by focusing an edition of the HDR on each topic: *HDR 1991* contains a Human Freedom Index; *HDR 1992* focuses on inequality and includes an Income-Inequality-Adjusted HDI; and *HDR 1998* addresses over-consumption and sustainability. The UNDP also responded to critiques regarding the HDI's original education index, which was based solely on adult literacy. This measure was changed, first by adding mean school years in *HDR 1991* to give a greater weight to current educational policies, and then by replacing mean school years with combined gross enrollment in *HDR 1995* because of difficulty obtaining data for mean school years for all countries.

2.3.3 Wrong specification

It has also been suggested that the formula used to calculate the HDI is arbitrary, unjustifiable, and incorrect.[11] The HDI's components are combined using a simple, unweighted mean – a method which has been likened to "adding apples and oranges." (Hopkins 1991: 1471) Sager and Najam (1998: 251) write that "the scheme of arithmetic averaging of the dimensions runs counter to the notion of their being essential and, therefore, non-substitutable."

One key critique of the HDI's specification regards relative deprivation, or "moving goal posts."[12] From 1990 to 1993 the HDI had minimum and maximum values for all three components based on variable criteria, like the actual minimum and maximum in the current year, or an average threshold value, as with income. Calculating the component indices using minimum and maximum values that change each year both makes it difficult to compare between years and, as noted by Kelley (1991: 319), "assumes that little or no progress in human development can be made by the developed countries." In 1994, the UNDP began using fixed goal posts to calculate HDI: 25 and 85 years for life expectancy, 0 and 100 percent for adult literacy, 0 and 15 years for mean school years, and $200 and $40,000 for GDP per capita. When combined gross enrollment replaced mean school years in *HDR 1995*, it was assigned "goals posts" of 0 and 100 percent. Also in *HDR 1995*, the lower bound for GDP per capita was changed to

$100. These same fixed goals posts, as assigned in 1994 and updated in 1995, are still used today.

The second major critique leveled at the formulation of the HDI regards the equal weights assigned to the three components. Biswas and Caliendo (2001) call this weighting procedure “unsettling” and remark that “to the extent that one component index has a different variance than another equal weights seem unsatisfactory. Greater variability in one component index relative to another represents information that is unused or ignored in simple averaging.” In *HDR 1991* (UNDP 1991: 88), the UNDP justifies its weighting procedure by explaining that the three indices are equally important, and, “All three of the HDI components thus deserve equal weight.” Many critics have found this explanation lacking. Chowdhury (1991: 126), for example, writes that: [13]

> It may be pointed out that there is an interesting paradox here. If a composite index is sensitive to weights, then one must be able to offer a solid defense of one’s chosen weights if the index is to be taken seriously. On the other hand, if the index is relatively robust, this would imply that the components are correlated, so that aggregation is pointless – any component would carry pretty much the same information.

Streeten (1994), on the other hand, defends use of a simple average stating that it is a good tool for focusing on decreasing gaps between countries, and that there is a political appeal to a simple method.[14]

Some scholars have focused on the relative weight of income as compared to life expectancy and education.[15] According to Kelley (1991: 319), “[I]t might be argued that the capacity to choose among many dimensions of human development accorded by expanded income in particular merits giving a relatively higher weight to this indicator.”

It is also important to note that the choice of the range of all three indicators affects the weight of the respective variable in the composite index (Kelley 1991).[16] In order to avoid a bias resulting from the choice of endpoints, Panigrahi and Sivramkrishna (2002) suggest standardizing each indicator before combining them.[17] The problem of implicit weights concealed by the explicit equal weights is discussed more fully in the section below on misspecification of the income indicator.[18]

Other possible weighting schemes include, according to Slottje (1991), establishing weights by: a social welfare function, a priori assumptions, regression coefficients, principal-components analysis (PCA), and the Borda method.[19] The PCA method, which uses the variance of linear combinations of the components to determine potential weights, has been tested by several researchers. In the Borda method, ranks for the three components are added together and the sums are then re-ranked, with these new ranks becoming the composite index's values.[20] Other methods not on Slottje's list include using a geometric mean (UNDP 1991); using D^2 statistics to calculate a composite index based on the standardized actual values and the standardized targeted values of the three components (Mazumdar 2003); and multiplying the three indices, so that HDI will be more sensitive to low values in any one index (Sager and Najam 1998). In addition, Paul (1996) offers a Modified-HDI that raises each index to a given power before taking the arithmetic mean, so that the higher the power, the greater difference between countries' index values.

Noorkbakhsh (1998b) compares several different methods of arriving at a composite index using the HDI data, including the arithmetic mean, PCA, and Borda methods, and finds that the ranks for all methods are very similar, which provides a justification for the current HDI specification. Similarly, Biswas and Caliendo (2001) use the PCA method to arrive at nearly equal weights for the three components – Life Expectancy Index 34 percent, Education Index 34 percent; GDP Index 32 percent – and conclude that:

> Despite the simplistic methodology, it appears that the HDI is a good method of combining the component indexes and should be viewed, perhaps, with less skepticism…[L]ittle is lost in the simplistic method, and much is gained in terms of straightforwardness. Indeed, while the strength of the HDI appears to lie in its easy comprehension, the weights used therein are consistent with multivariate techniques that generate weights optimally.

HDR 1993 also reports the results of PCA studies and concludes that these support equal weighting.

2.3.4 Wrong measure of income per capita

The fourth type of critique is about specification of the income component of HDI. The original measure was the shortfall of the base 10 logarithm of GDP compared to a maximum and minimum income value:

$$\text{(7) GDP-Index}_i^{1990} = \frac{\log_{10}(\$4861) - \log_{10}(\text{GDP}_i)}{\log_{10}(\$4861) - \log_{10}(\$220)}$$

where HDI was equal to one minus the average of the three indices, and the maximum and minimum values were chosen to equal the mean of the official poverty lines in nine OECD countries,[21] $4861, and the GDP per capita of the country with the lowest average income, Zaire with $220, respectively (UNDP 1990).

HDR 1990 (UNDP 1990: 12) explained the use of logarithms in calculating the GDP Index in this way:

> A further consideration is that the indicator should reflect the diminishing returns to transforming income into human capabilities. In other words, people do not need excessive financial resources to ensure a decent living. This aspect was taken into account by using the logarithm of real GDP per capita for the income indicator.

More recently Haq (1999: 49) also addressed the importance of adjusting income for diminishing returns:

> The HDI method thus emphasized sufficiency rather than satiety. It does not treat income as a means but reinterprets it in terms of the ends it serves. That is why, for example, the high income of the industrial countries is de-emphasized in the HDI and an overwhelming weight is given to the social progress they have achieved with this income.

Income is treated differently from the other variables because of the long-accepted practice in the field of economics of assuming that increases in income, and the goods and services that can be purchased with increased income, have a diminishing marginal effect on human well-being. Some critics of the HDI have raised the question of why life expectancy and literacy are not transformed to take their diminishing returns into account.[22] Noorbakhsh (1998a: 519) make this case in regards to the returns to literacy:

> It may be argued that the principle of diminishing returns also applies to educational attainments. To put it in a positive context, under similar conditions the early "units" of educational attainments to a country should be of much higher value than the last ones. In the context of policy-making in a country with 30% adult literacy, improvements in literacy are of far greater urgency than the same for a country with 90% adult literacy. On the other hand, it may be also argued that the value of the returns to increasing levels of educational attainment can be influenced in both directions, decreasing or increasing, by other factors such as the level of industrialization, capital accumulation and productivity.

Hicks and Streeten (1979: 571) addressed these concerns noting that for other social indicators, "skewness at the upper end is more limited than it is for income per head…There is practically no limit to how much income a man can receive, but the maximum life span is limited." They also point out that some social indicators, like life expectancy, capture the costs of both national affluence – for example, heart disease – and destitution.

The original specification for income in the HDI was critiqued both on the grounds of its income cap, and for the use of logs, for example, by Rao (1991: 1455):

“Since people do not compare ‘logs’ of incomes, it is better to simply use the absolute levels.”[23] In 1991, the UNDP changed to a new specification of income using what is referred to as a modified Atkinson concave transformation:

$$(8)\ f(Y) = \frac{1}{1 - \varepsilon} * Y^{1-\varepsilon}$$

where ε is extent of diminishing marginal returns to income, set for particular ranges of income such that: for 0 to y*, ε = 0; for y* to 2y*, ε = ½; for 2y* to 3y*, ε = ⅔, etc., where y* was the average poverty line for nine OECD countries (UNDP 1991). In general,

$$(9)\ Y\ Index_i^{1991} = y^* + 2(GDP_i - y^*)^{1/2} + 3(GDP_i - 2y^*)^{1/3} + \ldots$$

This formula creates a concave step function to represent the diminishing marginal utility of income. The formula for HDI’s income component remained unchanged until 1994, when a new method of arriving at the Atkinson-formula thresholds was introduced, along with the explanation that:

> It was always questionable, however, whether the poverty level of industrial countries was an appropriate income target for developing countries. So, for the 1994 HDI, the threshold value has been taken to be the current average global value of real GDP per capita in PPP$. Once a country gets beyond the world average, any further increases in per capita income are considered to make a sharply diminishing marginal contribution to human development. The HDI emphasizes sufficiency rather than satiety. On the new basis of real GDP per capita, the threshold is $5,120. (UNDP 1994: 91)

The Atkinson specification of income in the HDI was a popular target for critics, who condemned it for its discontinuity and recommended a more uniform transformation over the whole range of income.[24] The rejection of a cap on the un-discounted income is explained by Sager and Najam (1998: 253-4) in this way:[25]

> The overall application of the GDP adjustment artificially depresses the relative affluence for wealthy nations so that the gap between the rich and poor countries seems much narrower than it actually is. The result is that the standard-of-living index presents a falsely equitable picture of a world which in fact is more inequitable than ever…As

long as it is below that threshold the focus is on ensuring survival and not on adding to human development.

Ravallion (1997) offers a deconstruction of the Atkinson method and critiques it in terms of its "implicit trade-offs," that is, the terms under which countries can do well and poorly on differing indicators and end up with the same HDI score. He gives the example that $99 was equal to one year of life for countries with GDP per capita below the income threshold; at two-times the threshold, this value was $7,482; at three-times the threshold, $31,631; and at four-times the threshold, $65,038. Like Sager and Najam, Ravallion (1997: 633) sees these trade-offs as having an ethical content:

> In terms of both absolute dollar values and the rate of GDP growth needed to make up for lower longevity, the construction of the HDI assumes that life is far less valuable in poor countries that in rich ones; indeed, it would be nearly impossible for a rich country to make up for even one year less of life on average through economic growth, but relatively easy for a poor country.

HDR 1993 (UNDP 1993: 110) includes a discussion of the problem of implicit weights in which the UNDP cautions against this sort of interpretation:

> It would be tempting to interpret the relative coefficients as trade-offs, but a note of caution should be introduced. Superficially, it would be easy to say that one extra year of life expectancy is "worth" $150 of income, but these are not choices open to an optimizing economic agent. Take a poor country with per capita income as high as $1,500…An extra year of life expectancy (above a median value of about 50 years) would be the same as 10% growth in real per capita income. Neither of these two outcomes is likely in the short run, nor are they independent of each other in the real world. Thus, it would be wrong to interpret the coefficients as reflecting a "menu of policy choices."

In 1999, the UNDP switched to the current income specification in the HDI, with its continuous natural logarithm transformation[26] and high cap of $40,000.[27] *HDR 1999* (UNDP 1999: 159) lists three advantages of this new formula: the discounting is less severe; all levels of income are discounted uniformly; and middle-income countries receive recognition for increases in income that, under the Atkinson formula, would have been very heavily discounted.

2.3.5 Redundancy

The final category of critiques of HDI is redundancy. Various authors have suggested that the indicators in the HDI are highly correlated and that the HDI offers no new information beyond that readily available in GDP per capita.[28] Kelley (1991: 322), for example, begins by agreeing with *HDR 1990* on the essential differences between HDI to GNP per capita and (see Figure 2.2, which reproduces a graph of the HDI versus GDP per capita from *HDR 1990* updated with 2003 data from *HDR 2005*), but then plots HDI against log income per capita (see Figure 2.3, which reproduces Kelley's graph with updated data), and concludes that, "The notable disparity between HDI and GNP/N, as highlighted in the *HDR*, vanishes. Indeed, log GNP/N appears to represent a reasonable approximation to the HDI."[29]

In presenting this critique, Kelley uses the same strange graphing technique employed by the UNDP as shown in Figure 2.2: countries are put in order of their HDI and GNP per capita values, respectively, and then lines are drawn through all of the points for each measure thus ordered. This is to say that a vertical line drawn at any position in Figures 2.2 or 2.3 will touch on two points (one in each line) representing two different countries! The idea that conformity in the shape of one line to the other represents close correlation is simply incorrect.[30] This graphing technique is central to Kelley's conclusion that HDI is redundant.

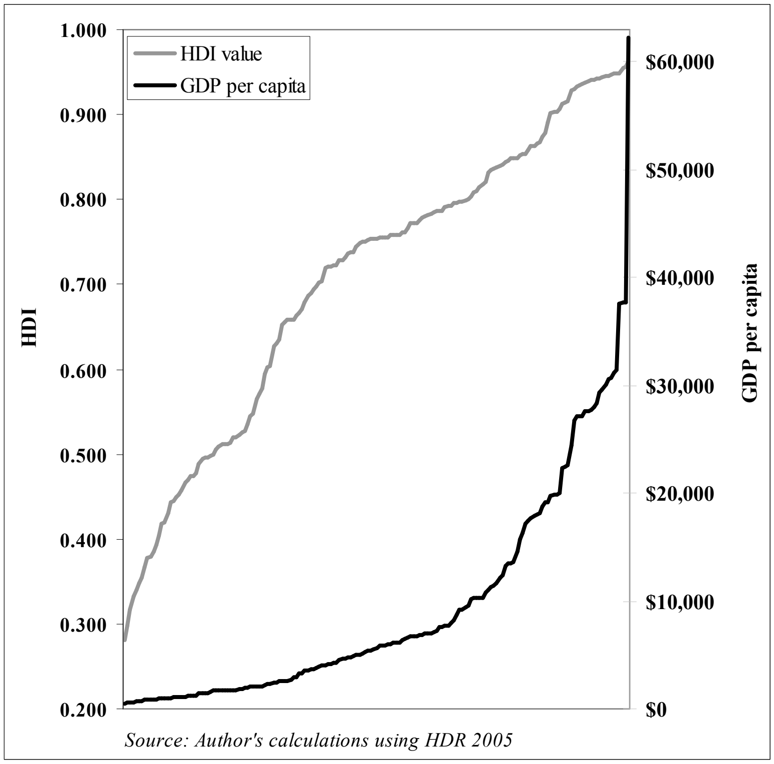


Figure 2.2: Ranking of HDI versus GDP per capita (2003)

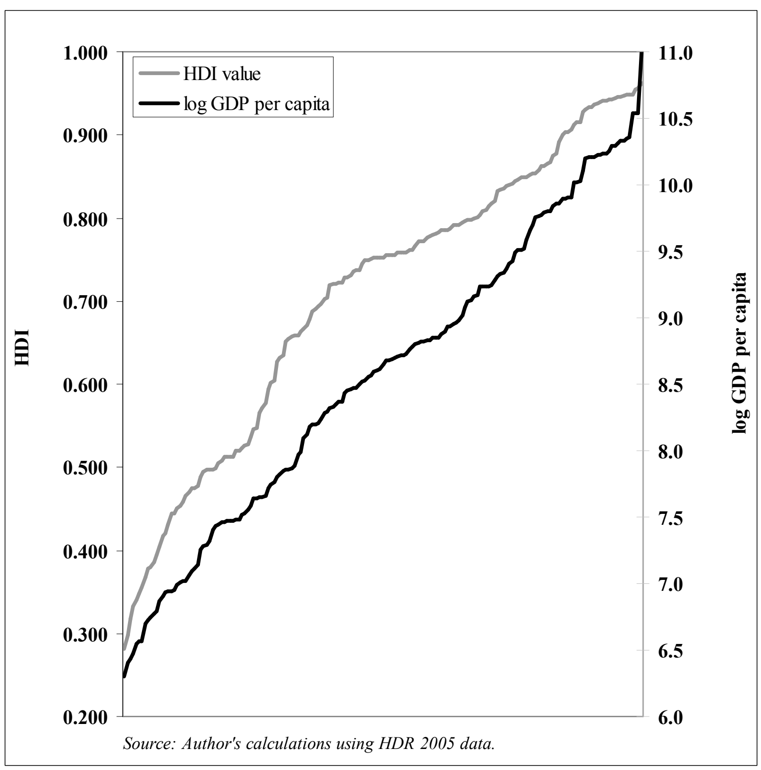


Figure 2.3: Ranking of HDI versus log GDP per capita (2003)

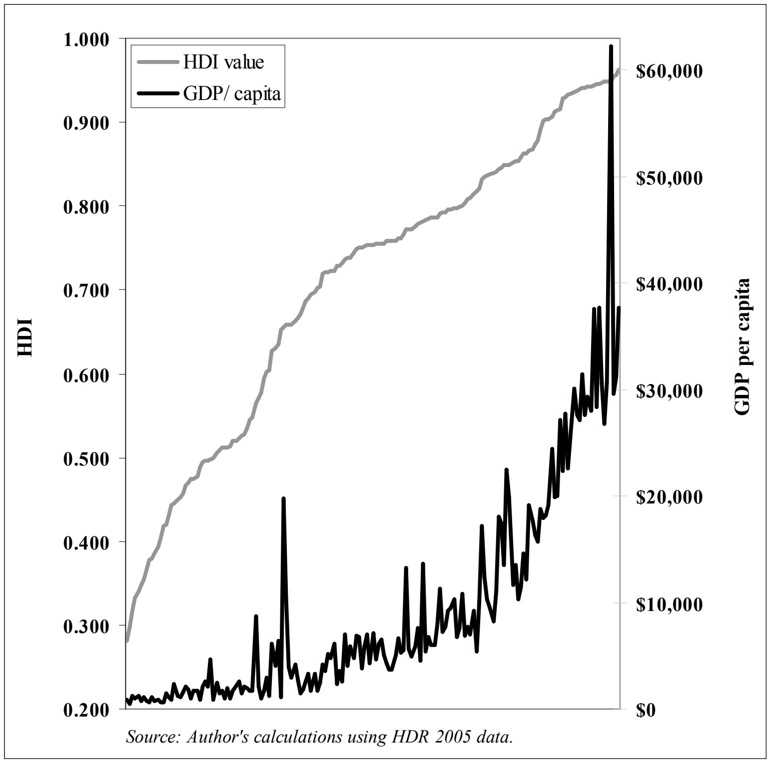


Figure 2.4: HDI versus GDP per capita, by HDI rank (2003)

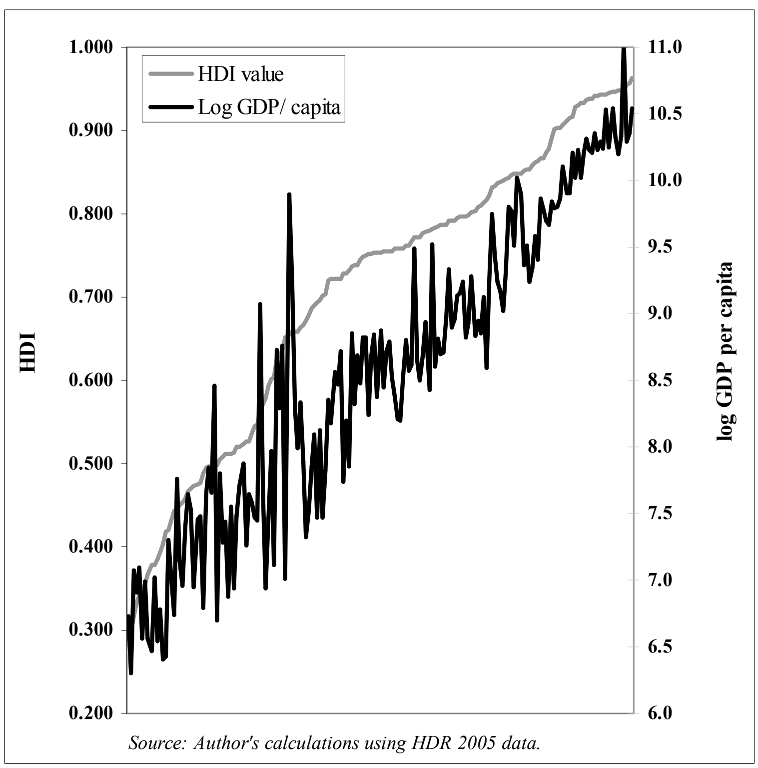


Figure 2.5: HDI versus log GDP per capita, by HDI rank (2003)

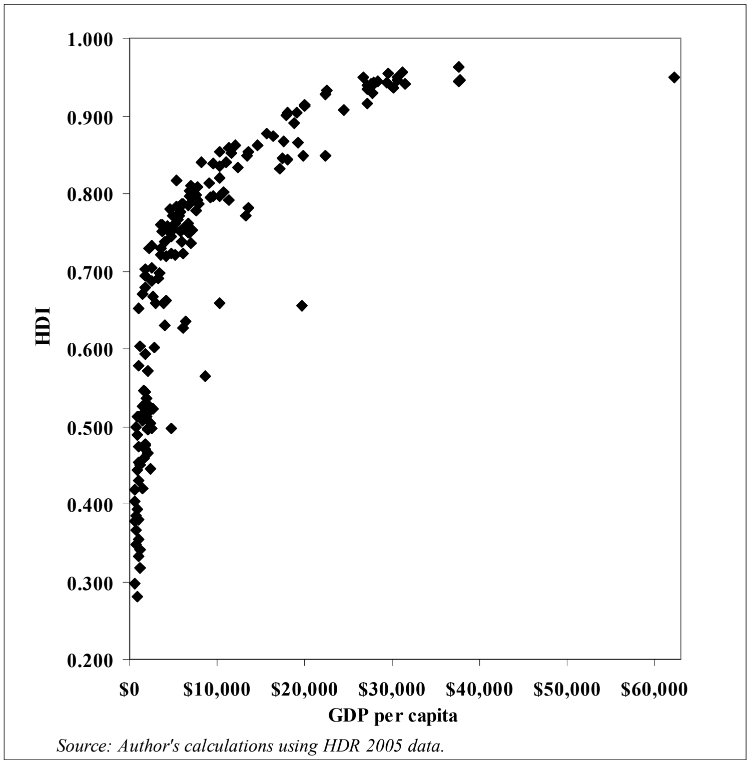


Figure 2.6: HDI versus GDP per capita (2003)

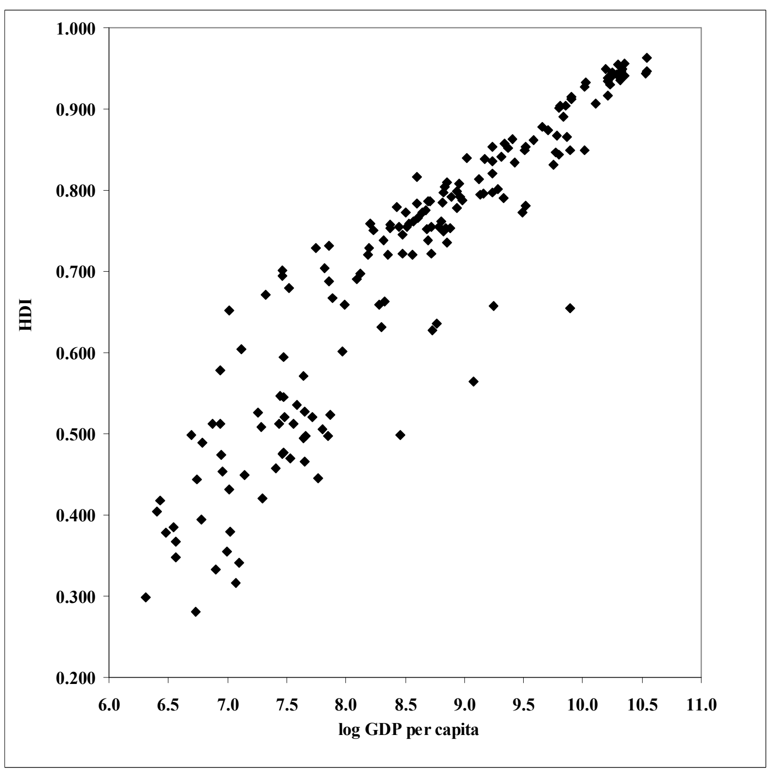


Figure 2.7: HDI versus log GDP per capita (2003)

In contrast, Figure 2.4 plots HDI against GDP per capita using HDI ranks to order both sets of data (so that a vertical line passes through two points that each represent the same country), and Figure 2.5 uses the same procedure to graph HDI and log GDP per capita. The difference – comparing Figures 2.2 and 2.4, and 2.3 and 2.5, respectively – is remarkable. A final technically correct, although less dramatic, way to graph the relationship between HDI and GDP per capita is as a scatterplot (see Figures 2.6 and 2.7). In Figure 2.6, countries with income per capita greater than $10,000 seem to display a positive correlation between HDI and income per capita. As GDP per capita increases, so does HDI, and vice versa. Figure 2.7 shows a similar relationship between HDI and log GDP per capita throughout the income range, but the wide field of plotted points is not consistent with the idea that all of the information in HDI could be expressed with GDP per capita or log GDP per capita. HDI provides additional, more nuanced information about human well-being.

2.4 Conclusions

The UNDP has been exceptionally receptive to criticism regarding poor data, incorrect choice of indicators, and poor specification of HDI overall and of HDI's income component in particular. On some points, HDI has been changed significantly in response to its critics: changes to the education and income indices, for example. On other points, improved arguments have been incorporated justifying the existing HDI formula. With regards to the final category of critiques, redundancy, the UNDP has disagreed with its critics and has maintained HDI as the central focus of all 15 *HDR*s. At the same time, the UNDP has lived up to the promise made in early *HDR*s, that, "The HDI should be seen as evolving and improving rather than as something cast in stone. It is also an exercise in which as many of its users as possible should actively participate."(UNDP 1993: 104)

HDI has played two key roles in the field of applied development economics: 1) as a tool to popularize human development as a new understanding of well-being, and 2) as an alternative to GDP per capita as a way to measure levels of development for comparison across both countries and time. The importance of these dual roles cannot be over emphasized. HDI, as reported in the *HDR*s along with its companion indicators, makes it possible for policy-makers and development professionals world-wide to gauge both moments and trends in the progress of human development and to tailor public action to suit current and future social and economic conditions. Still, in praising HDI, it is important to recall that its strength originates, at least in part, from not being a static measure, and instead being allowed to improve over time. Further revisions can continue to refine HDI in the future, to correct technical problems as they come to light, and to permit HDI to evolve towards the best possible measure of human capabilities and human development.

As an example of a possible important revision to HDI it may be recalled that, while the UNDP's path-breaking work in bringing quantitative measures of human development to scholars, development professionals, policy-makers, and the general public has changed the field of international development for the better, its original vision of human development included distribution of capabilities across each nation. If the UNDP (1990: 12) ignored distribution in the original operationalization of HDI, it did so only for a lack of data: "The case is strong for making distributional corrections in one form or another." For some aspects of distribution – notably gender-based inequality and income inequality – these data now exist. For other aspects, the data have yet to be developed, but to the extent that demand drives supply in measurement tools, to let the absence of such data be an excuse for excluding measures of inequality would seem somewhat myopic.

The existence of inequality in well-being can be addressed either by changes to HDI or by the addition of new inequality-related companion measures to the *HDR*s. These types of revisions have excellent potential as future steps in the continued improvement of human development measurement.

Notes

[1] An exception would be Marshall's short-term and long-term (Ackerman 1997a).

[2] Bread and opera tickets were the examples used by Robbins. It was also Robbins who first defined economics as the relationship between ends and scarce means (Cooter and Rappoport 1984).

[3] In addition, the macro-level application of the "potential Pareto improvement" criterion rests on the restrictive assumption that the prices by which the components of GDP are aggregated would not be affected by redistribution. Yet we know, for example, that redistribution from rich to poor would diminish demand for luxuries and increase demand for necessities, potentially altering their relative prices and thus the "size" of the GDP pie.

[4] Rawls' two principles of justice are quoted here from Sen (1992), where they are updated from Rawls (1971) based on Rawls subsequent speeches, writings, and correspondence.

[5] Sen writes that "[O]f course, it is clear that emphasizing *positive* freedom (i.e. a person being actually able to do this or be that), and the duty to help others in that respect as well, could strengthen the relevance of ethical considerations in the determination of actual behaviour. Moral acceptance of rights (especially rights that are valued and supported, and not just respected in the form of constraints) may call for systematic departures from self-interested behaviour. Even a partial and limited move in that direction in actual conduct can shake the behavioural foundations of standard economic theory."(1987a: 57)

[6] For further discussion see, Robeyns (2005) and Crocker (1992, 1995).

[7] See Kuznets (1947), Nordhaus and Tobin (1973), Hicks and Streeten (1979), Morris (1979), Ram (1982), Daly and Cobb (1989), UNDP (1990), Slottje (1991), Haq (1999), and Sen (2000a).

[8] As quoted in UNDP 1999: 23.

[9] For a discussion of changes in the HDI from 1990 to 2000 see Bhatnagar (2001).

[10] On civil and political liberties, see Hopkins 1991, Dasgupta 1993, Atkinson et al. 1997, and Dar 2004; on inequality, see Chowdhury 1991, Hicks 1997, and Chatterjee 2005; on the environment, see Paul 1996, Atkinson et al. 1997, Sager and Najam 1998, and Dar 2004; and on educational measures, see Kelley 1991.

[11] See Chowdhury 1991, Hopkins 1991, Kelley 1991, Ogwang 1994, and Sager and Najam 1998.

[12] See Kelley 1991, Rao 1991, Tabold-Nübler 1991, Dasgupta 1993, McGillivray and White 1993, Aturupane et al. 1994, Doessel and Gounder 1994, UNDP 1994, Paul 1996, Noorbakhsh 1998a; see also, Sen 1981.

[13] See also, Rao 1991.

[14] See also, Hopkins 1991.

[15] See Kelley 1991, and Atkinson et al. 1997.

[16] If, for example, the maximum value in calculating the H Index were set at ten years above the actual maximum, but the maximum used in the LIT Index were set to the actual maximum, then the highest H Index value would be much lower than the highest LIT Index value (assuming that they have roughly equal means and standard deviation). See also, Hicks and Streeten 1979.

[17] See also, Noorbakhsh 1998a and 1998b.

[18] See also, Ravallion 1997, Sager and Najam 1998, and Panigrahi and Sivramkrishna 2002.

[19] See also UNDP 1991; Slottje 1991; Dasgupta and Weale 1992; Dasgupta 1993; Aktinson, et al. 1997; Noorkbakhsh 1998b; Panigrahi and Sivramkrishna 2002.

[20] See UNDP 1993, Noorkbakhsh 1998b, Palazzi and Lauri 1998, Biswas and Caliendo 2001, and Cahill 2002.

[21] Australia, Canada, Germany, Netherlands, Norway, Sweden, Switzerland, United Kingdom, and United States.

[22] See Kelley 1991, Acharya and Wall 1994, Srinivasan 1994, Paul 1996, and Noorbakhsh 1998a.

[23] See Kelley 1991, Rao 1991, and McGillivray and White 1993.

[24] See McGillivray and White 1993, Ravallion 1997, Sager and Najam 1998, Bardhan and Klasen 1999, and Lüchters and Menkhoff 2000. Exceptions to this are Trabold-Nübler (1991) and Bhatnagar (2001); they both critique the Atkinson-type formula not for its discontinuity, but for its failure to conform strictly to diminishing returns. Bhatnagar recommends a different step function for utility that would exhibit diminishing returns more accurately (2001; 2002).

[25] See also Gormely (1995).

[26] Natural logs represent a change from the *HDR 1990* use of base 10 logs to discount income, but the base of the log in this formula is actually irrelevant: any base will return the same resultant GDP Index. Acharya and Wall (1994) proposed an alternative HDI that includes discounting income by natural logs, and they incorrectly justify this by claiming that the transformation using natural logs is less severe than that of base 10 logs. While it is true that natural logs provide a less severe discounting method than base 10 logs, this difference is erased when the GDP Index (using either the 1990 or the 1999 formula) is used. Dividing the log of X by the log of Y will always result in Z, regardless of the base of the logs. This is the "change of base formula" in reverse: $\log_a x = \log_b x / \log_b a$.

[27] $40,000 did not effectively act as a cap on income until 2001, when Luxembourg became the first country to have a GDP per capita greater than the cap – $42,769. To date, Luxembourg is the only country to which this cap is or has been applied in HDI.

[28] See Chowdhury 1991, Kelley 1991, McGillivray 1991, Dasgupta 1993, McGillivray and White 1993, Ogwang 1994, Srinivasan 1994, and Islam 1995; see also, Hicks and Streeten 1979. For a technical discussion of arbitrariness and robustness in multi-dimensional poverty measures in general, see Qizilbash 2004.

[29] Both Kelley's critique and the original Figure 1.2 from *HDR 1990*, used GNP per capita, not GDP per capita. HDI has been calculated using GDP throughout its history. One data adjustment has been made from the UNDP data for 2003: *HDR 2005* includes HDI values for Libya and Myanmar but omits these countries per capita GDPs; the missing values were replaced with GDP per capita from *HDR 2004*.

[30] McGillivray and White make a similar critique of this type analysis as it is used in *HDR 1990*.

CHAPTER 3

ACCOUNTING FOR INEQUALITY: A PROPOSED REVISION OF THE HUMAN DEVELOPMENT INDEX

Inequalities in health, education, and income – key components of human development – matter deeply to social welfare. The poorest fifth of the world's population receives less than two percent of the world's total income – while the richest fifth receives more than 80 percent (UNDP 1992). In developing countries, almost 60 percent of all births take place with no health professional in attendance. In one-third of all countries, 20 percent of the population or more lacks even the most basic literacy (UNDP 2005). Yet the best-known measures of social well-being either ignore distributional inequalities altogether or at best account for only some of their effects.

Per capita income, the most common measure of well-being, is a simple average. Its main alternative, the United Nations Development Program's (UNDP) Human Development Index (HDI), is likewise based on national averages, albeit for a wider set of welfare indicators. The practice of identifying averages with national well-being ignores potential social-welfare tradeoffs between increasing averages and decreasing differences in distribution. For example, as the rich get richer, average income may increase, but income inequality simultaneously may increase so sharply that the incomes of the poor decline, arguably resulting in a decrease in social welfare. More generally, measures based solely on national averages record unambiguous changes in social welfare in circumstances made ambiguous by changes in inequality.

The UNDP has done path-breaking work in disseminating HDI as an alternative to per capita income – hitherto the hegemonic measure of social welfare – and in bringing quantitative measures of human development to scholars, development professionals, policy-makers, and the general public in its annual *Human Development Reports,* the first of which was published in 1990. HDI measures social welfare by combining average measures of health, education, and the natural logarithm of per capita national income (embodying the assumption that as income increases its marginal impact on welfare grows smaller). To calculate HDI, health, education, and income components are each transformed into index values ranging from 0 to 1, and the three indices are then averaged together.

The rationale for HDI is that average health and education are not simple functions of average income per capita. There are two reasons for this. First, health and education have a substantial public goods component; they are not private goods, distributed entirely according to income. Second, if the privately obtainable components of health and education are concave in income – that is, the marginal provision of health and education diminishes as income rises – then countries with the same average income but different income distributions will have different levels of average health and education. For the latter reason, HDI's inclusion of average health and education goes some way toward capturing the effects of income inequality on social welfare. But it fails to account for other welfare-relevant effects of income inequality, as well as for welfare-relevant effects of inequalities in the distribution of health and education outcomes. For example, inequalities in all three components of HDI may have corrosive effects on social well-being through their association with decreasing social cohesion, increasing violence, or increasing environmental degradation.[1] Moreover, there is evidence that many, if not all, people put some intrinsic value on equality as an end in itself (Sen 1992).

In this chapter, I argue that it is both desirable and feasible to reformulate the Human Development Index to push the boundaries of social-welfare measurement beyond national averages. The chapter begins with a summary and critique of the UNDP's own efforts to measure inequality in its *Human Development Reports*. Next, I explore the impacts of inequality on social welfare in greater detail. I then propose a new "Inequality-adjusted HDI," providing a detailed explanation of the necessary data and methodology, and discussing the theoretical underpinnings of this methodology. Finally, I calculate this new measure for 46 countries, and compare the results to the current HDI.

3.1 Inequality in the Human Development Reports

Early *Human Development Reports* (HDRs) explicitly recognized distribution's importance to human development:

> Presenting average figures for each country disguises many important disparities – between urban and rural areas, between rich and poor, between male and female, as well as between ethnic groups and different regions. The HDI should try to reflect how people really live. (UNDP 1992: 21)

Lack of data was cited as the only reason for leaving measures of inequality out of HDI (UNDP 1990:12).

Today, somewhat better data are available. And where data are not yet adequate to the task, the UNDP's demand for distributional data could help to improve the supply. The *HDRs* have the capacity to shift not only practices for data collection but also the development discourse itself. Yet in recent years the UNDP appears to have retreated from its earlier stance. "The purpose of HDI is to provide a *summary measure, not a comprehensive measure*, of human development," the director of the Human Development Report office stated in 2001 (Fakuda-Parr 2001: 247, original emphasis).

"It measures *average achievement* and does not reflect disparities and deprivation…Though disparities are a major concern in human development analysis, HDI is a measure of national average and does not integrate inequality."

The *HDRs* not only present HDI, but also contain a narrative report on human development-related themes that vary from year to year. Over the years, the *HDR*s' narratives and its statistical appendices have contained a number of different measures of poverty and inequality. Of these, only measures of absolute poverty and measures of gender inequality have achieved a permanent place in the *HDR*s. Others have appeared in only one or a few *HDR*s, or as limited examples; for example, disaggregations of HDI for subnational groups often have been reported but only by means of examples for one or two countries.

3.1.1 Poverty

In *HDR 1996*, the UNDP introduced the Capability Poverty Measure (CPM), a composite measure of three basic capabilities: being well-nourished and healthy (the proportion of underweight children under the age of five); capability for healthy reproduction (the proportion of births unattended by a trained health professional); and education (female illiteracy). The CPM was designed to place particular emphasis on the deprivation of women because of their importance to the human development of families and society (UNDP 1996: 27).

The following year, the CPM was replaced by the Human Poverty Index (HPI), which measured: longevity (the percentage of people expected to die before age 40); knowledge (adult illiteracy); and a living standards (the percentage of people with access to health services, the percentage of people with access to safe drinking water, and the percentage of underweight children less than five years of age). The UNDP (1997: 20) explained the need for HPI stating that, while HDI uses a perspective in which everyone's well-being counts – rich and poor – HPI focuses only on the least well-off.

In *HDR 1998*, the UNDP (1998: 15) renamed HPI – it is now called HPI-1 and is earmarked exclusively for the measurement of poverty in developing countries – and added HPI-2 as a measure of poverty in industrialized countries "because human deprivation varies with the social and economic condition of a community." HPI-2 incorporates different measures of longevity (the percentage of people expected to die before age 60); knowledge (a higher standard of literacy than that used in HPI-1) and living standards (the percentage of people with disposable incomes of less than 50 percent of the median); and adds a measure of social inclusion (the proportion of long-term unemployment).

3.1.2 Income inequality

Most *HDR*s have reported some measure of income inequality, usually the Gini coefficient, or income shares by quintile (see Figure 3.1 below). Early *HDR*s also included an "income-distribution-sensitive HDI" that used each country's Gini coefficient (G) for income to adjust HDI's income component using a formula discussed in detail below. This measure was first mentioned (although without reference to its formula) in *HDR 1990.* It was included with more detail and results for a small sample of countries in *HDR*s 1991 through 1994, but since then it has not been reported.

Year	Income Disparities	Gender Disparities
1990	• Discussion in text with sample of HDI's sensitivity to income distribution • Quintile ratios and Gini in tables	• Technical note table on female and male HDI • Both female and male HDIs use GDP per capita for income measure
1991	• Table in text of income-distribution-sensitive HDI • Quintile ratios and Gini in tables	• Table in text of Gender-Sensitive HDI using estimated income • 1 gender table
1993		• 2 gender tables
1994	• Annex table of income-distribution-sensitive HDI • Quintile ratios in tables	• Annex table of Gender-Disparity-Adjusted HDI
1995	• Quintile ratios in tables only	• Tables in text on GDI and GEM • 7 Annex tables on gender • Table in text on burden of work time
1996		• Tables in text on GDI and GEM • GDI and GEM are Tables 2 and 3 • 2 other gender tables
1999	• Historical income distribution in text • Quintile ratios in tables	• Bardhan and Klasen income method introduced for GDI and GEM • GDI and GEM are Tables 2 and 3 • 4 other gender tables
2000	• Quintile ratios in tables only	
2001	• Gini table in text • Quintile ratios, Gini in tables	• GDI and GEM are Tables 21 and 22 or higher • 4 other gender tables
2002	• Quintile ratios and Gini in tables only	

Note: GDI = Gender-related Development Index; GEM = Gender Empowerment Measure

Figure 3.1: History of Changes to *HDR*'s Inequality Measures

3.1.3 Disaggregating HDI

Different dimensions of inequality can be distinguished in terms of how a population is disaggregated. Frances Stewart (2002: 2, original emphasis) notes that most analyses of poverty and inequality focus on the individual: they are, "concerned with the numbers of individuals in poverty in the world as a whole, not with who they are, or where they live." In a discussion of the origins of violent conflict, Stewart (2002: 3) goes on to distinguish between "vertical" and "horizontal" dimensions of inequality:

> It is my hypothesis that an important factor that differentiates the violent from the peaceful [countries] is the existence of severe inequalities between culturally defined groups, which I shall define as horizontal inequalities to differentiate them from the normal definition of inequality which lines individuals or households up vertically and measures inequality over the range of individuals – I define the latter type of inequality as vertical inequality. Horizontal inequalities are multidimensional – with political, economic, and social elements (as indeed are vertical inequalities, but they are rarely measured in a multidimensional way). It is my contention that horizontal inequalities affect individual well-being and social stability in a serious way, and one that is different from the consequences of vertical inequality.

Comparative HDIs calculated for specific regions or racial/ethnic groups within countries can and have been used to depict horizontal inequalities. A table in *HDR 1993* (UNDP 1993: 18), for example, disaggregated the United States' HDI by race and gender: U.S. whites had a higher HDI than Japan (the country ranking first in HDI that year), while U.S. blacks had an HDI near that of Trinidad and Tobago (HDI rank 31), and U.S. Latinos had an HDI near that of Estonia (HDI rank 34).[2]

3.1.4 Gender disparities

Disaggregation by gender is the only type of horizontal inequality for which comparable data have been reported regularly in the *HDR*s for a large set of countries. In fact, the UNDP has included some measure of female development or gender inequality in all sixteen *HDR*s (see Figure 3.1 above). Female- and Male-HDIs (that is, HDIs constructed as if a single gender were the entire population) were reported in a technical note to the first *HDR,* with GDP per capita used for both genders' incomes because of a lack of gendered income data. *HDR 1991* expanded coverage of gender inequality, stating that, "Of the many inequalities in human development, the most striking is that along gender lines." (UNDP 1991: 92)

Both *HDR 1991* and *HDR 1992* weighted the regular HDI by the ratio of Female- to Male-HDI for a small subset of countries, and presented the results as the "Gender-

Sensitive HDI." The Female- and Male-HDIs again were calculated using gendered data for life expectancy and literacy, and wage ratios and labor force participation rates by gender were used to construct gendered estimates of income. In 1993 and 1994, the UNDP switched to a very closely related "Gender-Disparity-Adjusted HDI," which did not use Female- and Male-HDIs as an intermediary step, instead, adjusting HDI by a gender disparity factor calculated as the average of the female-to-male ratios of life expectancy, educational attainment, and income (UNDP 1994: 97).

This approach was further refined to create the Gender-related Development Index (GDI) first presented in 1995, the year of the United Nations' Fourth World Conference on Women, held in Beijing. GDI is a measure of human development that takes into account the extent of gender inequality in each country (for details, see Stanton 2006, chapter 5). GDI is the only cross-country index related to gender disparities in human development that has been calculated consistently over a number of years. Also since 1995, the *HDRs* have reported a Gender Empowerment Measure (GEM), which measures gender inequality in political, professional, and economic participation.

3.1.5 Non-income inequalities

With the exception gender disparities, the inequality measures sporadically reported in the *HDR* have been been restricted exclusively to the income distribution, and none have been incorporated into the HDI itself. Sudhir Anand and Amartya Sen (2000: 97), the authors of the current specification of HDI's income component, have advocated adjustment of HDI not only for income inequality but also for health or education inequality: "Sensitivity to inequality in achievements requires that we adjust all three components of the HDI for inequality."[3]

Life expectancy – like health in general – is not distributed equally within nations. Hicks (1997: 1289) notes that, "[T]here is significant life-span inequality, ranging from infants who die at birth or before age one, to persons who die at ages over 100 years." Similarly, there is abundant evidence that literacy and school enrollment are not distributed equally within nations.[4]

The first *HDR* stated that all three average measures of human development "conceal wide disparities in the overall population," but that compared to income inequality, the "inequality possible in respect to life expectancy and literacy is much more limited: a person can be literate only once, and human life is finite." (UNDP 1990: 12) The argument that health and education inequalities are quantitatively more limited than income inequality is correct (as demonstrated below), although the replacement of binary variables, like literacy and school enrollment, with continuous variables, like years of schooling, allows for the detection of more inequality.

In *Inequality Reexamined*, Sen (1992: 28, original emphasis) nevertheless argues that unequal distributions of health and education also have important impacts on human well-being: "The extent of real inequality of opportunities that people face cannot be readily deduced from the magnitude of inequality of *incomes*, since what we can or cannot do, can or cannot achieve, does not depend just on our incomes but also on the variety of physical and social characteristics that affect our lives and make us what we are." To some extent, the distributions of health and education outcomes reflect private expenditures, and hence the distribution of income.[5] Publicly provided goods and services may be unequally distributed as well, because access to them is politically driven and affected by discrimination on the basis of race, ethnicity, religion, or gender. Because inequalities in the distribution of health and education have negative effects on human well-being, and are not simply a function of income inequality, they too should enter into measures of social welfare.

3.2 Why Inequality Matters for Social Welfare

HDI, the UNDP's measure of social welfare, is an important alternative to per capita national income because it includes non-income dimensions of welfare, and because to a limited extent it creates a more distribution-sensitive measure. This section explains what HDI does and does not achieve, and why the UNDP should go further in incorporating welfare-relevant aspects of distribution into HDI.

The most commonly used proxy for social welfare is per capita income ($\bar{Y}$), usually measured as a country's Gross Domestic Product (GDP) divided by its population (N):

$$(1)\ \bar{Y}_i = \frac{\mathrm{GDP_i}}{\mathrm{N_i}}$$

where the subscript i refers to the country. Per capita national income has often been criticized as a measure of aggregate well-being for its lack of information regarding non-monetary aspects of welfare.[6] A further limitation is its lack of distributional information: in two countries with identical GDP per capita but very different distributions of income, it is easy to imagine very different income impacts on aggregate well-being.

HDI is derived from three component indices: health (H-Index) as proxied by average life expectancy; education (E-Index) as proxied by a weighted average of literacy and school enrollment rates; and income per capita (Y-Index), using the natural logarithm in order to account for the diminishing marginal utility of income.[7]

The concept of diminishing returns in the fulfillment of human needs, was expressed by Alfred Marshall (1890, Book 3, Chapter 3) more than a century ago:

> There is an endless variety of wants, but there is a limit to each separate want. This familiar and fundamental tendency of human nature may be stated in the law of satiable wants or of diminishing utility thus: The total utility of a thing to anyone (that is, the total pleasure or other benefit it yields him) increases with every increase in his stock of it, but not as fast as his stock increases. If his stock of it increases at a uniform rate the benefit derived from it increases at a diminishing rate. In other words, the additional benefit which a person derives from a given increase of his stock of a thing, diminishes with every increase in the stock that he already has.

HDI's use of the logarithmic transform of per capita income to adjust for diminishing returns to income seems, at first glance, to be motivated by Marshall's principle of satiable wants. Yet the utilitarians and early marginalists like Marshall did not discuss diminishing returns to the *aggregate* per capita income of a country, which is what HDI currently takes into account. Rather, they posited diminishing marginal returns to *individual* income. In the same way, in modern neoclassical theory, diminishing marginal returns are applied to individual income, not aggregate income; indeed, neoclassical theory has no concept of aggregate social welfare beyond the notion of Pareto improvement.[8] To account for diminishing marginal returns to income, we therefore need to use a concave transform of income (such as natural logarithms) at the level of *individual* incomes, a point to which I return below.

In calculating HDI, the UNDP first normalizes life expectancy, education, and the natural log of income for conversion into indices, and then combines the three indices in a simple average. The normalization formula causes index values (called the X-Index in Equation 2 below, to generalize across the three) to range from 0 to 1, by comparing each country's indicator value ($\overline{X}_i$, the average value of variable X in the ith country) to a stylized range of indicator values among all countries:

$$\text{(2) X-Index}_i = \frac{\overline{X}_i - \text{minimum X value}}{\text{maximum X value} - \text{minimum X value}}$$

In the current HDI formula, the stylized range for average life expectancy values (LE_i) is 25 to 85 years; for literacy and enrollment rates (LIT_i and ENR_i) it is 0 to 100 percent; and for GDP per capita (Y_i) it is the natural log of $100 to the natural log of $40,000.

The formula for HDI is as follows:

$$\text{(3a) H-Index}_i = \frac{LE_i - 25 \text{ years}}{85 \text{ years} - 25 \text{ years}}$$

$$\text{(3b) LIT-Index}_i = \frac{LIT_i - 0\%}{100\% - 0\%}$$

$$\text{(3c) ENR-Index}_i = \frac{ENR_i - 0\%}{100\% - 0\%}$$

$$\text{(3d) E-Index}_i = 2/3(\text{LIT-Index}_i) + 1/3(\text{ENR-Index}_i)$$

$$\text{(3e) Y-Index}_i = \frac{\ln(Y_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$\text{(3f) HDI}_i = 1/3(\text{H-Index}_i) + 1/3(\text{E-Index}_i) + 1/3(\text{Y-Index}_i)$$

The inclusion of non-income dimensions is important for two reasons: first, because health and education are in part publicly provided goods, which are not distributed according to income; and second, because insofare as they are privately purchases, health and education – like utility – are concave in income. As a result of the latter, HDI to some extent captures the welfare effects of income inequality.

3.2.1 Income inequality's aggregation effect

Income inequality has been shown to be correlated negatively with the average level of health in a society. Daniels, Kennedy, and Kawachi (2000: 3) summarize this relationship:[9]

> We now know…that countries with a greater degree of socioeconomic inequality show greater inequality in health status; also, that middle-income groups in relatively unequal societies have worse health than comparable, or even poorer, groups in more equal societies. Inequality, in short, seems to be bad for our health.

In part, this is because the relationship between individual health and individual income is concave – that is, increases to income improve health but at a diminishing rate. For example, Michael Marmot's "Whitehall" studies of British civil servants have found a strong inverse relationship between social class and mortality from diseases: workers with the lowest status jobs had twice the mortality rate of those with the highest status jobs, a disparity attributed to differences in the psychosocial work environment (Marmot and Smith 1991; Marmot and Bosma 1997).

If health is concave in income, then a redistribution of income would change the average level of health. Figures 3.2a and 3.2b illustrate this effect. Individual income (Y_k) maps into increasing individual health (H_k), where subscript k denotes the individual with diminishing returns. The frequency distribution along the horizontal axes cause different average levels of health, depending on how individual incomes are spread out. In the population of two individuals depicted here, the incomes of Person 1 and Person 2 (Y_1 and Y_2) are much closer together in Figure 3.2b than in Figure 3.2a, although average income ($\overline{Y}$) is the same.

Figure 3.2a

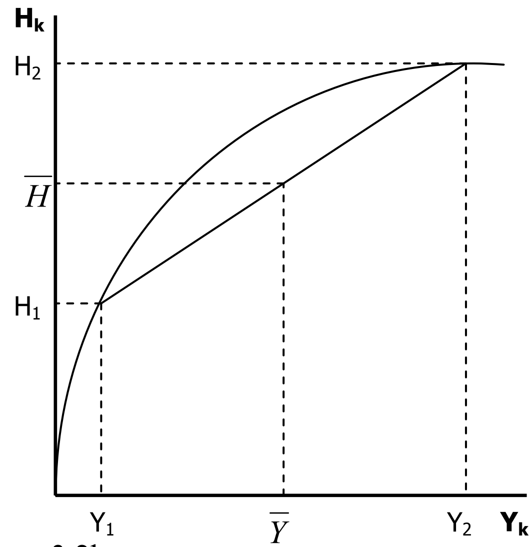
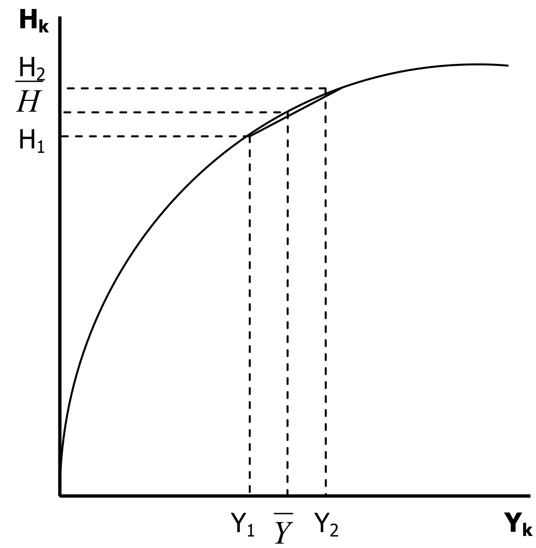


Figure 3.2b



Figures 3.2a and 3.2b: The Aggregation Effect of Income Distribution

Average health ($\overline{H}$) is higher in Figure 3.2b, where income is more equally distributed. This is can be described as an "aggregation effect": $\overline{H} = \text{H}(\overline{Y})$ only if $Y_k = \overline{Y}$ for all k (Heerink *et al*. 2001; Boyce 2006).[10] If two countries have identical average income but different income distributions, the country with greater income inequality will have lower average health – and therefore a lower HDI.

The same logic applies to education. The relationship between individual income and individual education is concave: As individual income increases so too do education levels, but at a decreasing rate (Tilak 2002; Hicks 1997; Noorbakhsh 1998). As a result, average education is higher when income is more equally distributed.

A ranking of countries by HDI differs from a ranking by $\overline{Y}$, therefore, in part because average life expectancy and education register the effects of income distribution, as well as because of the existence of publicly provided goods and other non-income determinants of health and education. While these effects make HDI a better measure of social welfare than $\overline{Y}$, three additional ways in which inequality can affect well-being are missing from HDI:

- The aggregation effects of inequality in *health and education* on individual welfare (as opposed to the aggregation effects of inequality in income on health and education);
- Shifts in the curves relating individual welfare to individual income, health, and education, due to the effects of inequality of other welfare-relevant variables that are not accounted for in HDI; and
- Inequality's intrinsic effect as a disamenity.

Each omitted effect is described in more detail below.

3.2.2 Aggregation effects of health and education inequalities

Individual welfare can be assumed to exhibit diminishing returns to both life expectancy and educational attainments.[11] Each additional year of life adds to our individual welfare, but it adds less than the previous year; thus, a four year-old who has succeeded this year in living to the age of five, arguably has gained more in welfare than a 74 year-old who has succeeding in living to the age of 75. Thus, according to Srinivasan (1994: 240):

> The components of HDI, namely, life expectancy and educational attainment, are 'functionings' in the Sen sense but their relative values need not be the same across individuals, countries, and socioeconomic groups. Besides, the 'intrinsic' value of a single 'functioning,' namely, ability to live a healthy life, is not captured by its linear deprivation measure in HDI, since a unit decrease in the deprivation in life expectancy at an initial life expectancy of, say, 40 years is not commensurate with the same unit decrease at 60 years.

Interdependencies among individuals also have relevance. If loved ones, and society as a whole, feel greater loss upon the death of a child than the death of an elderly person, this reinforces the concavity at the level of the individual.

Similarly, and perhaps less controversially, each extra year of schooling adds to our individual welfare, but it adds less than the previous year. For example, the completion of a year of primary school – and the acquisition of basic literacy – arguably has a greater impact on any individual's welfare than the completion of an additional year of advanced graduate studies. Noorbakhsh (1997: 519) makes a similar argument: "[T]he early 'units' of educational attainments to a country should be of much higher value than the last ones. In the context of policy-making in a country with 30% adult literacy, improvements in literacy are of far greater urgency than the same for a country with 90% adult literacy."

If individual welfare is concave with respect to both health and education, then for any given average level of health or education, a more equal distribution of these results in higher average well-being. In the simple two-person examples of Figures 3.3a and 3.3b (where w_k is individual welfare), as health becomes more equally distributed (H_1 and H_2 converge on $\overline{H}$), average welfare ($\overline{w}$) increases; again, because the relationship between the two variables is concave, $\overline{w} = w(\overline{H})$ only if $H_k = \overline{H}$ for all k. Implicitly modeling individual welfare as linear in both health and education, HDI omits the aggregation effects of health inequality and education inequality.

Figure 3.3a

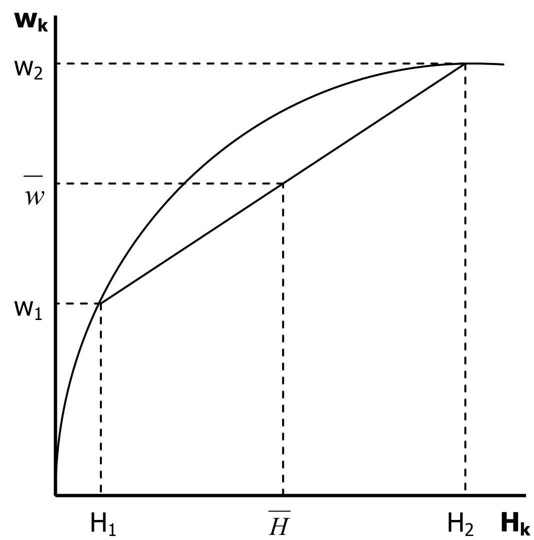
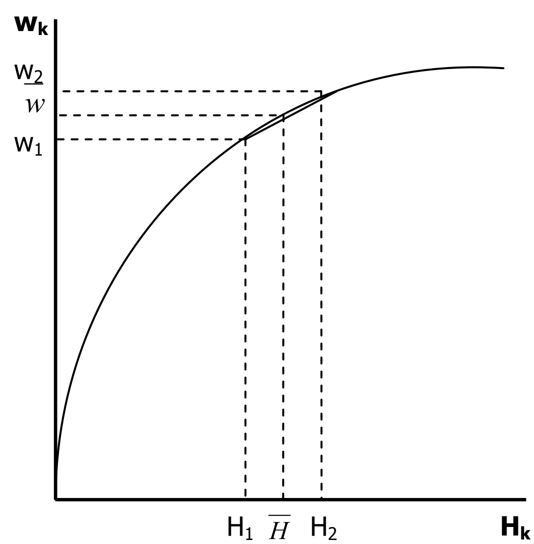


Figure 3.3b



Figures 3.3a and 3.3b: Aggregation Effect of Health and Education Inequality

3.2.3 Shift effects

In addition to these aggregation effects, inequalities in health, education, and income further impact social welfare through what can be called "shift effects": changes in the position of the curve relating individual welfare to these variables (as opposed to changes in the frequency distribution along the horizontal axis) (Boyce 2006). Figure 3.4

depicts a shift effect: individual welfare (w_k) is a concave function of individual health in both countries A and B, but country A has a more unequal distribution of health than country B. Two individuals with the same level of health (H_A and H_B) will have different levels of individual welfare (w_A and w_B) depending on their country, for either or both of two reasons: 1) instrumental shift effects, and 2) intrinsic shift effects.

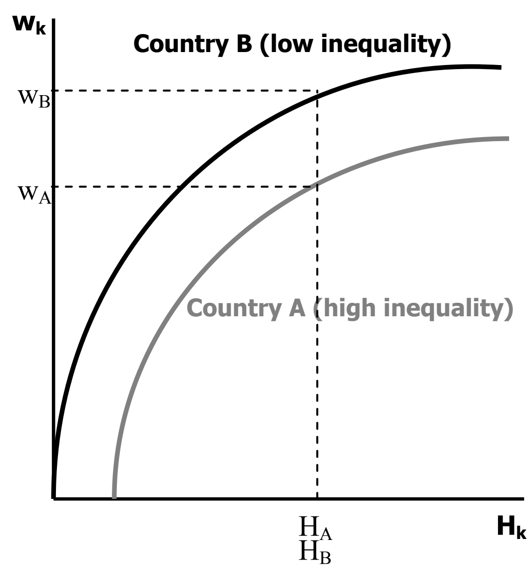


Figure 3.4: Inequality's Shift Effect

3.2.3.1 Instrumental shift effects

"Instrumental effects" refer to inequality's impact on social welfare by way of some other variable, regardless of whether or not inequality is seen as bad in and of itself (Ray 1998: 170). Inequalities in health, education, or income that have an adverse impact on some other welfare-relevant variable(s) absent from HDI would cause a negative shift effect – a decrease in everyone's welfare – an effect that is omitted from HDI as currently constructed.

An unequal distribution of health, for example, may affect the existence and distribution of public goods that are created through community labor, as in the case where communities disproportionately impacted by HIV/AIDS lack sufficient adults to care for children, either publicly or privately. Similarly, the distribution of educational attainment – and not just the average level of education – may have a profound impact on the distribution of power in society, and in turn on outcomes related to public goods, like electoral participation or environmental quality. A society with a broad distribution of education, in contrast to a society with large educational disparities, may have an enhanced ability to engage in collective action, take part in political processes, and resist misuses of power that erode public goods.

To cite another example, income inequality, and the unequal distribution of power with which it is correlated, can negatively impact environmental quality. There are winners as well as losers in every instance of environmental degradation. Boyce (2002: 34-38) posits a power-weighted social decision rule: when those who are hurt by environmental degradation are less powerful than those that benefit from it, the environmental damage will exceed the "social optimum," on the other hand, when the victims of environmental degradation are more powerful than the beneficiaries, environmental degradation will be sub-optimal. Boyce argues that these two possibilities do not balance each other out: "The power-weighted social decision rule yields an unambiguous prediction: the greater the inequality of power, the greater the extent and social cost of environmental degradation."

Boyce offers three explanations for this result. First, power correlates positively with wealth, and hence with the ownership of productive assets; since industry causes many environmentally degrading activities, the wealthy and powerful who own industrial capital more often tend to be winners. The rich also benefit more as consumers, insofar as firms pass along cost savings from cost externalization to consumers; since the rich consume more than the poor, they will reap a greater share of the resulting increases to consumer surplus. Second, too little environmental degradation can be easily "corrected," but too much cannot; shifts over time in the balance of power will not be able to correct irreversible damage. Finally, rising marginal costs of environmental degradation mean that higher levels of degradation have a greater welfare impact per unit degradation than lower levels.

Income inequality can also undermine political processes, disrupt social and civic life, exacerbate crime, and ignite civil conflicts (Birdsall 2004). Thurow (1971: 327) warns that, "Preventing crime and creating social or political stability may depend on preserving a narrow distribution of income or a distribution of income that does not have a lower tail." Similarly, Sen (1973) mentions inequality's negative effects on social cohesion, especially where the perception of inequity is strong. Environmental quality and social cohesion again are important components of social welfare, but both are omitted from HDI. The impacts of inequality on such variables have negative instrumental shift effects that are likewise omitted from HDI.

3.2.3.2 Intrinsic shift effects

Inequality's intrinsic impacts on social welfare can also cause shifts in the curves relating individual income, health, and education to individual welfare. Ray (1998: 169) refers to "philosophical and ethical grounds for aversion to inequality," or the negative weight that society places on inequality.[12] In this same vein, Thurow (1971) describes income inequality as a "public bad" and suggests that income redistribution is necessary to achieve a Pareto optimal state if one or more of the following contributes to an individual's welfare: the income of others; the process of giving gifts and charity; or the income distribution itself.[13] In the latter case:

> Each individual in society faces the same income distribution. No one can be deprived of the benefits flowing from any particular income distribution. My consumption of whatever benefits occur is not rival with your consumption. In short, the income distribution meets all of the tests of a pure public good. (Thurow 1971: 327)

Inequality of health, education, or income thus may enter into individual welfare functions because of what may be a universal intrinsic value placed on equity. According to Sen (1992: 130), "[A]ll the major ethical theories of social organization tend to demand equality in some space – a space that has some basic importance in that theory." In his earlier work on this topic, *Economic Inequality*, Sen (1973) describes inequality as a departure from an "appropriate" distribution, where the appropriate distribution could be based on what a person needs or deserves. Intrinsic preferences for equality would cause negative shift effects, or a decrease in everyone's welfare.

HDI, as currently constructed, thus misses a number of ways in which inequalities affect social welfare: the aggregation effects of inequalities of income, health, and education (apart from the aggregation effects of income inequality on health and education themselves); the instrumental shift effects of inequalities of income, health, and education (again, apart from those of income inequality on education and life expectancy), such as impacts on the provision of social services, participation in public life, environmental quality, and social cohesion; and the intrinsic shift effects arising from preferences for greater equality.

The Inequality-adjusted HDI (IHDI), which I propose below, accounts for these missing components of social welfare with four important adjustments. First, social welfare is modeled as concave in all three components of HDI, not just per capita income, to reflect diminishing returns. Second, the role for concavity is extended beyond the average measure for the relevant indicators in order to better account for the aggregation effects of inequality. Third, binary education variables are replaced with continuous variables, which better depict inequality. Fourth, social welfare is further adjusted to account for shift effects due to instrumental and intrinsic impacts of inequality on social welfare.

3.3. Constructing the IHDI: Data

Construction of the IHDI requires distributional data for health, education, and income for two purposes: 1) to model welfare with respect to each of these components as a concave function, so as to capture aggregation effects; and 2) to construct measures of the inequality for each country for all three of these components, so as to capture shift effects. (A detailed description and analysis of the data used is presented in Appendix A.) The measures of inequality used for the latter purpose in this chapter are Gini coefficients. When calculating a Gini, the indicator values for each individual (or each group) in a given country are first ordered from lowest to highest; then cumulative shares of the population are compared to cumulative shares of the country's aggregate value of that indicator.[14]

In the case of educational attainment, for example, a country's population can be ordered from the individual(s) with the lowest education (no schooling whatsoever) to the individual(s) with the highest education (say 20 or more years of schooling). If each cumulative percentile of the population had exactly the same cumulative share of total years of schooling – so that the first 10 percent of the population had 10 percent of the total years of schooling, the first 20 percent of population had 20 percent, and so on – the country would exhibit perfect equality in schooling, and the Education Gini for the country would be zero. If on the other hand, only one person in the country had any schooling at all, and all others had none whatsoever, the country would exhibit perfect inequality and its Education Gini would be 1. All countries fall somewhere in between these hypothetical extremes: for example, the first 10 percent of the population might have only 1 or 2 percent of the total years of schooling. The Lorenz curve, from which the Gini coefficient can be derived, represents perfect equality as a 45-degree line emanating from the origin. The more inequality, the greater the divergence of the Lorenz curves from the 45-degree line (as shown in Appendix Figures A2, A4, and A6).[15]

Distributional data on health are available for 81 countries; on education for 110 countries; and on income for 113 countries. Altogether, data for at least one of the three components are available for 149 countries, but all three measures are available for only 46 countries. The proposed IHDI is calculated below only for these 46 countries, a sample that does not include any of the least developed countries.[16]

In general terms, Health Ginis are relatively low, falling primarily between 0.1 and 0.2, a result consistent with the UNDP's prediction that intrinsic limits of a lifespan result in a more equal distribution of life years than of income, on which there is no such limit.[17] Health Ginis are not perfectly correlated with average life expectancy, but there is an observable trend in that lower average life expectancies are associated with higher Health Ginis. The distribution of Education Ginis is more dispersed than that of Health Ginis. Lower average years of schooling are associated with higher Education Ginis, but there is a substantial spread in the observations indicating that average years of schooling do not fully reflect differences in educational inequality. Income Ginis have no strong relationship to per capita income. (See Appendix Figures A1, A3, and A5.)

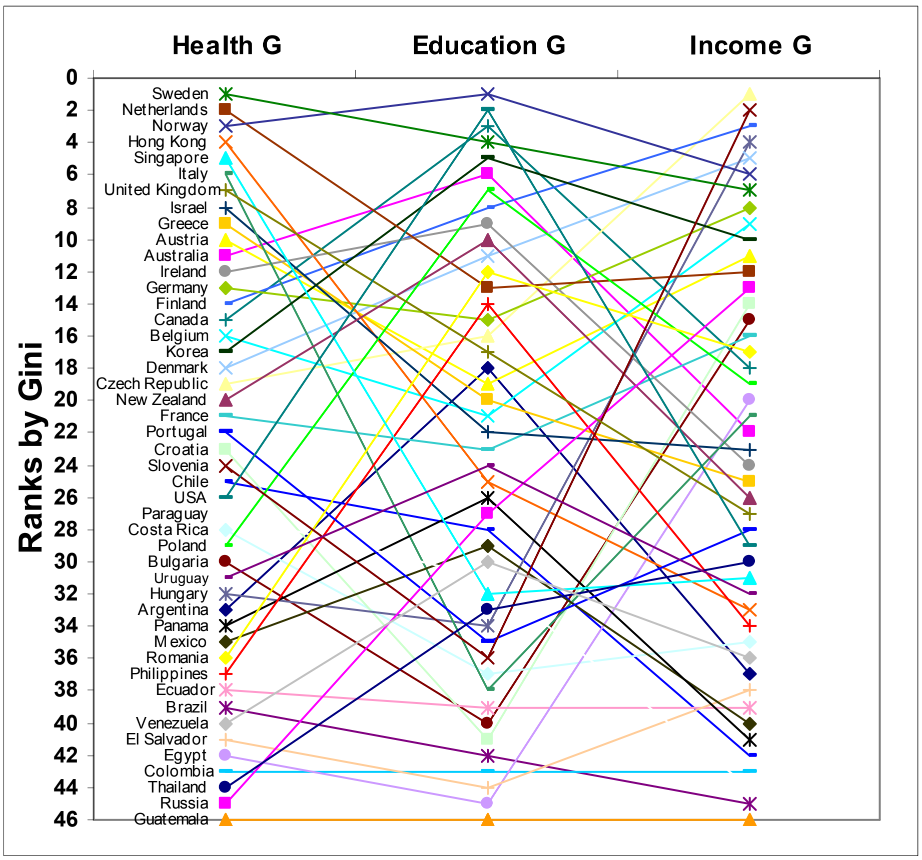
3.3.1 Correlations

Table 3.1 presents a correlation matrix for the three Gini coefficients and average levels of life expectancy, educational attainment, and income. The pairwise correlations between the Health, Education, and Income Ginis range from 0.50 to 0.62. Income inequality, therefore, is not a satisfactory proxy for health and education inequalities. The negative correlation between Gini coefficients and the corresponding indicator's average value is strongest between the Health Gini and average life expectancy, 0.91, and weakest between the Income Gini and per capita income, 0.60. The use of all three inequality measures can be justified by the very different ranges of the Ginis and the imperfect inter-country correlations among them. By averaging these three Ginis to form a "Human Development Gini" (as proposed below), we can obtain a useful summary measure. For example, very high income inequality could be tempered by taking into account the extent to which public provision of health and education means that these are not distributed as unequally as income.

Table 3.1: Correlation Matrix for IHDI Gini Coefficients and Average Indicator Values (2003)

	G^H	G^E	G^Y	Average LE	Average EA	Average Y
G^H	1.000					
G^E	0.623	1.000				
G^Y	0.550	0.502	1.000			
Average LE	-0.914	-0.573	-0.391	1.000		
Average EA	-0.561	-0.885	-0.630	0.512	1.000	
Average Y	-0.779	-0.669	-0.596	0.783	0.658	1.000

Figure 3.5 below depicts the within-country correlations of the Health, Education, and Income Gini ranks, showing that, with a few exception like Guatemala, there is little correlation of the three Ginis within each country. Because the data presented here come from separate data sets, there is no way to empirically establish the extent to which the income-poor are also the health-poor and the education-poor. It is my hypothesis, however, that these inequalities are cumulative. Marmot (2005: 101) presents evidence from several countries that adult mortality rates vary inversely with education levels.



Source: Author's calculations using data from the current study.

Figure 3.5: Correlation between Health, Education, and Income Gini Ranks

Similarly, Tilak (2002: 198) demonstrates an inverse relationship between education levels and income poverty: "Poverty of education is a principal factor responsible for income poverty; and income poverty, in turn, does not allow the people to overcome poverty of education."

3.4 Constructing the IHDI: Methodology

Early *HDRs*, as noted above, reported results for an Income-Distribution-Adjusted HDI (HDI^{A*}). This measure used the Gini coefficient for income to penalize HDI values for the extent of income inequality in each country: [18]

$$\text{(4a) H-Index}_i = \frac{LE_i - 25 \text{ years}}{85 \text{ years} - 25 \text{ years}}$$

$$\text{(4b) E-Index}_i = 2/3(\text{LIT-Index}_i) + 1/3(\text{ENR-Index}_i)$$

$$\text{(4c) Y-Index}^{A*}_i = \frac{[(1 - G_i^Y)*\ln(Y_i)] - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$\text{(4d) HDI}^{A*}_i = 1/3(\text{H-Index}_i) + 1/3(\text{E-Index}_i) + 1/3(\text{Y-Index}^{A*}_i)$$

In calculating HDI^{A*}, the life expectancy and education indices thus remained unchanged, but the income index (Y-Index^{A*}) was adjusted for income inequality: before employing the normalization formula, the natural log of income was multiplied by 1 minus the Gini coefficient for income (G^Y). Since Ginis range from 0 (perfectly equality) to 1 (perfect inequality), the greater the extent of income inequality the greater the reduction to the income component of HDI^{A*}, and the lower HDI^{A*} itself. *HDRs* 1990 through 1994 contained HDI^{A*} results for a sample of countries.

Hicks (1997) proposed an Inequality-Adjusted HDI (HDI^{B*}) that made adjustments for distribution in all three component indices. In addition to the more commonly available Gini coefficient for income (G^Y), Hicks constructed Ginis for health (G^H) and education (G^E) using data for age at death and educational attainment respectively.[19] In HDI^{B*}, the component indices were identical to those used in HDI with one exception: the three Ginis were used to penalize their respective index values for the extent of inequality in that particular component.[20] Hicks' method of introducing the Ginis into his adjusted HDI differed from the UNDP method described above, being inserted into the component indices after normalization rather than beforehand: [21]

$$(5)\ HDI^{B*}_i = 1/3[(1 - G^H_i) * \text{H-Index}_i] + 1/3[(1 - G^E_i) * \text{E-Index}_i] + 1/3[(1 - G^Y_i) * \text{Y-Index}_i]$$

In HDI, each of the three component indices account, on average, for about one-third of the value of HDI – that is, the three components are very nearly equally balanced. The placement of the adjustments for inequality (1 – G) outside of the normalization formulae in Hicks' HDI^{B*} has the unfortunate side-effect of upsetting this balance. Using data from the current study, 3.2 compares the average weight of each component in the values of HDI and Hicks' HDI^{B*}.[22]

Table 3.2: Average Component Shares in HDI and Hicks' HDI^{B*} (2003)

	H	E	Y
HDI	32.7%	35.6%	31.7%
Hicks' HDI^{B*}	39.1%	34.4%	26.5%

Source: Author's calculations using data from the current study.

The current study proposes a new Inequality-Adjusted HDI (IHDI) that differs from HDI not only in the inclusion of Ginis for health, education, and income – which are introduced with out changing the balance among the three HDI components – but also in an adjustment to each component to reflect diminishing returns. To do the latter, the indicators for life expectancy, education, and income are first transformed (before incorporation in the index normalization formulas) into social welfare (W) using the distributional data discussed above:

$$(6a)\ W^{H}_{i} = \Sigma^{n}_{k=1} [a^{H}_{ik} * \ln(LY_{ik})]$$

$$(6b)\ W^{E}_{i} = \Sigma^{n}_{k=1} [a^{E}_{ik} * \ln(EA_{ik})]$$

$$(6c)\ W^{Y}_{i} = \Sigma^{n}_{k=1} [a^{Y}_{ik} * \ln(Y_{ik})]$$

where LY is life-years, and EA is educational attainment. The social welfare functions for life expectancy (W^H), education (W^E), and income (W^Y) are the weighted average (using the set of weights a_{ik}) of the natural log of the values of that component for k individuals in the ith country. The use of natural logs results in individual welfare functions that are concave with respect to the logged variable.

IHDI uses the average of the natural log of individual values, whereas HDI uses the natural log of an average value (in the case of the income component). Taking the natural log of $\overline{Y}$ was a way for the UNDP to make the HDI less sensitive to income differences between countries then it otherwise would have been. This provided an incomplete solution to the diminishing marginal utility of income, in that it only addresses differences between national averages and not differences within countries. Taking the average of the natural logs adjusts individual welfare for diminishing returns to health, education, and income, and thereby allows the average to reflect the associated aggregation effects.[23]

The weights (a_{ik}) can take different values summarized by the following general case:

$$(7)\ a_{ik} = \frac{(1/share_{ik})^{\alpha}}{\Sigma^{n}_{k=1} (1/share_{ik})^{\alpha}}$$

where "$share_{ik}$" is the kth individual's percentage share of the total value of that indicator summed across all individuals; that is, when $\alpha = 1$ the weights are the inverse of each person's share of the total indicator value for that country. The higher the α, the greater the weight placed on the well-being of the least well-off group, making this weighting system analogous to the Foster-Greer-Thorbecke class of poverty measures, in which $\alpha = 2$ is the most commonly used value (1984).[24]

When $\alpha = 0$, the weights the ith country are equal to one divided by that country's population (N_i) for all k individuals; each person gets the same weight. This weighting system, when combined with taking the natural log of the indicator, is analogous to the system of "equal weights" described by Ahluwalia and Chenery (1974). The result of the equal weighting system is that a given percentage change in any individual's indicator value (life-years, educational attainment, or income) has the same effect on social welfare, regardless of the individual's indicator level. For example, a one percentage change in the richest individual's income has exactly the same impact on IHDI as a one percentage change in the poorest individual's income.

When $\alpha = 1$, the weights are the inverse of the individual's share of the total indicator value for that country; the smaller the individual's share of the indicator, the greater that individual's weight in social welfare. At higher values for α, the individual with the smallest share of the indicator would take on greater and greater importance in the social welfare function. This weighting system corresponds to Ahluwalia and Chenery's "poverty weights." As α approaches infinity, the weighting system approaches a Rawlsian concept of social welfare in which only the well-being of the least well-off member of society is considered in the social welfare function.[25]

For simplicity, weights such that $\alpha = 0$ will be used in the calculations that follow. The social welfare functions with respect to health, education, and income, therefore, can be restated as:

$$(6a^*)\ W^H_i = \Sigma^n_{k=1}\ [1/N_i * \ln(LE_{ik})]$$

$$(6b^*)\ W^E_i = \Sigma^n_{k=1}\ [1/N_i * \ln(EA_{ik})]$$

$$(6c^*)\ W^Y_i = \Sigma^n_{k=1}\ [1/N_i * \ln(Y_{ik})]$$

The social welfare functions with respect to life expectancy (W^H), education (W^E), and income (W^Y) are then normalized using the same type of formula employed in HDI:

$$(8a)\ \text{H-Index}^*_i = \frac{W^H_i - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

$$(8b)\ \text{E-Index}^*_i = \frac{W^E_i - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

$$(8c)\ \text{Y-Index}^*_i = \frac{W^Y_i - \text{minimum value}}{\text{maximum value} - \text{minimum value}}$$

In calculating IHDI, each stylized maximum value was assumed to be a little bit more than the actual maximum, and each stylized minimum value was assumed to be a little bit less than the actual minimum. This buffer around the actual maximum and minimum was included to increase the likelihood that IHDIs calculated for different years could use the same end points and would therefore be comparable. The specific buffer for each indicator's endpoints was chosen to improve the balance of the three component indices in terms of their shares of IHDI.[26] Descriptive statistics of the component indicators, including their average component shares of IHDI, are shown in Table 3.3.

Table 3.3: Descriptive Statistics for IHDI (2003)

	H	E	Y
average	0.564	0.604	0.599
standard deviation	0.097	0.196	0.217
component share of IHDI	33.3%	33.5%	33.1%

Source: Author's calculations using data from the current study.

IHDI is one minus the average of the Ginis for health (G^H), education (G^E), and income (G^Y), multiplied by the average of the adjusted health, education, and income indices:

$$(9)\ IHDI_i = [1 - (1/3G^H_i + 1/3G^E_i + 1/3G^Y_i)] * (1/3H\text{-}Index^*_i + 1/3E\text{-}Index^*_i + 1/3Y\text{-}Index^*_i)$$

Denoting the average of the three Ginis as HD-Gini, and the average of the three components as HD-Index*:

$$(10)\ HD\text{-}Gini = 1/3G^H_i + 1/3G^E_i + 1/3G^Y_i$$

$$(11)\ HD\text{-}Index^* = 1/3H\text{-}Index^*_i + 1/3E\text{-}Index^*_i + 1/3Y\text{-}Index^*_i$$

$$(12)\ IHDI = (1 - HD\text{-}Gini) * HD\text{-}Index^*$$

This method of including the three Ginis maintains the balance between the component indices. On average, the elasticity of IHDI with respect to the HD-Index is 0.98 (a one percent change in the HD-Index causes a 0.98 percent change in IHDI), while the elasticity of IHDI the with respect to HD-Gini is negative 0.34 percent.

In sum, modeling social welfare as the weighted average of the natural log of indicator values adjusts HDI for the aggregation effects of inequality. Weighting the average of the component indices by the average of the Gini coefficients adjusts for shifts in the social welfare function due to inequality's instrumental and intrinsic effects on human well-being.

3.5 IHDI Results

Among the 46 countries in the sample, Norway ranks first by the IHDI and Guatemala ranks last (Appendix Table B reports IHDI, with comparisons to HDI and Hicks' HDI^{B*}, for all 46 countries). The inequality adjustments in IHDI yield significant differences from HDI in terms of countries' rankings (for examples, see Table 3.4).

Table 3.4: IHDI Results with comparisons to HDI (2003), selected countries

Country	**IHDI**	**IHDI rank**	**HDI**	**HDI rank**	**HDI rank less IHDI rank**
Norway	0.682	1	0.963	1	0
Korea	0.568	12	0.901	23	11
Brazil	0.229	43	0.792	37	-6
Guatemala	0.098	46	0.663	45	-1

Source: Author's calculations using data from the current study.

Figure 3.6 presents a histogram of all rank changes from HDI to IHDI; five countries kept the same rank, 22 had worse ranks by IHDI, and the remaining 19 had better ranks. The average (absolute value) change in rank was 3.3, which is quite large considering that these are rank changes among only 46 countries.

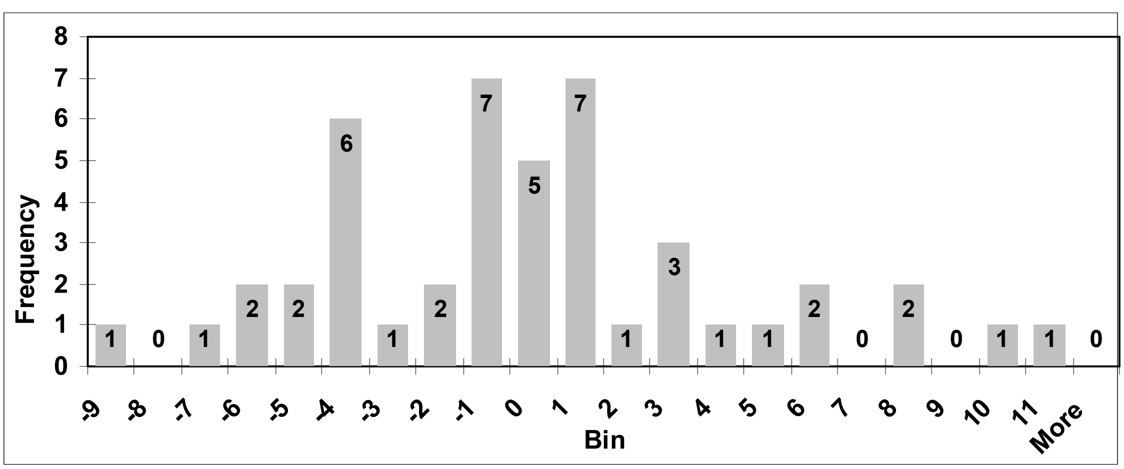


Figure 3.6: Histogram of Rank Changes, HDI Rank minus IHDR Rank (2003)

3.6 Conclusions

The Inequality-adjusted Human Development Index (IHDI) incorporates several new elements that make HDI more sensitive to inequality. First, social welfare functions with respect to health, education, and income are modeled as the average of the natural logs of these variables, as opposed to the average of the variables or (in the case of income) the natural log of the average. This method captures the aggregation effects of inequality. Moving from binary classifications for literacy and school enrollment to the continuous variable of educational attainment makes it easier to identify inequality in education.

Second, IHDI introduces the possibility of varying the weights on individuals in calculating social welfare, via a parameter adjustment to reflect the degree of emphasis on equality. The higher the parameter α, the greater the weight placed on the well-being of the least well-off. This option is important for two reasons:

- The relationship between the component variables (health, education, and income) and individual welfare may be even more concave than the logarithmic transformation specifies. Does an extra $100 for someone with an annual income of $100 really make the same contribution to social welfare as extra $1 million to someone with an annual income of $1 million? Assigning values of 1 or higher to α would (in effect) increase the degree of concavity in individual welfare functions.
- If inequality is indeed considered bad for social welfare, then a social planner attempting to maximize social welfare would choose higher values for α with the

goal of prioritizing increases to the well-being of the least well-off and reducing inequality.

Third, Gini coefficients are used to adjust the resulting composite indices – in a way that maintains balance among the components – to take into account further instrumental and intrinsic costs of inequality beyond the aggregation effect.

GDP per capita and HDI are commonly used as measures of social welfare to indicate which countries' policies have been the most effective in providing the best quality of life. When social welfare is measured without reference to inequality, these rankings incorporate conceptual flaws. HDI thus ranks some countries, like Korea, too unfavorably, and others, like Brazil, too favorably.

By the same token, when distributional inequalities are omitted from HDI, progress in improving social welfare may be overlooked – as may certain kinds of deterioration of social welfare. IHDI can both provide a better ranking of countries at any given time and better illuminate changes in social welfare over time. While the data necessary to calculate IHDI are not yet available for the full set of countries covered in the *HDR*s, this chapter provides a roadmap to a more robust measure of social welfare for use in international and inter-temporal comparisons.

Notes

[1] On social cohesion, see Thurow (1971); on violence, see Birdsall (2004); on environmental degradation, see Boyce (2002).

[2] See also Stanton (2006), chapter 4.

[3] See also Chowdhury 1991, Sagar and Najam 1998, and Chatterjee 2005.

[4] Indeed, any rate of literacy or school enrollment less than 100 percent indicates an unequal distribution of educational resources where some have received the benefits of education while others have not.

[5] Even when the provision of health and education is public, access to them can be affected by the distribution of purchasing power. For example, travel to even a free health clinic may be constrained by lack of income, or children's need to work to support themselves or their families may constrain their effective access to education.

[6] See Ackerman *et al.* (1997) and UNDP (1990) among many others.

[7] According the UNDP (2005: 341), "Income is adjusted because achieving a respectable level of human development does not require unlimited income. Accordingly, the logarithm of income is used." Using slightly different language, the first *HDR* explained the use of logarithms this way: "[Since] there are diminishing returns in the conversion of income into the fulfillment of human needs, the adjusted GDP per capita figures have been transformed into their logarithms." (UNDP 1990: 13)

[8] A Pareto improvement occurs when some individual is made better off without making anyone worse off.

[9] See also Kawachi and Kennedy (2002).

[10] A more familiar example of the aggregation effect concerns the diminishing marginal utility of income: aggregate utility (social welfare) is maximized when income is equally distributed.

[11] For discussions, see Sen 1981, Kelley 1991, Srinivasan 1994, Noorbakhsh 1998, Cahill 2002, and Deaton 2003.

[12] The term "aversion to inequality" is also used by the UNDP (1995) to explain its rationale for the Gender-related Development Index.

[13] See also Birdsall (2004: 297-8).

[14] For details, see Ray (1998: 188).

[15] For a discussion of the Gini coefficient's attributes as a measure of inequality see Ray (1998) and Hicks (1997). Hicks also makes a compelling case for the appropriateness of constructing Gini coefficients for health and education.

[16] Of these 46 countries, Egypt has the lowest HDI rank, 119 out 177, and no country is among those classified as "low human development" by the UNDP (2005).

[17] Although, if countries with high levels of infant mortality were included in the sample, the average Health Gini would be much higher.

[18] Since the HDI's technique for adjusting GDP per capita for diminishing returns has changed over time, the formula presented here combines the *HDR 1990* adjustment for income distribution and the current income index.

[19] Income distribution data by quintile for Hicks' study was taken from the World Bank, education data from a study by Ahuja and Filmer (1995) that broke educational attainment into six categories, and longevity data from the UN Demographic Yearbook's age at death (Hicks 1997).

[20] Foster *et al*. (2005) have also presented a distribution-adjusted HDI using distributional data for Mexican states. The authors point out that Gini coefficients, while excellent measures of inequality in many other ways, are "sub-group inconsistent" (that is, it is theoretically possible for the income, for example, of one group to worsen while that of all other groups remains the same and for the Gini coefficient to fail to reflect the greater inequality). Foster *et al.* instead propose the use of a version Atkinson's welfare measure for each of HDI's component indices: $W(x) = (\Sigma^{n}_{k=1} x_k^{1-\varepsilon})^{1/1-\varepsilon}$. While Atkinson's welfare measure is superior in this one respect, it is much less transparent than Hicks' measure or the IHDI proposed here; for example, it would be extremely difficult to isolate the impact of inequality on social welfare in Atkinson's or to describe its implicit social welfare function. Foster also argues that Hicks' measure is problematic because it is unknown whether its three types of inequality are cumulative or off-setting, but this would seem to be a problem of data not formula. Without consistent groups across the three measures, Atkinson's welfare measure suffers from the same failing.

[21] The formula for Hick's Inequality-Adjusted HDI as presented here has been updated for consistency with the current HDI formula.

[22] Despite HDI's simple formula, the average share of HDI taken up by the components is not equal to one-third each because the three indices differ in their average values and standard deviations, as shown below. The original endpoints (stylized maxima and minima) chosen to normalize each index resulted in very nearly balanced shares. But as data have changed while endpoints have remained the same (making it possible to compare HDI across years), the component shares have drifted slightly from this balance:

Descriptive Statistics for HDI (2003)

	H	E	Y
average	0.845	0.920	0.826
standard deviation	0.065	0.081	0.122

Source: Author's calculations using data from the current study.

[23] Correcting for aggregation effects by taking the average of the natural log of income also means that when comparing between countries, the diminishing marginal utility has already been taken into account.

[24] This rule does not follow, however, for α values between 0 and 1; for those values, higher α values put less value on the well-being of the least well-off.

[25] Regardless of the weighting scheme chosen, since the data used in this study are for groups and not individuals a small adjustment is necessary. For each group, the individual indicator value is the group's average indicator value; the product of the weight and the logged indicator for each "individual" is then multiplied by the number of group members before it is aggregated into social welfare.

[26] For health, the range was set at five percent less than the maximum and five percent more than the minimum; for education, six percent less than the maximum and five percent more than the minimum; and for income, four percent less than the maximum and ten percent more than the minimum

CHAPTER 4

HUMAN DEVELOPMENT AND HORIZONTAL INEQUALITY IN THE UNITED STATES: A DISAGGREGATION OF THE HDI BY GENDER, RACE/ETHNICITY, AND STATE

The United States (U.S.) is one of the most prosperous countries in the world: its gross domestic product (GDP) per capita is the fourth highest in the world in purchasing power parity terms;[1] primary and secondary schooling are public and free; and the average life expectancy, while lower than many other industrialized countries at 77.4 years, is still very high in comparison to those of most countries (UNDP 2004). By most measures of *average* income, education, and health, residents of the U.S. are better off than those of all but a few other countries. But average measures can hide disparities in well-being between women and men, among different racial/ethnic groups, and from location to location.

The U.S. is ranked eighth in the world by the United Nations Development Program's (UNDP's) Human Development Index (HDI), which is a measure of social welfare based on national values for average life expectancy, rates of adult literacy and school enrollment, and income per capita. HDI is reported in the UNDP's annual *Human Development Reports* (*HDR*s) commonly used by scholars, policy-makers, and development professionals to compare levels of development among nations and to gauge each nation's progress in development.

In calculating HDI, the UNDP first normalizes data for life expectancy, literacy, school enrollment, and income to convert them into the Health, Education, and Income Indices (H-Index, E-Index, and Y-Index). The normalization formula causes index values to range from 0 to 1, by comparing each country's indicator value to a stylized range of values among all countries. In the current HDI formula, the stylized range for average life expectancy (LE_i) is 25 to 85 years; for literacy and enrollment rates (LIT_i and ENR_i) it is 0 to 100 percent; and for GDP per capita (Y_i) it is $100 to $40,000.[2] In addition, the income indicator values, minimum, and maximum are all transformed into natural logarithms in order to adjust for diminishing marginal returns to income. Finally, HDI's three component indices are combined in a simple, unweighted average:

$$(1)\ \text{H-Index}_i = \frac{LE_i - 25\text{ years}}{85\text{ years} - 25\text{ years}}$$

$$(2)\ \text{E-Index}_i = 2/3(\text{LIT-Index}_i) + 1/3(\text{ENR-Index}_i)$$

$$(3)\ \text{Y-Index}_i = \frac{\ln(Y_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$(4)\ HDI_i = 1/3(\text{H-Index}_i) + 1/3(\text{E-Index}_i) + 1/3(\text{Y-Index}_i)$$

While HDI is most often presented at the national level, it also can be disaggregated for subnational groups using this same formula. This is to say that HDIs can be calculated for U.S. Black women, or Alaskans, or any subnational groupings for which data exist. Disaggregating national HDIs makes it possible to observe what Frances Stewart (2002: 2) has termed "horizontal inequalities," or inequalities between groups or regions. Stewart notes that most analyses of poverty and inequality focus on the individual: they are, "concerned with the numbers of individuals in poverty in the world as a whole, not with who they are, or where they live." Such identity-blind analyses focus on "vertical inequalities," among individuals ranked from the least advantaged to the most advantaged. Yet horizontal inequalities can be important, too.

Inequalities in health, education, and income matter to social welfare because of the intrinsic value of equity, as well as these inequalities' instrumental effects on other welfare-relevant variables, like environmental degradation or social cohesion.[3] These inequalities would matter to social welfare even if they were randomly distributed across important subnational groups. But inequality's impact on social welfare may be even greater when health, education, and income are unequally distributed along the lines of gender, race/ethnicity, or region. Stewart (2002: 3) explains the importance of horizontal inequalities in the context of the origins of violent conflict:

> It is my hypothesis that an important factor that differentiates the violent from the peaceful [countries] is the existence of severe inequalities between culturally defined groups, which I shall define as horizontal inequalities to differentiate them from the normal definition of inequality which lines individuals or households up vertically and measures inequality over the range of individuals – I define the latter type of inequality as vertical inequality. Horizontal inequalities are multidimensional – with political, economic, and social elements (as indeed are vertical inequalities, but they are rarely measured in a multidimensional way). It is my contention that horizontal inequalities affect individual well-being and social stability in a serious way, and one that is different from the consequences of vertical inequality.

The UNDP's *Human Development Reports* (*HDRs*) have provided several examples of disaggregations of HDI by gender, race/ethnicity, region, urban versus rural, and indigenous versus non-indigenous peoples. Figure 4.1 summarizes these efforts. Many of the dissaggregations reported in the *HDR*s originate in the UNDP's series of *National Human Development Reports*. For example, the most recent *South Africa National Human Development Report* (2003: 44-45) reports HDIs by province, race/ethnicity, and urban versus rural.

Year	Countries	Type of Disaggregation
1993	United States	race, gender
1993	India and Mexico	state
1993	Turkey	rural/urban
1993	Swaziland	gender
1994	South Africa, Brazil, Egypt, China, Malaysia, Canada, Germany, Poland	race/ethnicity, region
1996	Mexico	indigenous/non-indigenous
1996	Philippines, South Africa, Venezuela	region
1998	Namibia, Nigeria, Bolivia, Zambia	region
2003	Indonesia, Colombia, Nepal, Sri Lanka, Philippines, Russia	region

Source: UNDP, various years.

Figure 4.1: Disaggregations of HDI in the *Human Development Reports*

In this chapter I report the results of an original disaggregation of the U.S. HDI by gender, race/ethnicity, race/ethnicity by gender, and state for the year 2002. The U.S. aggregate HDI that is reported and disaggregated here has been calculated using national data sources, and these yield different results than the UNDP's measure for the United States, which is constructed from international data sources. I therefore analyze the origins of the differences between the two resulting measures of U.S. aggregate HDI and discuss how these differences reflect on the quality of the UNDP's data.

4.1 Disaggregating the United States' HDI: Data

U.S. national data for average life expectancy, literacy and school enrollment rates, and per capita income by gender (female and male), race/ethnicity (White, Black, American Indian, Asian, Pacific Islander, and Latino),[4] race/ethnicity by gender (for example, Black women), and states (50 U.S. states plus the District of Columbia) are drawn from a number of different data sources (see Appendix A). In this section,, I review differences between the national data used in this study and the international data sets used by the UNDP (2004), and explain the assumptions that were necessary to calculate HDI using these data.

4.1.1 Life expectancy

The life expectancy indicator is the most straightforward. The UNDP (2004: 137) uses a projection of life expectancy at birth for the five-year cohort that contains the data year, in this case 2002. U.S. life expectancies at birth disaggregated by gender, race/ethnicity, race/ethnicity by gender, and state are all available for 2002.

4.1.2 Literacy

The UNDP (2004: 137) defines adult literacy as the "percentage of people above age 15 who can, with understanding, both read and write a short simple statement related to their everyday life." The U.S. and 19 other industrialized countries are assigned 99.0 percent as a literacy rate by assumption because, "Many high-income OECD countries, having attained universal primary schooling for their populations, no longer collect literacy statistics."[5]

Literacy data for the U.S. disaggregated by gender, race/ethnicity, and state are taken from actual national surveys that score literacy on a 1-to-5 scale in each of three categories: prose, document, and quantitative literacy. Prose literacy levels 2 through 5 were considered "literate" for the purposes of this study because the description of Prose Level 2 is the closest match to the UNDP (2004) definition of literacy. Prose Level 2 requires the ability to "Interpret instructions from an appliance warranty," and "Write a brief letter explaining an error made on a credit card bill." (National Center for Education

Statistics 2002) The literacy rates used in this study refer to 1992 data, the most recent for which these data are available.[6]

4.1.3 School enrollment

For the purposes of HDI, the UNDP (2004: 137) defines school enrollment as "combined gross school enrollment for primary, secondary and tertiary schools…calculated by dividing the number of students enrolled in all levels of schooling by the total population in the official age group corresponding to these levels. The tertiary age group is set to five cohorts immediately following on the end of upper secondary school in all countries."

The U.S. national school enrollment rates by gender, race/ethnicity, race/ethnicity by gender, and state used in this study are the ratio of the number of students enrolled from the earliest grade of school through college, divided by the number of people from ages 5 through 24. These data refer to the years 2000, 2003, or 2004, depending on the data source.

4.1.4 Income

Finally, the UNDP's (2004: 138) measure of income in used in calculating HDI is GDP per capita for 2002. The U.S. individual income data are available by gender, race/ethnicity, race/ethnicity by gender, and state is based on surveys that ask people. Aggregate income is only one component of GDP. U.S. GDP per capita for 2003 was $34,772 whereas the U.S. income for 2003 was only $23,276 per capita (BEA NIPA 2006; U.S. Census Bureau 2005). The disaggregated income values in this study therefore have been multiplied by a scalar of 1.49 to adjust upwards for this disparity (see Appendix A for details).

In the UNDP's (2004) international set of HDIs, GDP per capita is capped at $40,000. This affects only Luxembourg, the only country where per capita GDP is greater than $40,000. In this study, the groupings all Whites, all men, White men, Asian men, and Pacific Islander men, as well as the states of Connecticut, Maryland, Massachusetts, New Hampshire, New Jersey, New York, and Virginia, and the District of Columbia (D.C.), have per capita incomes greater than $40,000. For consistency with the UNDP's methodology, in those cases incomes have been capped at $40,000.

4.2 Horizontal Inequalities in the United States

HDI's for the U.S. for genders, race/ethnicities, race/ethnicities by gender, and for the country as a whole are shown in Table 4.1 below. White women rank highest, followed closely by all Whites and White men. Black men had the lowest HDI and all Blacks the second lowest.[7]

HDIs by state are reported in Table 4.2 for the states that ranked highest and lowest (see Appendix B1 for HDIs for all 50 states and Washington D.C.). Minnesota's HDI was highest, with New Hampshire a close second. The lowest HDI, by far, is that for Washington D.C.: despite having the maximum possible Income Index value; D.C. ranks last both by its Health Index and its Education Index.

Table 4.1: U.S. HDI by Gender and Race/Ethnicity (2002)

HDI Rank		H-Index	E-Index	Y-Index	HDI
1	White Women	0.933	0.841	0.948	0.907
2	All Whites	0.875	0.838	1.000	0.904
3	White Men	0.832	0.836	1.000	0.889
4	All Asians	0.954	0.713	0.996	0.888
5	Asian Women	1.007	0.708	0.939	0.885
6	All Women	0.920	0.795	0.929	0.881
7	Pacific Islander Women	1.007	0.708	0.928	0.881
8	All Pacific Islanders	0.952	0.713	0.977	0.881
9	Asian Men	0.917	0.718	1.000	0.878
10	Pacific Islander Men	0.917	0.718	1.000	0.878
11	United States total	0.852	0.789	0.981	0.874
12	All Men	**0.808**	**0.780**	**1.000**	**0.863**
13	American Indian Women	0.935	0.767	0.865	0.856
14	All American Indians	0.848	0.764	0.908	0.840
15	American Indian Men	0.793	0.761	0.943	0.833
16	Black Women	0.827	0.676	0.901	0.801
17	Latino Women	0.972	0.591	0.835	0.799
18	All Latinos	0.888	0.584	0.893	0.788
19	Latino Men	0.842	0.578	0.933	0.784
20	All Blacks	0.730	0.676	0.915	0.774
21	Black Men	0.650	0.675	0.931	0.752

Source: Author's calculations using data described in Appendix A.

Table 4.1: U.S. HDI by State (2002), selected states

HDI Rank	State	H-Index	E-Index	Y-Index	HDI
1	Minnesota	0.879	0.848	0.996	0.908
2	New Hampshire	0.862	0.856	1.000	0.906
3	Colorado	0.866	0.841	0.995	0.901
4	Connecticut	0.865	0.833	1.000	0.900
5	Vermont	0.859	0.848	0.987	0.898
47	South Carolina	0.809	0.754	0.966	0.843
48	Alabama	0.811	0.759	0.955	0.842
49	Louisiana	0.801	0.736	0.948	0.828
50	Mississippi	0.801	0.725	0.933	0.819
51	District of Columbia	0.717	0.680	1.000	0.799

Source: Author's calculations using data described in Appendix A.

While the data used to calculate HDI for the 20 groupings by gender and race/ethnicity, and 50 states plus D.C. are internally consistent, thereby making it possible to compare between genders, race/ethnicities, and states, they are not consistent with HDIs for other countries. U.S. HDI as calculated by the UNDP is 0.939 and ranks eighth between Iceland and Japan, but U.S. HDI calculated from national data is 0.874 and would rank 32nd, between Malta and the Czech Republic (see Table 4.3 and 4.4).[8] As shown in Table 4.3, the disparity between the two measures of U.S. HDI stems almost entirely from the Education Index, which is 0.97 according to the UNDP and 0.79 by the national data. More specifically, the UNDP records literacy and school enrollment rates for the U.S. for 2002 as 99 percent and 92 percent, respectively, whereas the data used for this study were 79 percent literacy and 78 percent school enrollment for the U.S. as a whole.

Table 4.2: U.S. Total HDIs by UNDP and by National Data (2002)

HDI Rank	Country	H-Index	E-Index	Y-Index	HDI
8	United States (UNDP)	0.87	0.97	0.98	0.939
32	United States (national data)	0.85	0.79	0.98	0.874

Source: Author's calculations using data described in Appendix A.

Table 4.3: HDI (2002), selected countries

HDI Rank	Country	H-Index	E-Index	Y-Index	HDI
28	Korea, Rep.	0.84	0.97	0.86	0.888
29	Barbados	0.87	0.95	0.84	0.888
30	Cyprus	0.89	0.89	0.87	0.883
31	Malta	0.89	0.87	0.86	0.875
32	**United States (national data)**	**0.85**	**0.79**	**0.98**	**0.874**
33	Czech Republic	0.84	0.92	0.84	0.868
34	Brunei Darussalam	0.85	0.87	0.88	0.867
35	Argentina	0.82	0.96	0.78	0.853
36	Seychelles	0.80	0.90	0.87	0.853

Source: Author's calculations using data described in Appendix A.

The data for literacy used in this study were from a 1992 survey, which was the most recent data available. It seems unlikely that this is the root of the discrepancy, however, since the UNDP (1994) recorded U.S. literacy for 1992 at 99 percent as well. As noted above, it is the UNDP's (2004) practice to record the literacy rates of all industrialized countries as 99 percent in the absence of actual data. The *International Adult Literacy Survey* conducted by the OECD (1997) from 1994 to 1995, however, found literacy rates (defined as the Prose Level 2 described above) ranging from 78.2 to 92.5 in nine of the most industrialized countries, as shown in Table 4.5. It may be that the Prose 2 literacy classification used in this study is not, after all, a good match to the UNDP's (2004) requirements for literacy. The UNDP (2004) compiles its international data set on literacy from national sources. With each country reporting literacy rates from its national data – excluding the set of industrialized countries that do not report literacy at all – it seems unlikely that all countries are following exactly the same guidelines.

Table 4.4: Literacy Rates in Industrialized Countries

Country	Literacy Rate
Sweden	92.5%
Netherlands	89.5%
Germany	85.6%
Canada	83.4%
Australia	83.0%
Switzerland (French)	82.4%
Belguim	81.6%
New Zealand	81.6%
Switzerland (German)	80.7%
United States	79.3%
United Kingdom	78.2%

Source: OECD 1997.

It is also possible that the UNDP may calculate combined gross school enrollment using a slightly different method then the one applied in this study. The method described in the data section above follows the UNDP's (2004) description of its method exactly, but the UNDP's actual method may be more complicated than its published description.

HDR 1993 (UNDP 1993: 103) contains these instructions for cases in which HDIs calculated with national data fail to reconcile with their counterparts in the international data set:

> "A country HDI using the same data components as the subnational HDIs is also calculated, and the country figure is adjusted to equal the figure for the national HDI…All group calculations are then adjusted proportionately so that the disaggregated HDIs are comparable to the national HDIs…In this way, it is possible to say where disaggregated groups of a particular country would rank among the other countries."

This method, in essence, interprets these differences as absent of meaning: a mathematical problem that can be solved by a proportional adjustment to all subnational groups. In this study, no such adjustment has been made for three main reasons.

First, the differences in the two measures of literacy and school enrollment are of a scale that demands explanation. For example, it seems unlikely that small differences in calculation method are the sole cause of the difference between 78 and 92 percent school enrollment. This type of discrepancy calls for more transparency in methodology on the part of the UNDP.

Second, the large discrepancies in U.S. literacy rates point both to the possibility that literacy rates around the world are based on dissimilar definitions and that the practice of assigning a near-universal literacy rate to all industrialized countries give these countries an undeserved advantage in HDI rankings. In the U.S., for example, where 8 percent of the population was born elsewhere (not including U.S. residents who lack immigration documentation), is universal schooling adequate support for the assumption of universal literacy? In addition, a number of studies have demonstrated the failure of many U.S. schools to ensure that all students achieve even the most basic skills (Kozol 1992).

Third, it seems extremely unlikely that whatever factors are causing the discrepancy between the national and international figures are distributed proportionately across U.S. genders, race/ethnicities, and states.

Keeping in mind these serious concerns with data comparability, HDIs using national data for genders, race/ethnicities, race/ethnicities by gender, and states, and HDIs using the UNDP's (2004) data for countries are presented together in Appendix Table B2, which also includes both measures of U.S. HDI. Table 4.6 presents some of the highest and lowest ranked of the national data HDIs together with the countries that would rank closest to them. Minnesota ranks 23rd and White women 24th, while D.C. ranks 123rd and Black men 155th out of a total of 249 groups and countries.

Table 4.5: U.S. HDIs for Subnational Groups and Country HDIs (2002)

HDI Rank	Country	H-Index	E-Index	Y-Index	HDI
22	Israel	0.90	0.94	0.88	0.908
23	**Minnesota**	**0.88**	**0.85**	**1.00**	**0.908**
24	**White Women**	**0.93**	**0.84**	**0.95**	**0.907**
25	**New Hampshire**	**0.86**	**0.86**	**1.00**	**0.906**
26	Hong Kong, China (SAR)	0.91	0.86	0.93	0.903
121	Antigua and Barbuda	0.82	0.80	0.78	0.800
122	**Latino Women**	**0.97**	**0.59**	**0.84**	**0.799**
123	**District of Columbia**	**0.72**	**0.68**	**1.00**	**0.799**
124	Bulgaria	0.77	0.91	0.71	0.796
154	Philippines	0.75	0.89	0.62	0.753
155	**Black Men**	**0.65**	**0.68**	**0.93**	**0.752**
156	Maldives	0.70	0.91	0.65	0.752
249	Sierra Leone	0.16	0.39	0.28	0.273

Source: Author's calculations using data described in Appendix A.

4.3 Conclusions

Disaggregation of the U.S. HDI by gender, race/ethnicity, and state provides a wealth of information about U.S. social welfare that is not at all apparent in the aggregate U.S. measure. The well-being of U.S. residents differs dramatically based on their gender, race/ethnicity, and state of residence. Blacks are worse off than any other group in the U.S., and the residents of D.C. – 58 percent of whom are Black – are worse off than those of any state (U.S. Census Bureau 2000). Of course, this result may be influenced by the effect of D.C. being a city rather than an entire state; if data were available for other major U.S. cities their HDIs would very likely differ from those of their states. Subnational HDIs, like the ones presented in this chapter, provide a good tool for policy-makers and social activists to analyze the effects of public policy and advocate for change.

The results of this disaggregation reveal an additional interesting pattern: in every U.S. race/ethnicity, women fare better than men according the HDI rankings. Several effects contribute to this result. First, on average women around the world have a five-year advantage in life expectancy over that of men; a possible refinement of the technique used here would be to compare women and men's life expectancies to each gender's own life expectancy range. Second, U.S. college students are disproportionately female. Third, following the example of Luxemburg's treatment in the UNDP's HDI, U.S. White, Asian, and Pacific Islander men have had their incomes capped at $40,000 in this study; had their incomes remained uncapped, their HDIs would surpass those of women for U.S. Asians and Pacific Islanders, and closely approach that of women for Whites. This raises the question of whether or not HDI captures the aspects of welfare most relevant to differences in well-being between women and men. Bardhan and Klasen (2000: 194) suggest that variables such as gender bias in education choices, the quality of education, and access to employment, training, job advancement, or leisure time would better demonstrate the forms of gender inequality that exists in industrialized countries.

Finally, the exercise of disaggregating the U.S. HDI draws attention to the horizontal inequalities that are concealed in every national HDI. The distribution of well-being is not just unequal in many, if not most, countries: it is unequal along the lines of gender, race/ethnicity or other culturally important designations, and region. Disaggregations of other national populations would not only allow for comparison among the subnational groups in each country, but could also – to the extent that that subnational and international HDIs can be made consistent – shed light on disparities in well-being among groups in different countries.

Notes

[1] Purchasing power parity adjustments to GDP per capita are used to eliminate differences in price levels between countries (UNDP 2004).

[2] Since the stylized range for literacy and school enrollment is 0 to 100, their index values are simply the rates divided by 100.

[3] For more on the welfare effects of inequality see Stanton (2006), chapter 3.

[4] In most cases, these groups contain data only for that race/ethnicity "alone" – meaning that people that report themselves as belonging to more than one group have not been included. An important exception is that those Latinos who have reported themselves as being both Latinos and one other category are, in most cases, recorded as Latinos only.

[5] In addition, twelve industrialized countries and former Soviet Socialist Republics that reported higher literacy rates in *HDR 2004* had these rates lowered to 99.0 percent in the UNDP's (2004) calculation of HDI, and five countries that reported lower literacy rates were raised to 99.0 percent.

[6] Literacy rates for race/ethnicity by gender are not available. instead these rates were assumed to be identical for both males and female in each race/ethnicity.

[7] Asian women and Pacific Islander women have Health Indices greater than 1, which indicates that their average life expectancies are above 85 years.

[8] The UNDP (2004) reports HDI to three significant figures, but its component indices to only two significant figures.

CHAPTER 5

ENGENDERING HUMAN DEVELOPMENT: A CRITIQUE OF THE UNDP's GDI

The Gender-related Development Index (GDI), published annually since 1995 in the United Nations Development Program's (UNDP's) *Human Development Report* (*HDR*), is designed to highlight gender disparities in human development. A variation on the Human Development Index (HDI), GDI is a composite index used to rank human well-being among 140 countries. Measures of life expectancy, adult literacy, school enrollment, and income per capita are first assigned a penalty based on the extent of gender inequality present in a given nation and then combined in a formula identical to that of HDI.[1] The difference between HDI and GDI can be interpreted as a gender-inequality penalty. GDI, then, is not a measure of women's development, nor of gender inequality, but rather a measure of human development that includes health, education, and income, plus the degree to which the well-being of a society as a whole suffers as a result of any gender disparity in access to these three proxies for human capabilities.

This chapter questions whether or not GDI, as currently constructed, achieves the best possible measure of gender-inequality-sensitive human development. I begin with an examination of the quality of the data used to calculate GDI and the appropriateness of the components chosen to assess gender inequality. Without a strong foundation of high-quality data well-suited to drawing attention to disparities between women and men, all the calculations that follow are irrelevant. Key questions include: How good are the data that are used in computing GDI? Is GDI based on the data most appropriate to measuring gender inequality?

Special attention is given to the estimation of women's and men's incomes used in GDI. Unlike for life expectancy, literacy, and school enrollment, gender-specific income data do not exist for most countries. The techniques used to first estimate gendered incomes and then discount them to reflect diminishing marginal utility have important effects on GDI values. How best can gendered incomes be estimated in the absence of data, or is there a better way to measure women's material well-being? How best can gendered incomes be adjusted for diminishing returns to each new unit of income?

In constructing GDI, indices for health, education, and income are generated, and then these three indices are combined in a simple, unweighted average. While on the surface this implies a balance of importance among the gender-inequality penalties for the three components, implicit weights may exist if the range of the component penalties is imbalanced. Does each of the components have the same average impact on the final GDI value?

The health, education, and income indices are assigned penalties for the extent of gender inequalities in a formula that includes female and male population shares, the gender-specific component indices, and a parameter representing society's aversion to gender inequality. The value assigned to gender inequality's impact on overall human development, the treatment of cases where female indices exceed males, and the effect of particularly uneven female and male population shares each can have unexpected, and unintended, consequences for GDI. How strong is society's aversion to gender inequality, and is this reflected in GDI? Should female advantages in capabilities be treated the same as male advantages when measuring gender inequality? What effect does a disproportionately small female population have on GDI values?

After the data are chosen, gendered income is estimated, penalties are assigned, and components are averaged together, the resulting GDI is expected to differ from HDI. That difference represents the loss of well-being due to gender inequality in each country. How large are the differences between HDI and GDI, and do they accurately portray levels of gender inequality?

Finally, in order for GDI to be useful not just to economists but to policy-makers, development professionals, and a broader public, GDI must not only be distinguishable from HDI. It also must be clear and relatively simple. Is the GDI accessible to policy-makers and development practitioners world-wide? Or does it require a specialist to calculate it, or even to interpret it? Before embarking on an examination of these concerns in greater detail, the next section of this chapter will explain the construction of the GDI.

5.1 Understanding the GDI[2]

GDI is a social welfare function that includes health, education, income, and the degree to which a country's aggregate wel-being suffers as a result of gender disparities in the availability of these three capabilities. More specifically, the GDI is a variation on the HDI in which each component – life expectancy, adult literacy, school enrollment, and income – is penalized for its extent of gender inequality before the four components are combined into a single index. GDI is not a measure of women's development, nor is it a measure of gender inequality. Instead it is a measure of overall human development that takes into consideration gender disparities' negative impacts on the average well-being of an entire society.

Each of the four components of GDI uses the same basic formula to penalize gender disparities. First, female and male-specific indices are calculated using the same normalization method as in HDI:

$$\text{(1) Female-Index}_i = \frac{\text{Female Actual Value}_i - \text{Female Minimum Value}}{\text{Female Maximum Value} - \text{Female Minimum Value}}$$

$$\text{(2) Male-Index}_i = \frac{\text{Male Actual Value}_i - \text{Male Minimum Value}}{\text{Male Maximum Value} - \text{Male Minimum Value}}$$

where the subscript i indicates the country.

Then the female and male indices for each component, along with the female and male population shares (FemalePopShare and MalePopShare) are combined to form an "Equally Distributed Index" (ED Index) using the following formula:

$$\text{(3) ED-Index}_i = [(\text{FemalePopShare}_i * \text{Female-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

The parameter ε represents aversion to inequality. On the choice of values for ε the *HDR 2005* (UNDP 2005: 344) states the following:

> The value of ε is the size of the penalty for gender inequality. The larger the value, the more heavily a society is penalized for having inequalities. If $\varepsilon = 0$, gender inequality is not penalized (in this case the GDI would have the same value as the HDI). As ε increases towards infinity, more and more weight is given to the lesser achieving group. The value 2 is used in calculating the GDI…This value places a moderate penalty on gender inequality in achievement.

When $\varepsilon = 0$, the above formula becomes the arithmetic mean weighted by female and male populations shares, and the resulting index should be equal to the component index for the whole population as used in HDI.[3] When, as in the calculations for the GDI, $\varepsilon = 2$, the above formula becomes the harmonic mean weighted by the population shares (UNDP 1995: 73).[4] Any difference between the female index and the male index –

regardless of its direction – is penalized in the ED Index. This is to say that – for all three components – the Equally Distributed formula can only impose a penalty, not award a bonus.

5.1.1 Equally distributed health index

The Equally Distributed Health Index (EDH) is calculated using female and male life expectancy data, primarily from the UN's Department of Economic and Social Affairs. The minimum and maximum life expectancies values used by the UNDP to normalize the Female and Male Health Indices are 27.5 and 87.5, and 22.5 and 82.5, respectively. The five-year difference between these ranges is attributed to the difference in women's and men's actual average life spans.[5] The harmonic mean of these two indices, weighted by their population shares, is then taken, resulting in the EDH:

$$(4)\ \text{Female-H-Index}_i = \frac{\text{Female LE}_i - 27.5 \text{ years}}{87.5 \text{ years} - 27.5 \text{ years}}$$

$$(5)\ \text{Male-H-Index}_i = \frac{\text{Male LE}_i - 22.5 \text{ years}}{82.5 \text{ years} - 22.5 \text{ years}}$$

$$(6)\ \text{EDH}_i = [(\text{FemalePopShare}_i * \text{Female-H-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-H-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

5.1.2 Equally distributed education index

For most countries, *HDR 2005*'s Equally Distributed Education Index (EDE) relies on gendered adult literacy and combined gross school enrollment data from the United Nations Educational, Scientific and Cultural Organization's Institute for Statistics. Since the literacy and enrollment data are percentages, they are already normalized between 0 and 100.[6] The literacy and enrollment data for each gender are combined in a weighted average (with literacy receiving twice the weight of enrollment) to form the

Female and Male Education Indices. The harmonic mean of these two indices, weighted by their population shares, is then taken to calculate the EDE:

$$(7)\ \text{Female-E-Index}_i = 2/3(\text{Female Literacy Index}_i) + 1/3(\text{Female Enrollment Index}_i)$$

$$(8)\ \text{Male-E-Index}_i = 2/3(\text{Male Literacy Index}_i) + 1/3(\text{Male Enrollment Index}_i)$$

$$(9)\ \text{EDE}_i = [(\text{FemalePopShare}_i * \text{Female-E-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-E-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

5.1.3 Equally distributed income index

The calculation of the Equally Distributed Income Index (EDY) is somewhat more complex than that of the other component indices because data on income by gender are not readily available. In order to overcome this absence of data, the UNDP makes the assumption that the female share of a country's gross domestic product (GDP) is equal to the female share of wages.[7] The UNDP's (1995) female "estimated earned income" (Y_f) is, therefore, equal to the female share of the wage bill (S_f) times GDP divided by the female population (N_f):

$$(10)\ Y_f = \frac{S_f * GDP}{N_f}$$

Using data from the International Labour Organizations's (ILO's) LABORSTA database, the UNDP calculates the female share of the wage bill, using the ratio of female to male non-agricultural average hourly wages (W_f/W_m) as a proxy for the female to male ratio of all wages in a given country, and the ratio of female to male shares of the economically active population (EA_f/EA_m) as a proxy for the ratio of female to male paid hours worked. The female to male ratio of shares of the wage bill is the wage ratio weighted by the economically active population ratio:[8]

$$(11)\ \frac{S_f}{S_m} = \frac{W_f}{W_m} * \frac{EA_f}{EA_m}$$

Solving for the female and male shares of the wage bill:

$$(12)\ S_f = \frac{W_f/W_m * EA_f}{(W_f/W_m * EA_f) + EA_m}$$

$$(13)\ S_m = 1 - S_f$$

GDP is then multiplied by the female or male share of income and divided by the female or male population to result in that gender's estimated earned income:

$$(14)\ Y_f = \frac{S_f * GDP}{N_f}$$

$$(15)\ Y_m = \frac{S_m * GDP}{N_m}$$

In all countries, the resulting female estimated earned income is smaller than male estimated earned income.

The Female and Male Income Indices are calculated using a normalization formula designed to correct for diminishing marginal returns to income by taking the natural logarithms of the actual, minimum, and maximum values.[9] The minimum and maximum values used to normalize the Female and Male Income Indices are $100 and $40,000; this maximum level effectively acts as a cap on income in the male index, since five countries have male estimated earned incomes higher than $40,000. The harmonic mean of these two indices, weighted by their population shares, is then taken to calculate the EDY:

$$(16)\ \text{Female-Y-Index}_i = \frac{\ln(\text{Female } Y_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$(17)\ \text{Male-Y-Index}_i = \frac{\ln(\text{Male } Y_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$(18)\ EDY_i = [(\text{FemalePopShare}_i * \text{Female-Y-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-Y-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

Table 5.1 reports the range of each Equally Distributed Index for 2003 as presented in *HDR 2005*.

Table 5.1: Component Index Data (2003)

	Health	Education	Income
ED Index high	*Japan 0.948*	*Australia, Belgium, Finland, Sweden, UK 0.993*	*Luxembourg, Norway 0.988*
Female high value	*Japan 85.4 years*	*Literacy: 39 countries 99.0% Enrollment: UK 133%*	*Luxembourg $34,890*
Male high value	*Iceland, Hong Kong 78.7 years*	*Literacy: 45 countries 99.0% Enrollment: Australia 114%*	*Luxembourg $89,883*
ED Index low	*Swaziland 0.114*	*Niger, Burkina Faso 0.154*	*Sierra Leone 0.249*
Female low value	*Swaziland 32.9 years*	*Literacy: Burkina Faso 8.1% Enrollment: Bhutan 14%*	*Sierra Leone $325*
Male low value	*Swaziland 32.1 years*	*Literacy: Burkina Faso 18.5% Enrollment: Bhutan 16%*	*Malawi $717*

Source: HDR 2005 and author's calculations using HDR 2005 data.

5.1.4 Gender-related Development Index

In the final step, GDI is calculated by taking the arithmetic mean of the EDLE, EDE, and EDY:

$$(19)\ GDI_i = (1/3)EDH_i + (1/3)EDE_i + (1/3)EDY_i$$

Using 2003 data, GDI values range from 0.961 in Norway to 0.271 in Niger, the same two countries that rank first and last in HDI (UNDP 2005). In between, a number of countries change rank due to greater or lesser degrees of gender inequality.

For more than ten years, GDI has been a powerful tool – and very nearly the only available tool – for comparing human well-being, adjusted for gender inequality, among countries and for observing how each country has changed over time. But does GDI present an accurate picture of gender-inequality-adjusted human development? If it doesn't, in what ways is it distorted? And what are the consequences of an image that is blurred or out of proportion?

5.2 Critiques of GDI

Many serious questions have been raised in the development economics literature about just how accurate a measure of gender-inequality-adjusted human development GDI really is. Several of the critiques that follow are new to the literature, notably, a detailed accounting of data assumptions used in calculating GDI, and demonstrations of the existence of three biases stemming from: an inconsistent use of income caps; a hidden penalty resulting from a reversal in the order of operations; and a gender mortality bias introduced through the female and male population shares. Other topics addressed in this section are restatements of critiques received from the literature that I have illustrated using original techniques and the most recent UNDP data. Both original and received critiques have been included to provide a comprehensive treatment of GDI, its strengths, and its weaknesses.

5.2.1 Assessing data quality

Any index is only as accurate as its underlying data. The data used to calculate HDI and GDI are much more likely to be available for the two genders combined than for each gender individually. In calculating the GDI, *HDR 2005* eliminates 37 of the 177 countries for which HDI values are available due to lack of gender-specific data and makes a number of assumptions in order to either present GDIs for certain countries in the absence of complete data or to smooth over the rough spots where the actual data fail to conform to their assumed range.[10]

A general critique of GDI's data availability and reliability has been provided by Bardhan and Klasen (1999), including questions about the quality of life expectancy data where no official registration of birth or death exists, and infant deaths, especially, tend to go unreported. Life expectancy is, however, the only component for which there are gendered data for every country that is included in GDI. These data are more likely to be available because life expectancy at birth is a prediction about the expected life spans of children born in a given year, not a measurement of the average age of death of those that have died.

In addition, the UNDP (2005) makes assumptions about certain countries for which gendered data are missing or outside of the assumed range, and, in a few cases, where actual data do exist and are within the assumed range. Twenty-four industrialized countries – the top 21 countries by HDI rank plus Portugal, the Republic of Korea, and the Czech Republic – are simply assumed by the UNDP, in the absence of any reference to available data, to have female and male adult literacy rates of 99.0 percent.[11]

Female and male adult literacy rates for an additional twelve countries are rounded down from their reported rates to 99.0 percent, and for Greece are rounded up to 99.0 percent from 88.3 percent for females and 94.0 percent for males. Uzbekistan's male literacy rate is reported to be 99.6 percent, which is not rounded down in *HDR 2005*, giving it the highest male literacy rate in the world for UNDP purposes. Five more countries have literacy rates that are rounded down to 99.0 percent for males only.

In order to calculate the "combined gross school enrollment" used in GDI, the number of students enrolled in primary, secondary, and tertiary schools is divided by the number of people in each country's normal age groups for those grades. The presence of students recorded as living in a different country from the one in which they attend school, as well as the existence of any students older than the normal age of the highest tertiary school grade, can return a combined gross school enrollment of greater than 100 percent. The UNDP (2005) has chosen to round these numbers down to 100 percent for the purposes of calculating GDI. Enrollment rates are rounded down for men in five and women in nine countries, all of which are classified as by the UNDP as high human development. Actual enrollment rates, before rounding down are as high as 133 percent for females in the United Kingdom and 114 percent for males in Australia.

Finally, the data used by the UNDP to estimate gender-specific incomes are not in fact available for many countries. *HDR 2005* (UNDP 2005: 346) does not make explicit the extent of the assumptions used for missing data points in calculating estimated earned income, but notes that, "Where data on the wage ratio are not available, a value of 75% is used." *HDR 1995* stated that the ratio of female to male non-agricultural wages was only available for 55 out of 130 countries, and that the average ratio for these 55 countries – 75 percent – was applied to the remaining countries. In *HDR 2005*, data for the wage ratio and the shares of the economically active population by gender are cited as coming from the ILO's LABORSTA database for 2005 and 2002, respectively. Examination of the publicly-available LABORSTA data for those years, however, showed only nine countries with data for wage ratios and 69 with data for the share of economically active population by gender. In the nine countries for which data was available, wage ratios ranged from 0.50 in Japan to 0.86 in New Zealand.[12]

In their review of GDI as a prelude to the construction of an African-GDI on behalf of Economic Commission for Africa, Charmes and Wieringa (2003: 428) question the use of international data sets in GDI, stating, "Nobody will contest that the most detailed and recent data are available at the national level, because their gathering and entry into an international database takes time and requires full examination and possibly adaptation." They suggest that GDI would be more accurate if it were calculated at the national level.

For the data on which GDI is based, what Charmes and Wieringa refer to as the "adaptation" of data is pervasive. Without these data adaptations, of course, GDI could only be presented for a small subset of countries. Comparing GDI values for a large set of countries provides valuable information, but when data adjustments assume optimistically high values in developed countries in the absence of data or assume values based on elaborate calculations and very little data, the *HDRs* should provide detailed explanations justifying these choices.

5.2.2 Choosing the right components

Just because life expectancy, literacy, school enrollment, and income are used to measure well-being in the HDI does not mean than the gender gaps in these variables are necessarily the best data for illuminating the overall disparity in human development between women and men. Choosing which components to include, and which to exclude, in any measure of human well-being, requires a delicate balance of political, practical, and even ethical concerns. Several critiques of GDI have pointed out ways in which its data could be improved, including by starting over to redesign it from scratch:

> Had the UNDP attempted an independent formulation of the GDI, deriving its framework from the experience of developing countries, it could not but have taken note of indicators such as access to fuel and water, property rights, incidents of violence against women, etc. While an index cannot be expected to capture adequately the subtle yet all pervading discrimination against women in various spheres, the UNDP's effort would have been more meaningful had it attempted constructing a comprehensive index that is sensitive to the special problems faced by women in developing countries. (Prabhu et al. 1996: 72)

Bardhan and Klasen (2000: 194) make a similar argument about constructing a GDI in a way that would highlight gender inequality in rich countries. They suggest that variables such as gender bias in education choices, the quality of education, and access to employment, training, job advancement, or leisure time would better demonstrate a more "subtle" form of gender inequality.

With regard to GDI's measures of life expectancy and education, Bardhan and Klasen (1999: 991-993) argue for the inclusion of both "stock" and "flow" measures to balance the effects of past and present discrimination against women (where "stock" measures are interpreted as those that capture elements of past discrimination), and they point out that while GDI's education component includes the stock measure of adult literacy as well as the "flow" measure of school enrollment, life expectancy only measures current, and projected future, discrimination (see also Dijkstra and Hanmer 2000: 50, 57).[13] According to Bardhan and Klasen (1999: 1003 n.13), GDI ignores biases in past gender mortality, where the impact could only be observed in cohorts older than the one born in the current year. They suggest that it may be "ethically dubious not to consider victims of discrimination simply because they have died as a result of this discrimination," a point to which I return below. Also absent from GDI's life expectancy measure is the impact of pre-natal discrimination (i.e., sex-selective abortion) (Klasen 2006: 248).[14]

Many critiques of GDI, including those related to data appropriateness, focus a substantial share of their attention on the EDY and GDI's procedure for estimating gendered income. These concerns are addressed in greater detail in the following two sections.

5.2.3 Measuring gendered income

Unlike the other components in GDI, gendered income is a rough estimate. Several critiques have questioned the appropriateness of using non-agricultural wages together with labor force participation as gender weights for GDP per capita.[15] The ratio of female to male non-agricultural wages approximates the ratio of all female to male wages only if agricultural and non-agricultural wages are similar and the informal sector (where wages are not recorded) is very small. The ratio of female to male labor force participation approximates the ratio of female to male paid hours worked only if women and men have the same average number of paid hours of work. These two ratios multiplied together approximate the ratio of female to male income only if there are no non-wage sources of income – no home production, and no investment or rental income.

Applying the resulting female or male shares of income to GDP divided by the female or male population (the UNDP's formula for estimated earned income) approximates women and men's standard of living only if there are no non-market goods or services, public goods are equally distributed with respect to gender, women and men live separately (or with no shared income), children are wards of the state, and women and men enjoy equal amounts of leisure time, or if gender-specific effects in these arenas mirror the calculated earned income shares. The problem of disaggregating household income in such a way as to make a meaningful proxy for material well-being by gender is not well-suited to the kinds of broadly available data sets found in the *HDR*s.[16] To the extent that women and men have claims on other sources of income and wealth, neither the level of consumption nor the standard of living can be inferred from estimated gendered income alone. Women and men's relative contributions to household and children's expenses are another important consideration, as is the direct impact of household labor on living standards (Bardhan and Klasen 1999: 992-993).

One suggestion for improving the income component of GDI is to replace gendered "estimated earned income" with some other relevant measure. For example, the UNDP's Human Poverty Index for developing countries (HPI-1) measures deprivation in living standards as the percentage of the population without sustainable access to an improved water source and the percentage of children under-weight for their age; the HPI-2 (for industrialized countries) uses the percentage of people living below the poverty line. Data that are not currently available for many countries – but perhaps could be made available with encouragement and funding from the UNDP and other international institutions – might better distinguish female from male material well-being, like the percentage of under-weight children by gender, or the percentage of people living in poverty by gender.

5.2.4 Discounting gendered income

In the field of economics, income is commonly assumed to have a diminishing marginal utility, that is, the more you have, the less each new dollar means to you. In the EDY, as in the HDI's income component, estimated earned income is capped at $40,000 and then discounted by taking its natural logarithm (so that a doubling of income has the same effect on GDI regardless of the level of income). Both the application of the income cap and the discounting procedure present special problems in GDI. In addition, the average gender-inequality penalty to the income component is larger than that of life expectancy or education, with the result that gender disparities in income dominate the total gender-inequality or GDI penalty.

5.2.4.1 Inconsistent income cap

Five countries have male estimated earned incomes over $40,000 (female income is below $40,000 in all countries included in GDI). Only one of these five, Luxembourg, is actually capped at $40,000; the other four – Austria, Ireland, Norway, and the United States – are not capped, resulting in Male Income Indices greater than 1.000.[17] Ignoring the $40,000 income cap in countries where estimated male income is greater than $40,000 maintains the greatest consistency with HDI. Applying the income cap (as the GDI formula dictates) in countries, like Luxembourg, where both GDP per capita and estimated male income exceed $40,000, however, both fails to maintain consistency with HDI[18] and artificially shrinks the gap between female and male income, thereby decreasing the gender-inequality penalty.

A method that maintains some consistency with HDI without shrinking gender gaps in income is to use $40,000 minus one-half the gender gap to calculate the female income index and $40,000 plus one-half the gender gap for the male income index. In this way, both Luxembourg's mean income level as assumed in HDI, $40,000, and the size of the gap between female and male income, $54,993, are considered in the calculation of GDI. The effect would be to reduce Luxembourg's GDI from 0.944 to 0.923, and its GDI rank from seventh to twentieth, below Germany and above Spain. While this problem is currently limited to one country's GDI, several other countries' GDP per capitas are rapidly approaching $40,000.

5.2.4.2 Hidden penalty

A second concern is with GDI's adjustment for the diminishing marginal utility of income. Unaccounted for interactions exist between the discounting effect and the gender-inequality penalty effect. The UNDP (2005: 344) states that when ε is set equal to zero, GDI reverts to HDI. But in fact, HDI is not equal to GDI with $\varepsilon = 0$ (hereafter referred to as the Weighted-HDI).[19]

Table 5.2 divides the total GDI penalty (or the difference between HDI and GDI) into two steps: the difference between HDI and Weighted-HDI, and the difference between Weighted-HDI and GDI. With three components and two steps, there are six possible sources of differences that together make up the total GDI penalty.[20] If HDI and Weighted-HDI were equal, then 100 percent of the penalty would come from the difference between Weighted-HDI and GDI.[21] Instead, 45 percent of the penalty is the result of differences between HDI and Weighted-HDI, and nearly all of this disparity stems from the income component.

Table 5.2: Average share of penalty by component (2003)

	Health	Education	Income	Total Penalty
HDI less Weighted HDI				
	0.000	0.000	0.011	0.004
	-1.4%	*-1.0%*	*47.8%*	*45.3%*
Weighted HDI less GDI				
	0.001	0.005	0.006	0.004
	5.1%	*22.7%*	*26.9%*	*54.7%*
HDI less GDI				
	0.001	0.005	0.017	0.008
	3.6%	*21.7%*	*74.7%*	*100.0%*

Source: Author's calculations using HDR 2005 data.

In the regular income index used to calculate HDI, GDP per capita is, in effect, the average of female and male incomes weighted by gendered population shares. The order of operations used to calculate the income component in HDI is, therefore, first a weighted average, then a log transformation for discounting, then normalization. In GDI and Weighted-HDI, however, the order of operations is first log transformation, then normalization, then weighted average. This is of concern because the natural log of a weighted average is not equal to the weighted average of a natural log.[22] (For a demonstration of this effect see Appendix C).

In Tables 5.3 and 5.4 below, all three indices have had their orders of calculation reshuffled to more closely approximate HDI. For EDH and EDE, a harmonic mean, weighted by the female and male populations shares, is taken of the values themselves (for Weighted-HDI this becomes the weighted arithmetic mean). These penalized values are then normalized using the regular ranges or goalposts.[23] For EDE, the weighted harmonic mean of both literacy and enrollment is taken before normalization; then the two components are averaged using the normal two to one weighting. For EDY, first the weighted harmonic mean is take of female and male income, then the penalized income is discounted and the normalization formula is applied.

Using this new order of operations, Weighted-HDI is much closer in value to HDI, and the gap between HDI and GDI has gotten slightly larger (compare Table 5.4 to Table 5.2). EDH is the only component where HDI still diverges from Weighted-HDI after the change in order of operations. This result is a good example of how small the numerical differences are between HDI and GDI. Life expectancy as reported in the *HDR 2005* and life expectancy calculated in the recalculated Weighted-HDI are the same to the tenth of a year in almost all cases, and that is all the significant figures that really exist here.

Table 5.3: Share of penalty by component after adjustment of calculation order (2003)

HDI less Weighted HDI

Health	Education	Income	Total Penalty
-0.001	0.000	0.000	0.000
-2.4%	*-0.8%*	*0.8%*	*-2.4%*

Weighted HDI less GDI

Health	Education	Income	Total Penalty
0.001	0.006	0.022	0.010
3.3%	*21.3%*	*77.8%*	*102.4%*

HDI less GDI

Health	Education	Income	Total Penalty
0.000	0.006	0.022	0.009
0.9%	*20.5%*	*78.6%*	*100.0%*

Source: Author's calculations using HDR 2005 data.

Table 5.4: Adjusted GDI with re-ordering of calculations (2003), selected countries

GDI rank	Country	GDI	adj- GDI	Change in GDI	Change in rank
41	Bahrain	0.836	0.830	0.006	-2
61	Oman	0.758	0.748	0.010	-3
65	Saudi Arabia	0.749	0.740	0.009	-3
76	Belize	0.734	0.728	0.006	0

Source: Author's calculations using HDR 2005 data.

Table 5.4 shows the results of adjusting GDI by reordering the calculations for selected countries. The resulting adjusted-GDI is, on average, smaller by 0.002, although 30 countries stay the same and six become slightly larger. The largest deductions are for Oman (0.010), Saudi Arabia (0.009), Bahrain (0.006), and Belize (0.006). The effect of this adjustment on GDI ranks is far less dramatic, since almost all GDI values change in the same direction.

5.2.4.3 Imbalanced penalties

GDI's three component indices are combined together in a simple, unweighted average. On the surface this implies a balance of importance among the health, education, and income gender-inequality penalties, but implicit weights may exist if the mean or variance of the component female to male gaps are imbalanced (Dijkstra 2002: 313). As shown in Table 5.2 above, the total gender-inequality penalty, or the difference between HDI and GDI, is 0.008, of which life expectancy accounts for 3.6 percent, education 21.7 percent, and income 74.7 percent.[24]

Bardhan and Klasen (1999: 990) used the same basic method to critique the uneven implicit weights given to life expectancy, education, and income in the overall GDI penalty using data from *HDR 1995*: "While the aim and underlying premise of the GDI (to see gender inequality as a human development issue and not primarily a 'women's issue') is to be welcomed, it appears that the current version of GDI is largely driven by gaps in one component, the earned-income component." In their study, the percentage of the total penalty that was accounted for by each term was: 1.0% health; 14.0% education; and 85.0% income. According to Bardhan and Klasen, this bias in GDI resulted in the assignment of higher penalties to countries whose gender inequality stemmed from income disparities – in the Middle East and North Africa – and lower penalties to countries whose gender inequality stemmed from disparities in life expectancy or education – Southeast Asia, Sub-Saharan Africa, Eastern Europe, and Russia (1999: 989-994; 2000: 194).

While the imbalance is somewhat smaller in the more recent data, income continues to drown out the effects of gender disparities in life expectancy and education.

Dijkstra (2006) and Klasen (2006) suggest standardizing all three components (which would have the unfortunate effect of making the GDI no longer comparable across years), choosing a higher ε for the life expectancy component, or increasing the minimum life expectancy value by ten years in the normalization formula. Raising the minimum life expectancy by just two and one-half years (to 30 years for women and 25 years for men) does increase the share of the GDI penalty attributable to gender disparities in life expectancy (see Table 5.5), but limits the comparability between HDI and GDI.

Table 5.5: Adjusted average share of penalty by component (2003)

HDI less GDI

Health	Education	Income	Total Penalty
0.015	0.005	0.017	0.013
40.6%	*13.4%*	*46.1%*	*100.0%*

Source: Author's calculations using HDR 2005 data.

5.2.5 Valuing gender inequality

The value assigned to the parameter ε is meant to result in GDI penalties that are of a size that seems consistent with gender inequality's negative impact on well-being in each country. When the UNDP (1995: 73) first introduced the GDI in 1995, it described ε as an "adjustable" parameter:

> [E]ach society can choose a specific value for its "aversion to gender inequality" (ε), depending on where it starts and what goals it wants to achieve over what time period. In previous [HDRs], ε was implicitly assumed to be zero – that is, no policy preference for gender equality was adopted. But policy-makers must make an explicit choice of the weight they wish to assign to their preference for gender equality…The illustrative calculations of the GDI…are based on ε = 2 (harmonic mean), which expresses a moderate degree of inequality aversion. This is only to show that, even with modest weights, the profile of gender inequality looks fairly bad in most countries.

The suggestion that policy-makers should first assign their own level of aversion to gender inequality and then recalculate the GDI before comparing various countries' GDIs to their own or evaluating their own country's progress in GDI seems somewhat unrealistic. An argument could be made that policy-makers in some countries seem to have little or no aversion to gender inequality, and that some actively seek to perpetuate gender disparities. The adjustable quality is no longer mentioned in more recent *HDR*s, leaving $\varepsilon = 2$ as the *de facto* value. The Equally Distributed Index formula, therefore, can be restated in a more transparent form:

$$\text{(22) ED-Index}_i = \frac{1}{\dfrac{\text{FemalePopShare}_i}{\text{Female-Index}_i} + \dfrac{\text{MalePopShare}_i}{\text{Male-Index}_i}}$$

The average penalty assigned for gender inequality in calculating GDI is just 0.008 (compared to HDI's range of 0.963 to 0.281). The loss of 0.008 of HDI is comparable to one of any of the following: 1.5 fewer years of average life expectancy; 3.5 fewer percentage points in the literacy rate; or 7.0 fewer percentage points in the school enrollment rate. Because of the adjustment for diminishing marginal returns, an equivalent reduction in GDP per capita would depend on the income level, for example, either from $40,000 to $34,500 or from $10,000 to $8,700.

The largest penalty – 0.040 for Yemen – is just a little bit larger than the size of the difference between the HDIs of Norway (ranked first by HDI) and Spain (ranked twenty-first).[25] Using the language of the *HDR*s, if society placed the "moderate" value on gender inequality assumed in GDI, then the decrease in Yemen's human development due to gender inequality – a country where on average women live less than three years longer than men (compared to the "normal" 5 years), 29 percent of women can read compared to 70 percent of men, 41 percent of young women are enrolled in school compared to 69 percent of men, and the average woman earns $400 a year compared to

$1300 for men – would have the same impact on well-being as the choice of living in Spain instead of Norway.

GDI penalties range from zero percent of HDI in nine countries to 8.2 percent in Yemen, with an average penalty of 1.3 percent. Is this a "moderate" degree of inequality aversion? And if it is, can the amount that society's well-being suffers as a result of gender inequality accurately be described as "moderate"? Table 5.6 below compares countries' ranks for Weighted-HDI ($\varepsilon = 0$), GDI ($\varepsilon = 2$), GDI with $\varepsilon = 10$, and GDI with $\varepsilon = 100$ for the ten countries with the lowest

Table 5.6: Rankings of GDIs with higher penalty factors (2003), selected countries

Rank	Weighted HDI	GDI	GDI ε = 10	GDI ε = 100
131	Congo, D.R.	Congo, D.R.	Burundi	Zambia
132	Mozambique	Burundi	Congo, D.R.	Congo, D.R.
133	Burundi	Mozambique	Mozambique	Mozambique
134	Ethiopia	Ethiopia	Ethiopia	Ethiopia
135	Guinea-Bissau	Guinea-Bissau	Mali	Mali
136	Chad	Mali	Burkina Faso	Burkina Faso
137	Mali	Chad	Chad	Chad
138	Burkina Faso	Burkina Faso	Guinea-Bissau	Guinea-Bissau
139	Sierra Leone	Sierra Leone	Niger	Sierra Leone
140	Niger	Niger	Sierra Leone	Niger

Source: Author's calculations using HDR 2005 data.

ranks by each of these measures. (For results for all 140 countries see Appendix D). The average penalty for GDI with $\varepsilon = 10$ is 3.5 percent and for GDI with $\varepsilon = 100$ is 6.2 percent. For Yemen, the GDI penalty reaches 18.3 percent with $\varepsilon = 10$ and 22.0 percent with $\varepsilon = 100$.

In past *HDR*s, the UNDP has referred to gender inequality as a "persistent neglect to the creativity and productivity of half of humanity," (1995: 23) and has stated that, "Of the many inequalities in human development, the most striking is that along gender lines.” (1991: 92) The best value for ε is, of course, subjective, but an ε value larger than that currently used in GDI – and an average penalty for gender inequality larger than one percent of HDI – would seem better aligned with the size of the burden of gender inequality portrayed in the *HDR*s.[26]

5.2.6 Regarding the direction of penalties

Any difference between female and male component indices – regardless of its direction – is penalized by a reduction in the Equally Distributed Index formula. This is to say that, even when the female index is higher than the male index, a penalty will nonetheless be assessed.[27] This gender-blind feature of GDI does not appear to have been the intention of UNDP (1995: 73) in electing to use this particular measure of human development, as evidenced by this description of what value GDI takes as ε approaches infinity: “In the extreme case, if ε = infinity, only achievements of women get a positive weight, and the relative achievements of men are ignored.” This, of course, could be true only if female indices were exclusively lower than male indices.

To be clear, a female advantage in one component does not offset a male advantage in another. Instead, any gender inequality – regardless of direction – adds to the GDI penalty.[28] This renders the meaning of GDI somewhat difficult to interpret. The idea that male disadvantages are added on top of female disadvantages to sum up to a final gender inequality penalty is complex and counter-intuitive. It seems at odds both with what someone who has not read the technical notes to the HDR is likely to assume “gender inequality” means and with the UNDP’s own rhetoric, in which the terms “gender inequality” and men’s advantages over women are used interchangeably.[29]

For 2003, 77 out of 140 countries have at least one component in which the female index is higher than the male index (see Appendix Table E). When female and male component indices are used independently to calculate Female-HDIs and Male-HDIs, seven countries have higher Female than Male-HDIs: Luxembourg and six former Soviet Republics.[30] The meaning of the resulting GDI penalty, and of GDI itself, is unclear – especially in countries in which females are better off than males by some component indices but worse off by others. Table 5.7 is a correlation matrix for the gender-inequality penalties associated with the health, education, and income components; correlation between the three component penalties is low, and two of the three pairwise correlations are negative.

Table 5.7: Correlation matrix of component penalties (2003)

	H penalty	**E penalty**	**Y penalty**
H penalty	1.000		
E penalty	0.028	1.000	
Y penalty	-0.240	-0.197	1.000

Source: Author's calculations using HDR 2005 data

5.2.7 Rewarding gender mortality bias

Each Equally Distributed Index is weighted by the female and male population shares. The inclusion of unequal population shares in the ED formulas introduces a bias (not unlike a perverse incentive) for low female to male sex ratios, where a low female share of the population gives a correspondingly low weight to women's lower index values, thereby underestimating gender disparities.[31] In addition, when males have the lower index values, the low female population share result in a greater emphasis on male disadvantages. (For a demonstration of these effects see Appendix F.)

This bias could be called the "missing women" effect after Amartya Sen's (1990) observations about gender mortality bias. Missing women are the additional women and girls who, but for the existence of past and present gender mortality bias, would be alive today. Sen used the sex ratio in Sub-Saharan African, 102 females for every 100 males (or a female population share of 0.505), as the sex ratio that would be expected under conditions of low gender mortality bias. Comparing this expected sex ratio to the actual sex ratios in other regions, he found a deficit of 11 percent. One hundred million of the women that would be expected in South Asia, West Asia, China, and North Africa were missing. All of the countries with missing women are rewarded in terms of their GDI value whenever the remaining women are disadvantaged in health, education, or income.

If Sen's expected gender population shares are used in the calculation of GDI in place of each country's actual population shares, nine countries' GDIs increase by 0.001 and 95 countries' GDIs stay constant. The remaining 36 countries have lower GDIs using Sen's population shares; the change in GDI after this adjustment is the size of the bonus given to these countries' GDIs for gender mortality bias. The countries that receive the highest missing women bonuses are shown in Table 5.8 below.

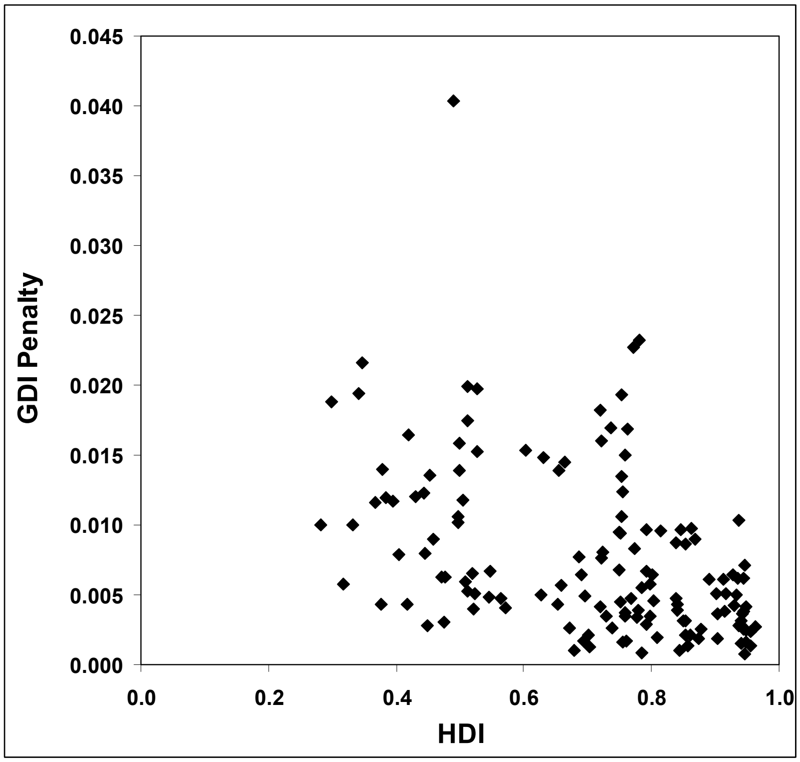
Table 5.8: Adjusted GDI with Sen's population shares (2003), selected countries

GDI rank	Country	Female share of population	GDI	adjusted-GDI	GDI less adjusted-GDI	GDI rank less adjusted-GDI rank
39	Kuwait	0.400	0.843	0.837	0.006	-1
41	Bahrain	0.430	0.836	0.830	0.007	-2
61	Oman	0.438	0.758	0.749	0.009	-3
65	Saudi Arabia	0.460	0.749	0.743	0.006	-3
73	Jordan	0.480	0.740	0.737	0.002	-1
98	India	0.487	0.587	0.585	0.002	0
103	Papua New Guinea	0.484	0.518	0.516	0.002	0
107	Pakistan	0.485	0.508	0.505	0.003	-1
121	Yemen	0.493	0.449	0.447	0.002	-1
128	Côte d'Ivoire	0.492	0.403	0.401	0.002	0

Source: Author's calculations using HDR 2005 data

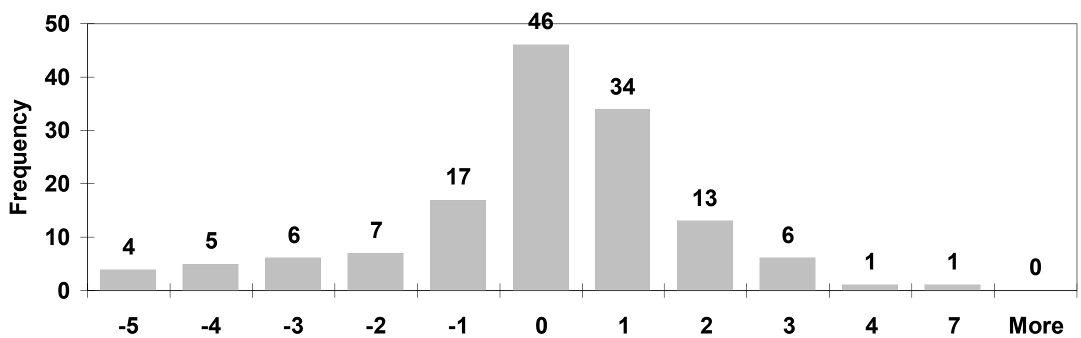
5.2.8 Identifying the differences from HDI

After the data are chosen, gendered income is estimated, penalties are assigned, and components are averaged together, the resulting GDI should be different from HDI – a difference that is meant to represent the extent of loss of well-being due to gender inequality in each country. Figure 5.1 is a scatterplot of GDI penalties versus HDI values using 2003 data. Most GDI penalties are very small, which suggests that GDI values are dominated by the information in HDI; that is, the new information meant to differentiate GDI, and to emphasize the impact of gender inequality on all human well-being, is being overshadowed by the rest of the HDI. In thirteen countries the difference between HDI and GDI is less than one one-thousandth, and therefore not appreciable in the three significant figures in this data; in a further 22 countries, the GDI penalty is 0.001.



Source: HDR 2005 and author's calculations using HDR 2005 data.

Figure 5.1: GDI Penalties versus HDI (2003)



Source: Author's calculations using HDR 2005 data.

Figure 5.2: Histogram of Rank Differences (HDI rank less GDI rank) (2003)

When GDI ranks are compared to HDI ranks, the largest changes in rank are for Sri Lanka (GDI is 7 ranks higher than HDI); Guyana (4 ranks higher); Belize, Oman, Peru, and Saudi Arabia (5 ranks lower); and Ireland, Lebanon, Pakistan, Paraguay, and

Yemen (4 ranks lower). For 46 out of the 140 countries, there is no change in rank (see Figure 5.2 above), and for 51 the difference is only one rank up or down.

GDI has a noticeable effect on HDI ranks, but very little impact on HDI values. One can only hope that society's aversion to gender inequality is greater than that represented by the penalty to GDI.

5.2.9 Simplifying the GDI

In introducing the GDI, *HDR 1995* (UNDP 1995: 72) emphasized its practical use to policy-makers, stating:

> [GDI is] suggested to capture gender disparities and their adverse effects on social progress. Capturing such a complex reality in a single, simple index is not easy. But a beginning must be made, however limited, to place the problem of gender inequality firmly on the social agenda. For policy-makers particularly, it is useful to look at composite measures – for their own countries and for others – to draw policy conclusions about critical shortfalls in gender capabilities or opportunities, and about priorities to consider in their plans of action.

A clear preference for a clearer, simpler, more straightforward measure has been expressed in several critiques of the GDI.[32] Charmes and Wieringa (2003: 429-30), in the context of creating an African-GDI, state that, "The complexity of this measure of calculation, coupled with the fact that its computation is based on international data sets, effectively means that the control of the data is out of reach of many NGOs in developing countries." Likewise, Dijkstra and Hanmer (2000: 45) remark that, "[W]hether ε is set equal to infinity, one, or two, none of the resulting measures translates readily into an indicator of the position of women which can be easily used and understood by nonspecialists and policy-makers." More recently, Schüler (2006) describes how GDI has often been mistaken for a measure of gender inequality in academic articles and even in UNDP reports.

GDI is not computationally simple; its calculation is clearly more complicated than HDI, requiring several extra steps and the use of exponents in a penalty formula the effect of which is far from transparent. Neither is GDI conceptually simple; the meaning of an index that adds male penalties to female penalties to result in a gender inequality penalty is obscure. Finally, GDI's use or interpretation is not simple; GDI values are very nearly the same as HDI values. What interpretation can these small differences be given with regards to the state of countries' gender-inequality-adjusted well-being, except that disparities between women and men have little or no effect on human development?

5.3 Conclusions

GDI is a valuable, but flawed, tool. This chapter has endeavored to critically examine GDI's shortcomings in its role as a measure of human development penalized for the extent of gender inequality. The main critiques set out here may be summarized as:

- GDI's underlying data suffer from numerous deficiencies in data availability that have made necessary numerous assumptions in place of actual data values. For most of the source data, these assumed data values are the exception, but in the case of the data used to estimate female and male earned incomes, it may be that more data are assumed than measured.
- Life expectancy, literacy, school enrollment, and income may not be the best collection of capabilities with which to observe gender disparities. Other possible components that might be more appropriate to the task include: access to fuel and water; property rights; incidents of violence against women; gender bias in

education choices; the quality of education; access to employment, training, and job advancement; and access to leisure time.

- The method used to estimate female and male earned incomes ignores: the existence of self-employment; biases in women and men's access to full-time paid work; and the complex nature of intrahousehold distribution of money, goods, and labor.
- The diminishing marginal utility of income is represented in GDI by a cap on income at $40,000 that is applied to one country, but not to others, and by taking the natural logarithm of income. The log of income is taken before the gender inequality penalty is calculated, whereas in HDI taking the log comes in the final step. This difference in the order of operations between HDI and GDI creates a hidden and unintended penalty to GDI.
- Life expectancy, education, and income do not make up equal shares of the value of GDI. Instead, gender disparities in income dominate the GDI penalty.
- In the calculation of GDI, society is assumed to have an aversion to inequality that is equal, on average, to one percent of the value of HDI. This implicit assessment of gender inequality's significance to human well-being seems out of step with the UNDP's own rhetoric regarding the enormous impact of disparities between women and men.
- Female and male disadvantages in capabilities are treated identically in GDI, so that penalties for female deprivations are added to penalties for male deprivations to form a final gender inequality penalty. The meaning of gender inequality in this

sense is difficult to understand, and cannot be at all obvious to the casual user of GDI.

- GDI contains a "missing women," or gender mortality bias. The fewer women in a given country, the less the deprivation of those remaining women counts in GDI's method of measuring human development.
- While GDI ranks differ from those of HDI, GDI values are very nearly the same as HDI values. A measure of human development adjusted for gender inequality that is barely distinguishable from a measure of human development that is neutral to gender inequality seems deeply flawed.
- GDI requires a specialist to calculate and interpret it. A simpler, more straightforward measure would be preferable for the purposes of policy-makers and development professionals.

Several of these critiques are new contributions to the human development literature: the detailed accounting of data assumptions used in calculating GDI, and the demonstrations of the inconsistent use of income caps, the hidden penalty resulting from a reversal in the order of operations, and the gender mortality bias introduced through the female and male population shares.

A measure of human well-being that takes gender inequality into account is an essential element of the portrait of human development contained in the *HDR*s. Klasen (2006: 260) concludes a recent critique of GDI saying:

> I believe it is not useful to continue reporting the GDI as the main indicator for gender-related human development. It is frequently misunderstood and it is beset with serious conceptual and empirical problems. At the same time, it would be useful to re-consider a revised GDI within a range of distribution-sensitive HDIs.

Like Klasen, I believe that GDI is seriously flawed in its current formulation, and that it should be replaced by an improved or corrected GDI.

The following steps are recommended towards improving the resolution of gender inequality in the *HDR*s. First, GDI's Equally Distributed Index formula should be changed, and several suggestions for doing so have been described in this chapter. Second, GDI should be supplemented by measures of gender inequality, and women's and men's level of development to give a more complete picture of human development. Finally, these new formulas should be reported in the *HDR* and evaluated both by academics and by development professionals for clarity and usefulness as tools for demonstrating the existence of, observing changes in, and finally disassembling systems of gender disparities in human development. The next chapter of this dissertation addresses both complements and alternatives to the current GDI, including modifications to improve its quality.[33]

Notes

[1] HDI is the mean of component indices for health (based on average life expectancy), education (based on literacy and school enrollment rates), and income (based on purchasing-power-parity (PPP) adjusted Gross Domestic Product (GDP) per capita.

[2] The GDI values used throughout this chapter are based on the author's replication, made necessary because GDI's component indices and penalties are not reported in the *HDR*s. For 2003 data by gender for all 140 countries, as reported in *HDR 2005*, see Appendix A. For a discussion of the method of replication used in this study and values of component Equally Distributed Indices see Appendix B.

[3] The resulting index should be, but is not, equal to the component index for the whole population as used in HDI. I return to this point below.

[4] A harmonic mean is equal to $n/(1/x_1 + 1/x_2 + \ldots + 1/x_n)$, where n is the number of terms.

[5] For debate regarding the accuracy, meaning, and policy implications of the five-year gap in expected life spans see Dijkstra (2006) and Klasen (2006).

[6] The same result can, of course, be reached by using the normalization formula and applying 0 and 100 as the minimum and maximum values.

[7] GDP and GDP per capita refer to purchasing-power-parity (PPP) adjusted U.S. dollars throughout this chapter.

[8] If the female and male shares of the economically active population are equal ($EA_f/EA_m=1$), then the female to male ratio of shares of the wage bill (S_f/S_m) will equal the female to male wage ratio (W_f/W_m). If instead the female share of the economically active population is larger than the male share ($EA_f/EA_m>1$), then (S_f/S_m) will be greater than (W_f/W_m), and if the female share of the economically active population is smaller than the male share ($EA_f/EA_m<1$), then (S_f/S_m) will be smaller than (W_f/W_m).

[9] For more information on the logarithmic income conversion method now used in HDI and GDI, see Anand and Sen (2000).

[10] Five countries are eliminated for lack of gendered life expectancy data, fifteen for lack of adult literacy rates by gender (including ten countries not previously excluded for lack of life expectancy data), thirteen for lack of gendered enrollment data (including ten countries not previous excluded for lack of data described above), and twenty-three for lack of data necessary to calculate estimated earned income (twelve of which were not previously excluded for missing life expectancy or education data).

[11] Of these 24 countries, the UNDP (2005) reports literacy rates for the whole population (women and men combined) in only four countries: Italy (98.5 percent), Spain (97.7 percent), Portugal (92.5 percent), and the Republic of Korea (97.9 percent).

[12] For a discussion of the disparate definitions of labor force participation and earnings used within and between countries see Prabhu et al. (1996).

[13] The HDR uses life expectancy data from the UN's World Population Prospects: The 2004 Revision Population Database, which defines life expectancy at birth as "the average number of years of life expected by a hypothetical [5-year] cohort of individuals who would be subject during all their lives to the mortality rates of a given period."

[14] For other, more general discussions of which variables to include when measuring women's well-being see Robeyns (2003), Austen et al. (2003), and Charmes and Wieringa (2003).

[15] See Bardhan and Klasen (1999, 2000); Charmes and Wiering (2003); Dijkstra (2002, 2006); Dijkstra and Hanmer (2000); Klasen (2006); and Prabhu et al. (1996).

[16] See also Iversen (2003) on intra-household inequality, Cantillon and Nolan (2001) on poverty within households, and Folbre (2006) on including the care economy in measures of human development.

[17] This exception to the GDI formula is not explained in the *HDRs* (UNDP 2005).

[18] Using this method, when $\varepsilon = 0$, Luxembourg's Equally Distributed Income Index would be much small than its income index in HDI.

[19] Weighted-HDI is GDI with $\varepsilon = 0$, which, according to the UNDP (2005), is equal to the HDI, or more accurately, the HDI weighted by the female and male population shares. The population shares should be implicit in each of the HDI components.

[20] Note that each of the six sub-penalties is divided by three before being combined to form the total penalty.

[21] If Penalty = HDI – $GDI^{(\varepsilon = 2)}$ and HDI = $GDI^{(\varepsilon = 0)}$, then Penalty should = $GDI^{(\varepsilon = 0)} - GDI^{(\varepsilon = 2)}$. Instead, Penalty = $(HDI - GDI^{(\varepsilon = 0)}) + (GDI^{(\varepsilon = 0)} - GDI^{(\varepsilon = 2)})$.

[22] From 1995 to 1998, GDI was calculated using a different discounting method, which was applied after the weighting and penalty procedure. In *HDR 1999*, GDI was changed in both the discounting method and the order of operations to the current formula. The latter change was prompted by Bardhan and Klasen's (1999) argument that

applying the penalty before discounting resulted in disproportionately higher penalties for richer countries (993). Dijkstra (2002, 2006) has argued that Bardhan and Klasen's critique was incorrect and that discounting before applying the penalty in effect discounts the gaps as well as the values, thereby reducing the overall penalty (308-309).

[23] Except in EDH, where female life expectancy has five years subtracted from it and the male goalposts, 22.5 and 82.5, are used; for Weighted-HDI, five years is not subtracted and the goalposts are the regular 25 and 85.

[24] See also Klasen (2006); note that Klasen is measuring the gender penalty as the difference between the Weighted-HDI and the GDI, whereas here the penalty is the difference between the HDI and GDI.

[25] Throughout this chapter, HDI ranks have been recalculated to exclude 37 countries left out of GDI for lack of gendered data.

[26] Other critiques of the UNDP's choice of values for ε in GDI include Bardhan and Klasen 1999, and Dijkstra and Hanmer 2000. For further discussion on the choice of ε in this type of welfare measure see Grün and Klasen (2003).

[27] See Dijkstra (2002); Dijkstra and Hanmer (2000); Klasen (2006);and UNDP (1995: 74).

[28] A technical note to *HDR 1995* (UNDP 1995: 131) recognizes this issue, but concludes that it is not an important concern because it occurs in very few countries and those countries are at the highest levels of human development.

[29] See Schüler (2006) on misinterpretations of GDI in scholarly articles as well as UNDP reports.

[30] For further discussion of this topic see Klasen (2006).

[31] See also Kanbur and Mukherjee (2003) and Klasen (2006).

[32] See Bardhan and Klasen (1999); Charmes and Wieringa (2003); Dijkstra (2006); Dijkstra and Hanmer (2000); Klasen (2006); and Schüler (2006).

CHAPTER 6

ALTERNATIVE MEASURES OF GENDER INEQUALITY IN HUMAN DEVELOPMENT

From the earliest editions of its *Human Development Report*, the United Nations Development Program (UNDP 1991: 92) has declared its intention to take gender inequality seriously: “Of the many inequalities in human development, the most striking is that along gender lines.” Beginning with *HDR 1990*, UNDP has documented disparities between women and men’s well-being by reporting gendered data for life expectancy, literacy, school enrollment, and participation in the labor force and in government.

In 1995, the UNDP (1995: 23) called gender inequality the “persistent neglect to the creativity and productivity of half of humanity,” and began gauging levels and changes in gender parity in human development using the Gender-related Development Index (GDI). GDI is a gender-inequality-adjusted version of the Human Development Index (HDI), a very well-known measure of social welfare, if not among the general public, then certainly among policy-makers, development professionals, social scientists, and political journalists.[1] HDI is commonly referred to when explaining that the standard of living in one country or region is superior to that of another, or when describing a change in a particular country’s level of well-being over time.

In contrast, GDI is little known, seldom referenced, and poorly understood. An article in the *Journal of Human Development*’s recent special issue on gender (Schüler 2006) describes the frequent misuses of GDI, even in UNDP reports, concluding that GDI is “rarely and inappropriately used.” This and other articles in the same special issue (Dijkstra 2006; Klasen 2006; Schüler 2006) document the demand for gendered measures of human development and describe a proliferation of measures of gender inequality, but GDI, the most widely published measure, receives little attention.

In this chapter, I argue that the cause of this disregard is GDI's failures in the realm of common-sense or intuitive explanatory power. GDI is anything but intuitive. Indeed, it is counter-intuitive in at least three ways: first, in what it is measuring; second, in the way it is measuring it; and finally, in the results of this measurement. I then articulate and demonstrate a series of alternatives to GDI as currently formulated. These alternatives aim: first, to measure what the "woman in the street" would expect needs to be measured; second; to measure this using a method that makes immediate, intuitive sense; and finally, to produce results that credibly depict our common understanding of the state of gender equity within and between countries.

6.1 Measuring Gender Inequality?

The Gender-related Development Index, GDI, has a somewhat ambiguous name. It could plausibly be any one of the following:

a) A measure of women's human development.
b) A measure of inequality in human development between women and men.
c) A measure of human development adjusted downward for female deprivations in well-being.
d) A measure of human development adjusted downward for both female and male deprivations in well-being.

Indeed, three of these potential explanations for GDI have seemed plausible to reporters in English-language news sources around the world, in the some of the very few news stories that have discussed GDI:

a) *A measure of women's human development*: "The United Nations placed Norway at the top of…the Gender Development Index…which assess[es] women's quality of life..." (*The Guardian*, April 12, 2004)

b) *A measure of inequality in human development between women and men*: "*Machismo* is a concept perhaps by now indelibly linked with Latin America. Sticklers for precision, however, may have to revise that link in the light of the UNDP's latest *Human Development Report,* which has introduced what they call a 'Gender-related Development Index', [which] attempts to measure the inequality between the sexes." (*Latin America Weekly Report*, March 7, 1996)

c) *A measure of human development adjusted downward for female deprivations in well-being*: "The GDI, Licuanan said, reflects gender disparities in basic human capabilities. 'The GDI measures achievement in the same basic capabilities as the HDI, but takes note of inequality in achievement between men and women.…[Using GDI] one can estimate that in no society do women enjoy the same opportunities as men.'" (*New Straits Times* (Malaysia), April 25, 1996)

GDI is actually (d): a measure of human development adjusted downward for both female and male deprivations in well-being. In GDI, the effects of disparities in favor of females and males are cumulative, not offsetting.

6.2 Measuring Gender Inequality in Human Development

GDI is counter-intuitive not only in what it is measuring but in its methodology as well. The GDI formula has several steps. First, for each of its three component indices – health, education, and income – each country's values for females and males are first compared to a stylized expected range in order to normalize them to fall between 0 and 1. The gendered Health Indices, measured by life expectancy rates, have a styled range with endpoints of 27.5 and 87.5 for females and 22.5 and 82.5 for males; the five-year gap is attributed to the difference in average life-spans by gender. The gendered Education Indices are each a weighted average of that gender's literacy and school enrollment rates, where the endpoints are 0 and 100.[2] In the gendered Income Indices, the natural logarithm of income is compared to the logged minima and maxima, \$100 and \$40,000. This logarithmic transformation is included to account for the diminishing marginal utility of income: the more money we have, the smaller the impact of an additional unit of money on our well-being.

$$\text{(1a) Female-H-Index}_i = \frac{\text{Female LE}_i - 27.5 \text{ years}}{87.5 \text{ years} - 27.5 \text{ years}}$$

$$\text{(1b) Male-H-Index}_i = \frac{\text{Male LE}_i - 22.5 \text{ years}}{82.5 \text{ years} - 22.5 \text{ years}}$$

$$\text{(2a) Female-E-Index}_i = 2/3(\text{Female Literacy Index}_i) + 1/3(\text{Female Enrollment Index}_i)$$

$$\text{(2b) Male-E-Index}_i = 2/3(\text{Male Literacy Index}_i) + 1/3(\text{Male Enrollment Index}_i)$$

$$\text{(3a) Female-Y-Index}_i = \frac{\ln(\text{Female Y}_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

$$\text{(3b) Male-Y-Index}_i = \frac{\ln(\text{Male Y}_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

where the subscript i indicates the country. The closer that a country's indicator value is to the stylized maximum, the closer that index value is to 0, while indicator values that approach the stylized minimum return index values close to 1.

Next, the female and male indices thus created are combined, along with the female and male population shares (FemalePopShare and MalePopShare) for each country, in what is called an Equally Distributed (ED) Index. The formulae for the Equally Distributed Health (EDH), Equally Distributed Education (EDE), and Equally Distributed Income (EDY) Indices are:

$$\text{(1c) EDH}_i = [(\text{FemalePopShare}_i * \text{Female-H-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-H-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

$$\text{(2c) EDE}_i = [(\text{FemalePopShare}_i * \text{Female-E-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-E-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

$$\text{(3c) EDY}_i = [(\text{FemalePopShare}_i * \text{Female-Y-Index}_i^{1-\varepsilon}) + (\text{MalePopShare}_i * \text{Male-Y-Index}_i^{1-\varepsilon})]^{1/1-\varepsilon}$$

where ε = 2. The ED Index, therefore, is the harmonic mean of the female and male indices weighted by their respective population shares. To simplify (generalizing for all three components):

$$(4)\ \text{ED-Index} = \frac{1}{\dfrac{\text{FemalePopShare}}{\text{Female-Index}} + \dfrac{\text{MalePopShare}}{\text{Male-Index}}}$$

The effect of a harmonic mean like the Equally Distributed formula is as follows: If the female and male indices are equal, then the ED Index is their arithmetic mean value, weighted by the population shares; this result would approximate the component's value in HDI. If, on the other hand, there is a gap between the female and male indices, a penalty is assessed: The bigger the gap between the gendered indices, the bigger the difference between the arithmetic mean (or Index^{HDI}) and the harmonic mean (or ED-Index^{GDI}). The difference between the component Index^{HDI} and the component ED-Index^{GDI} is the gender-inequality penalty for that component. Thus, implicitly, each ED Index is composed of two parts: HDI's gender-inequality-neutral component index and a penalty for gender inequality. Using the EDH as an example:

$$(5)\ \text{H-Index}^{HDI} - \text{EDH-Index}^{GDI} = \text{H-Penalty}$$

and therefore:

$$(6)\ \text{EDH-Index}^{GDI} = \text{H-Index}^{HDI} - \text{H-Penalty}$$

In this way, any disparity in health, education, or income between women and men – regardless of the direction of the disparity – results in a penalty for gender inequality. To be clear, a positive penalty for female disparity in income would be added to a positive penalty for a male disparity in life expectancy; these penalties would not cancel one another out.

In the final step in calculating GDI, the EDH, EDE, and EDY are combined in a simple, unweighted average:

$$(7)\ GDI_i = (1/3)EDH_i + (1/3)EDE_i + (1/3)EDY_i$$

Like its component indices, the resulting GDI comprises two parts: HDI and a penalty for any gender disparities in human development (or the difference between HDI and GDI):

$$(8)\ GDI_i = HDI_i - Penalty_i$$

Where the total gender-inequality penalty for GDI is the average of the three component penalties:

$$(9)\ Penalty_i = (1/3)H\text{-}Penalty_i + (1/3)E\text{-}Penalty_i + (1/3)Y\text{-}Penalty_i$$

That HDI could be penalized for the extent of a country's gender inequality to arrive at a measure of human development that takes into account the degree to which the well-being of a society as a whole suffers as a result of gender disparities is easy enough to understand. What seems counterintuitive is not the existence of this penalty, but its nature. The result of adding female disadvantages on top of male disadvantages to sum up to a final gender inequality penalty is difficult to interpret.

More generally, while the ED formula (also called Atkinson's welfare measure, $W(x) = (\Sigma^{n}_{k=1} x_k^{1-\varepsilon})^{1/1-\varepsilon}$) is technically attractive in its ability to penalize mean values of well-being for the existence of gaps between groups, when presented in the form of a composite index it fails to illuminate what is most interesting about these sorts of gaps in at least two ways.[3] First, to the extent that our interest lies in determining the differences in well-being between two groups, the summation of several composite Atkinson welfare measures will inevitably leave us with an uninterpretable jumble in which all of the interesting features about these groups are thrown into a common soup. The exception, of course, is the case in which one group always and everywhere has lower well-being in all of the composite measures. Without this condition, adding together disparities in well-being experienced by more than one group leaves us with a penalty that may have some technical meaning, but offers little insight into the effects of each group's advantages and disadvantages.

Second, often what is most interesting about differences in well-being among groups is not a comparison of the same group (say, women) in different locales (for example, a comparison between Bulgarian women and Bolivian women), but rather a comparison between groups in the same locale (women and men in Bulgaria). Even if women did have average levels of health, education, and income that were always and everywhere lower than those of men – thereby rendering the GDI a more insightful measure, human development penalized for the extent to which women's well-being is lower than men's – we could still only use GDI to talk about differences between countries and not differences within a single country.

Certainly, GDI contains this information (that is, the extent of gender inequality within each country, or the GDI penalty) but to access this information we would have to perform an additional calculation: HDI less GDI. The *Human Development Reports* neither report the GDI penalty nor explain that the difference between HDI and GDI can be interpreted as a measure of gender inequality. For successful interpretation of this data, we need to know both the level of human development and the extent of gender inequality; their sum provides an interesting, but insufficient, viewpoint. The UNDP has chosen to centerpiece a gender-inequality-adjusted version of HDI which is by no means transparent and in which the gender-neutral quality of its penalties is left unexplained. The result is frequent misinterpretations of GDI.

In addition, UNDP's chosen measure, GDI, contains several serious technical problems (discussed in detail in Chapter 5 of this dissertation): 1) its estimates of female and male income ignore the complexities of disaggregating household income, and are based on scarce data and numerous assumptions; 2) its logarithmic transformation, included to adjust for diminishing marginal returns to income, takes place in a different steps in the GDI and HDI formulas, which greatly limits their comparability; and 3) its use of female and male population shares introduces an unintended gender mortality bias such in that countries with disproportionately small female population, female deprivations are given less weight in the GDI penalty and male deprivations are given more weight.

6.3 Interpreting GDI Values

Another test of GDI's intuitiveness is, given what we know about gender inequality, how well does GDI match our *a priori* expectations of its values in comparison to HDI values:

- We know, from the structure of the ED formula, that GDI can never be larger than HDI (the gender inequality penalty cannot be negative).
- We would expect the differences between GDI and HDI to be appreciable, that is, given that disparities exist between women and men in the real world, we would expect to be able to observe them in the size of the gender inequality penalty.

- It also seems plausible that there would be a relationship between the level of human development and the size of the gender inequality penalty, although the nature of this relationship would be difficult to predict with any certainty.

Figures 6.1 through 6.4 represent different *a priori* ideas of the relationship between the GDI Penalty and HDI. All four figures display the first assumption; there are no negative GDI penalties. Figure 6.1 is a counter-example to the second assumption; we expect there to be differences between HDI and GDI, but in Figure 6.1, there are none (as if every country had no gender inequality whatsoever and GDI equaled HDI). In Figure 6.2, there is no relationship between the level of human development and GDI: the GDI Penalty is randomly distributed between 0 and 1. Figures 6.3 and 6.4 show two possible types of this relationship, an absolute gap (GDI is always the same amount less than HDI) and a relative gap (lower human development levels correspond to larger GDI Penalties).

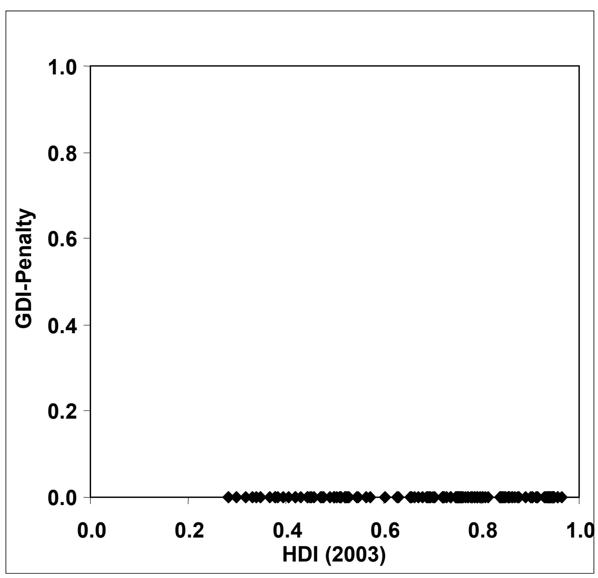


Figure 6.1: GDI Penalty-Zero versus HDI

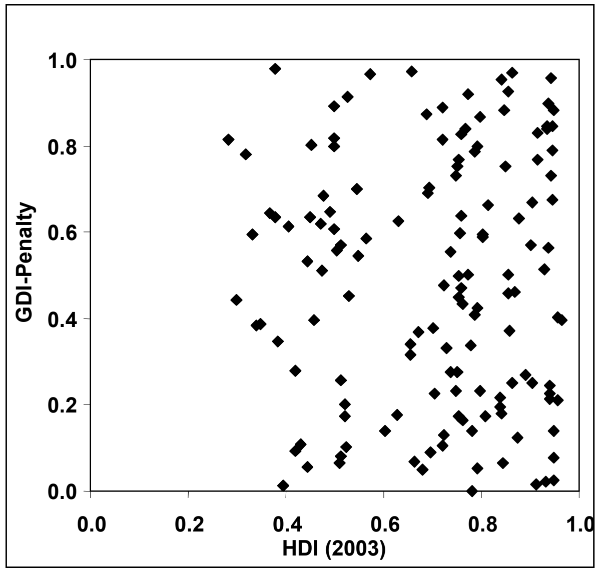


Figure 6.2: GDI Penalty-Random versus HDI

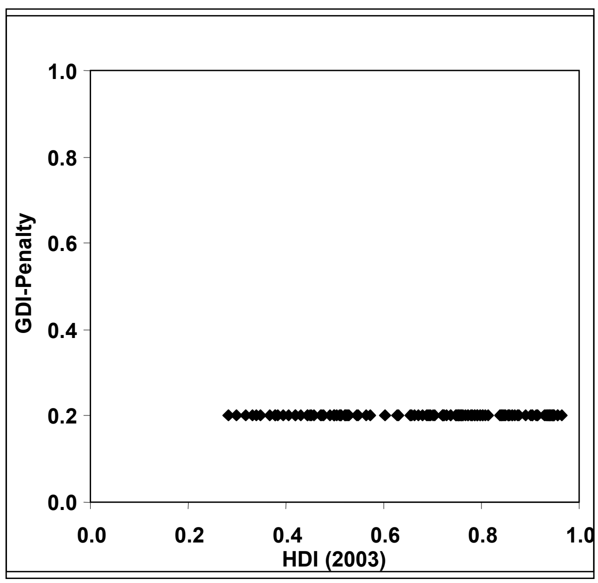


Figure 6.3: GDI Penalty-Absolute versus HDI

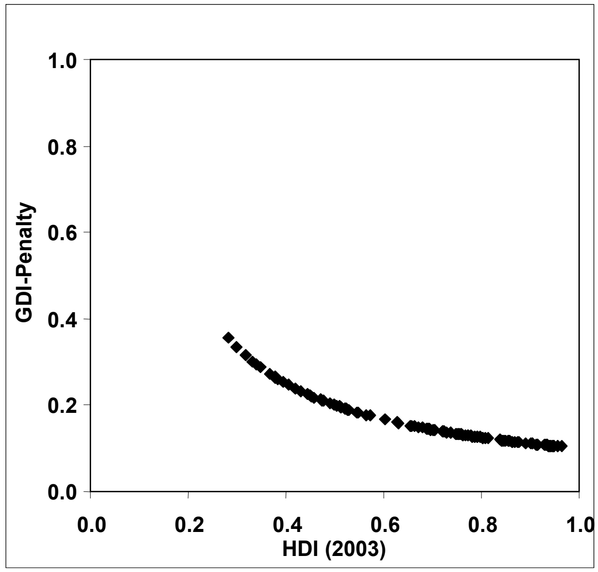


Figure 6.4: GDI Penalty-Relative versus HDI

Source: Author's calculations.

The actual scatterplot of GDI Penalties versus HDI values for 2003 data is shown in Figure 6.5. GDI Penalties range from 0.001 to 0.040. The average gap between GDI and HDI is 0.008 or 1.3 percent of HDI, a size that is difficult to reconcile with the UNDP's (1995) depiction of large scale gender disparities that are relevant to the welfare of the entire society.

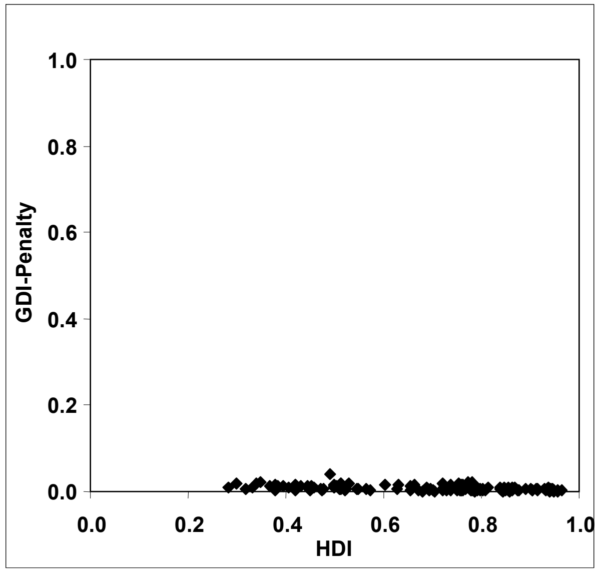


Figure 6.5: GDI Penalty-Actual versus HDI (2003)

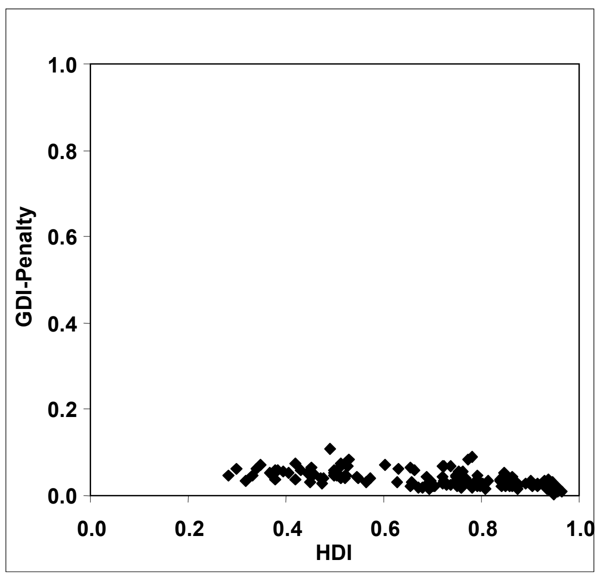


Figure 6.6: GDI (ε = 200) Penalty versus HDI (2003)

Source: Author's calculation using HDR 2005 data.

6.3.1 Inequality aversion parameter

One important factor in determining the size of the gender inequality penalty in GDI is the UNDP's choice of the parameter value representing society's aversion to gender inequality's such that ε = 2. The UNDP describes ε = 2 as a "moderate" emphasis on gender inequality, but the resulting minute gender inequality penalty – only about one percent of total human development – begs the question, is gender inequality small or is society's aversion to gender inequality small? If the value of GDI's ε were set to 200, as shown in Figure 6.6 above, the average gap between GDI and HDI would be 0.038 or 6.4 percent of HDI.[4] For comparison, when average gap between female and male component indices is compared to the average value for each component's index in HDI, the gaps amount to 5.2 percent of health, 9.1 percent of education, and 17.1 percent of income.

Society's aversion to inequality, of course, may be smaller than the inequality itself, but who do we mean by society and in what way does a "society" construct a collective idea of aversion? For example, it is not impossible that in some societies gender inequality in access to education or income could be perceived in a positive light – at least among national policy makers; similarly, gender inequality could be perceived as a characteristic of society that has both costs and some compensatory benefits to aggregate social welfare.

Alternatively, one could argue – in the style of many of the arguments of neo-classical economics – that if society had an aversion to gender inequality, then it would have already eliminated it and that, *ipso facto*, society does not perceive current disparities as iniquitous and, therefore, has no aversion to these disparities. In contrast, on one could argue that society's aversion to gender disparities is proportional to the extent of actual gender disparities, where perfect information about these inequities would result in a one to one relationship between the size of the inequality and the size of the aversion. Doubtless, the truth lies somewhere in between, and a relationship between gender-inequality and HDI that looked something like Figure 6.6 comes closer to that truth than that implied by the current measure.

6.3.2 Convexity in the Penalties

Also of concern is the convexity of the component penalties with respect to the gap between female and male index values. Assuming, for simplicity, that female and male population shares are equal, it can be shown that each component penalty is a convex function of the difference between the female and male component indices, or gender gap (GGap) (see Appendix A for a full proof). Using the education component as an example:

$$\text{(10) E-Penalty} = \frac{(\tfrac{1}{2}\text{E-GGap})^2}{\text{E-Index}^{\text{HDI}}}$$

where:

$$\text{(9) E-Gap} = \text{Male-E-Index} - \text{Female-E-Index}$$

The relationship between the component penalties and the gender gaps is depicted in Figure 6.7:

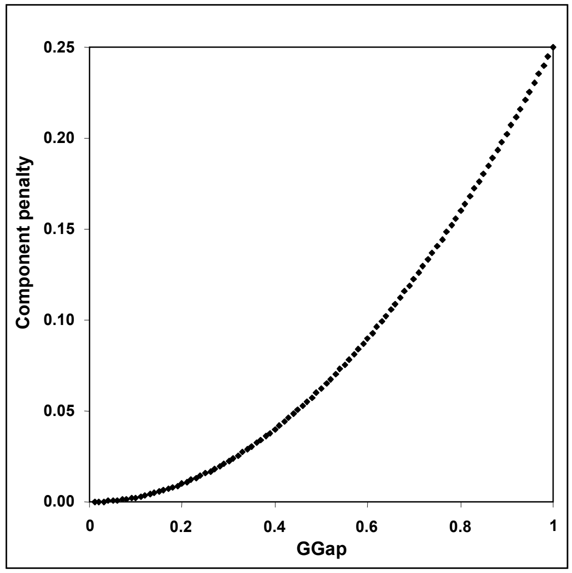


Figure 6.7: Component Penalties versus Gender Gaps

This being the case, the size of the penalty associated with a given *percentage gap* between female and male index values (PercentageGGap, or the ratio of the GGap to the component index in HDI), can be written as:[5]

$$(10)\ \text{E-Penalty}_i = (\tfrac{1}{2}\text{E-PercentageGGap}_i)^2 * \text{E-Index}^{HDI}$$

A given percentage, X, in the education gender gap results in a percentage change to the E-Penalty of $(\frac{1}{2}X)^2$. For example, a one percent gap between the Female-E-Index and Male-E-Index results in a E-Penalty that is 0.003 percent of the E Index, whereas a 20 percent gap would result in one percent penalty. Any given percentage gap returns the same percentage penalty, regardless of the level of E-Index, but the size of the percentage GDI penalty is always much smaller than that of the percentage gap between female and male indices. For example, if the Male-E-Index is 0.720 and the Female-E-Index is 0.880 (a 20 percent gap compared to the E-Index^{HDI}, 0.800), the E-Penalty would be 0.008 and EDE would be 0.792. When gender disparity is 20 percent of the mean indicator value yields an aversion to that inequality of just one percent does not seem "moderate."

To sum up: GDI as currently formulated fails to provide a common sense measurement of gender disparity in human development. It lacks clarity: it is frequently misunderstood and difficult to interpret when well understood. It lacks transparency: it adds together disparities to women and men, and it contains hidden biases and heroic assumptions. It lacks legitimacy: the small penalties assigned to gender inequality don't add up to a world in which deprivations in women's well-being are serious and need to be taken seriously. The objective of the remainder of this chapter is to set out a series of common-sense alternatives to GDI.

6.4 Building Common-Sense Alternatives

In creating common-sense alternatives to GDI, I began by imagining what it is that the "woman in the street" would expect needs to be measured given the goal of illustrating gender disparity in well-being. One approximation of this is provided by journalists' misconceptions of what GDI actually is, as discussed above (on the grounds that what people have imagined GDI to be must make more intuitive sense to them than what it actually is). To illustrate gender disparity in human development, therefore, would require not one but several indices:

A measure of women's human development;

A measure of inequality in human development between women and men; and

A measure of human development reduced by female deprivations in well-being.

The sections that follow introduce a series of six measures that, taken together, are designed to replace GDI with a more comprehensive picture of gender disparities in human development. In formulating these measures I have tried to keep in mind the objectives of clarity, transparency, and legitimacy as discussed above. Each of these measures has an intuitive appeal not only in what is being measured, but also in how it is measured and in what the resulting measurements mean.

6.4.1 Women's absolute human development

The first two indices in the series designed to replace GDI are separate measures of women's human development and men's human development, which calculate HDI as if a country were populated entirely by one gender. Female and Male-HDIs have different ranges of life expectancies: 27.5 to 87.5 years for women, and 22.5 to 82.5 years for men. Adult literacy and school enrollment indices are calculated as in HDI, but using gendered data, and in the absence of a good measure of how household income is distributed, the UNDP's "estimated earned income" is used to calculated female and male Income Indices.[6]

$$(11)\ \text{Female-HDI}_i = (\text{Female-H-Index}_i + \text{Female-E-Index}_i + \text{Female-Y-Index}_i)/3$$

$$(12)\ \text{Male-HDI}_i = (\text{Male-H-Index}_i + \text{Male-E-Index}_i + \text{Male-Y-Index}_i)/3$$

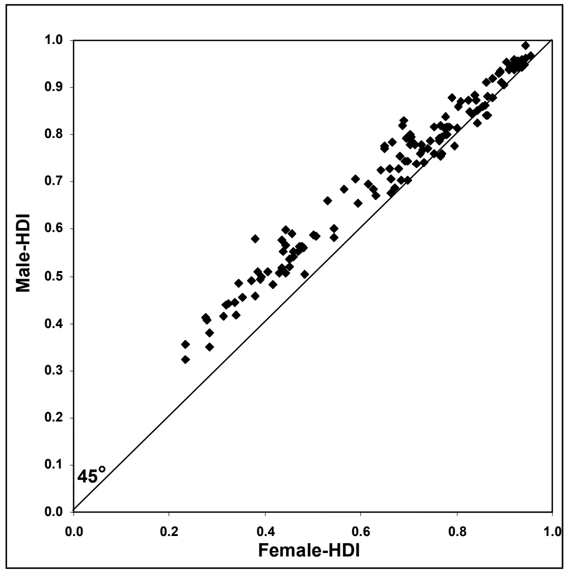
Table 6.1 shows a comparison between Female and Male-HDIs for the countries with the greatest differences in ranks by these two measures. (In Appendix Table B1, the two sets of HDIs have been ranked together, such that 140 "female countries" and 140 "male countries" are ranked from 1 to 280, so that disparities can be observed both among genders and between genders.) Differences in rank by Female-HDI and Male-HDI are as large as 34 in Oman (where Male-HDI is higher) and 25 in Belarus (where Female-HDI is higher).

Table 6.1: Female and Male HDIs ranked together (2003)

Country		Female HDI Rank	Female HDI Value	Country		Male HDI Rank	Male HDI Value	F-HDI less M-HDI
Female	Belarus	45	0.795	Male	Belarus	70	0.777	-25
Female	Ukraine	53	0.770	Male	Ukraine	75	0.761	-22
Female	Kazakhstan	55	0.767	Male	Kazakhstan	79	0.754	-24
Female	Jamaica	63	0.733	Male	Jamaica	82	0.740	-19
Female	Oman	79	0.689	Male	Oman	45	0.831	34
Female	Saudi Arabia	80	0.686	Male	Saudi Arabia	47	0.819	33
Female	Iran	85	0.666	Male	Iran	65	0.785	20
Female	Lesotho	103	0.482	Male	Lesotho	122	0.505	-19
Female	Yemen	125	0.379	Male	Yemen	105	0.580	20

Source: Author's calculations using HDR 2005 data.

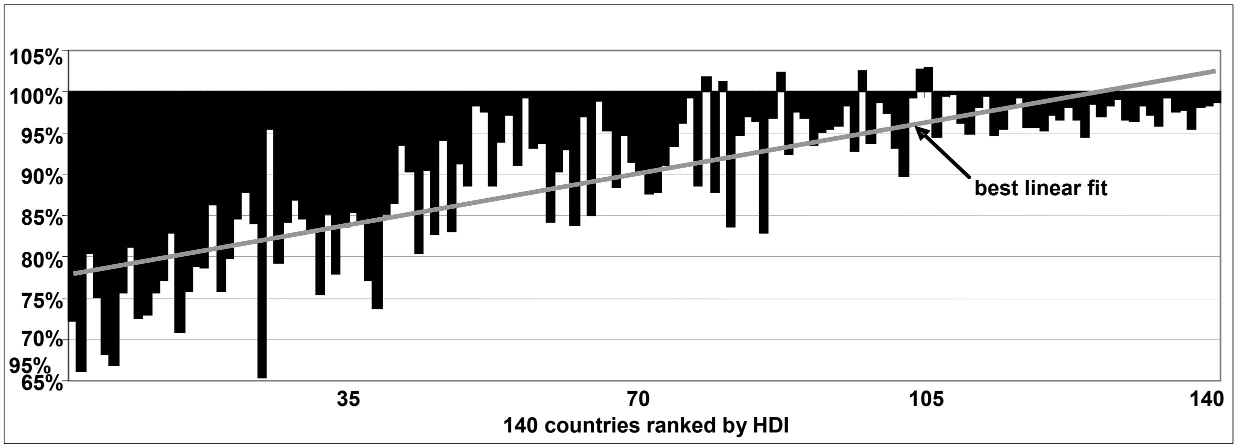
Figure 6.8 is a scatterplot of Male versus Female-HDI values. For the vast majority of countries, Male-HDI is higher than Female-HDI, and the difference between them tends to be smaller in the countries with higher human development levels (see also, Figure 9 below). In six countries, Female-HDI is larger than Male-HDI: Belarus, Estonia, Kazakstan, Latvia, Lithuania, and Ukraine. While their reported female and male adult literacy rates are identical, all six of these countries have much higher female than male enrollment ratios at the university level; their female to male gross tertiary enrollment rates range from 1.66 in Estonia and Latvia, to 1.07 in Belarus. The effect of this female advantage in school enrollment is, however, more than cancelled out by male advantage in income. The anomalous results of these countries are driven instead by the confluence of both higher education levels and a female advantage in life expectancy of 8 to 12 years, exceeding the expected five-year gap.



Source: Author's calculation using HDR 2005 data.

Figure 6.8: Male-HDI vs Female-HDI

Female and Male-HDIs were reported in a technical note to the first *HDR*, with GDP per capita used in place of a measure of gendered income because of a lack of data; among 130 countries, Japan ranked first and Niger last by Female-HDI (UNDP 1990: 110-111). *HDR 1990* stated that, "among countries with very similar HDIs there is enormous variation in the female-male disparity, particularly among countries belonging to the low and medium HDI groups," and demonstrated this result by graphing Female-HDI as a percentage of Male-HDI. This same observation still holds for the 2003 data, as shown in Figure 6.9 below.



Source: Author's calculations using HDR 2005 data. This chart is a replication (using 2003 data) of the one found in HDR 1990 on p.110.

Figure 6.9: Female HDI as a percentage of Male HDI (2003)

6.4.2 Women's relative human development

The second two indices in the series proposed to replace GDI are measures of inequality in well-being between women and men. Using the Female and Male-HDIs of the previous section, two simple measures of gender inequality – or of women's relative human development – are possible: the absolute gap between Female and Male-HDI (the Absolute Gender Gap or AGG), and the gender gap as a percentage of HDI (the Relative Gender Gap or RGG).

$$(13)\ AGG_i = \text{Male-HDI}_i - \text{Female-HDI}_i$$

$$(14)\ RGG_i = \frac{AGG_i}{HDI_i}$$

Table 6.2 shows rankings for a selection of countries for both the AGG and the RGG. (For AGG and RGG results for all 140 countries see Appendix Table B2).

Table 6.2: Absolute Gender Gap and Relative Gender Gap (2003)

AGG	Rank	Value	RGG	Rank	Value
Hungary	7	0.003	Hungary	7	0.37%
Poland	8	0.004	Poland	8	0.45%
Kyrgyzstan	9	0.005	Barbados	9	0.56%
Barbados	10	0.005	Kyrgyzstan	10	0.66%
Armenia	11	0.005	Slovenia	11	0.66%
Côte d'Ivoire	136	0.141	Côte d'Ivoire	136	33.63%
Togo	137	0.142	Chad	137	37.83%
Oman	138	0.142	Guinea-Bissau	138	39.33%
Pakistan	139	0.158	Sierra Leone	139	40.32%
Yemen	140	0.201	Yemen	140	41.19%

Source: Author's calculation using HDR 2005 data.

Using either measure, the first six countries by rank are the six countries discussed above that have higher Female HDIs than Male HDIs. Hungary ranks seventh by both AGG and RGG; its gender gap is 0.003 or 0.4 percent of HDI. Yemen ranks lowest with an AGG of 0.201 and RGG of 41.2 percent. Figures 6.10 and 6.11 plot AGG and RGG, respectively, against HDI. By these measures it is clear that lower levels of human development are associated with larger disparities between female and male well-being.

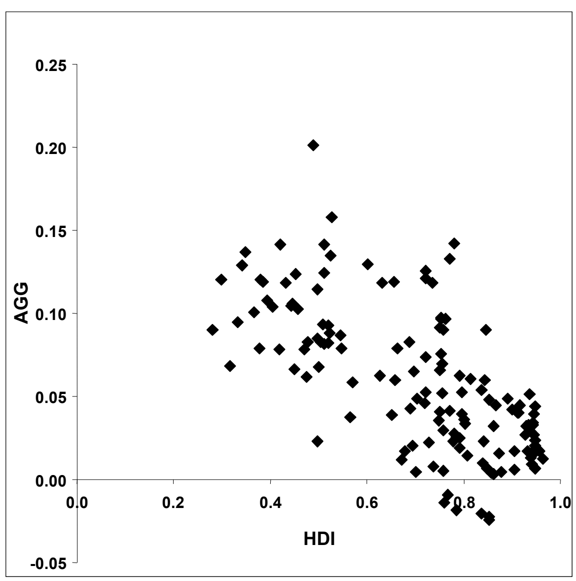
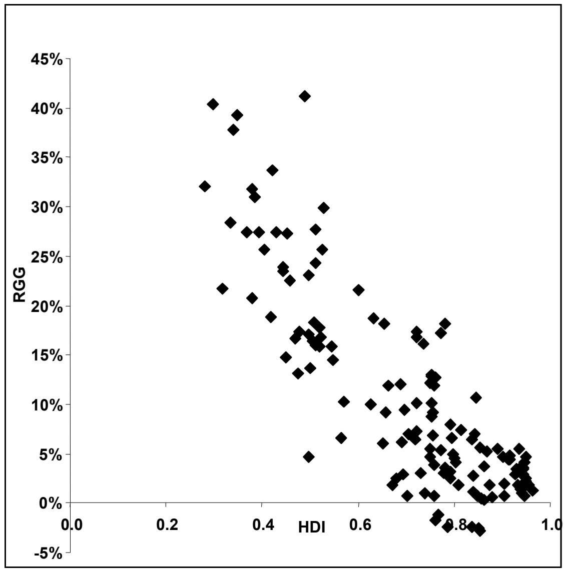


Figure 6.10: AGG versus HDI (2003)



Source: Author's calculation using HDR 2005 data.
Figure 6.11: RGG versus HDI (2003)

6.4.3 Overall human development

The fifth measure necessary for a complete picture of gender disparity in human development is a direct alternative to GDI – a measure of human development penalized for the extent that an entire country's well-being suffers as a result of deprivations to women. The measure of overall human development that is proposed here is called the HDI-G to emphasize the necessity of including measures of distribution – including gender distribution – in HDI itself, and not merely adding an additional GDI measure while maintaining the gender-inequality-neutral HDI as the primary indicator.

HDI-G adjusts each HDI component for the extent of gender inequality in that component, but, unlike GDI, uses an equal weighting procedure so that the size of the component penalty is equal to the size of the component gap in percentage terms, in the style of Ahuwalia and Chenery's (1974) equal weighting scheme. Each Equally Weighted (EW) Index weights the HDI component index by one minus the percentage gap between the female and male indices.[7]

$$(15)\ \text{EWH-Index}_i = \text{H-Index}_i - (\text{Male-H-Index}_i - \text{Female-H-Index}_i)$$

$$(16)\ \text{EWE-Index}_i = \text{E-Index}_i - (\text{Male-E-Index}_i - \text{Female-E-Index}_i)$$

$$(17)\ \text{EWY-Index}_i = \text{Y-Index}_i - (\text{Male-Y-Index}_i - \text{Female-Y-Index}_i)$$

$$(19)\ \text{HDI-G}_i = 1/3\text{EWLE-Index}_i + 1/3\text{EWE-Index}_i + 1/3\text{EWY-Index}_i$$

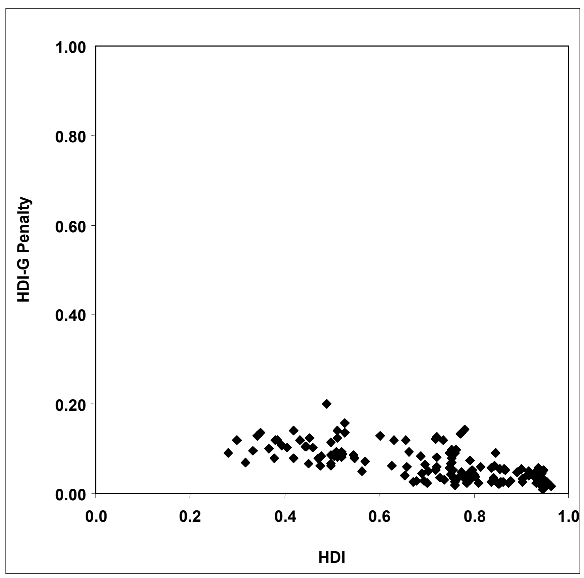
In those cases in which the gender gap is negative (where a female index is greater than a male index), the gap is entered into the EW formula as zero. HDI-G measures human development penalized for the extent of deprivations to women, and not the extent of the deprivations to men (the problem of negative gender gaps will be considered more fully below). The result of the EW formula is that a one percent gap in life expectancy, for example, becomes a one percent penalty to the H-Index^{HDI}.

Table 6.3: HDI-G (2003)

HDI-G rank	Country	HDI-G	HDI-G Penalty	HDI-G rank	Country	HDI-G	HDI-G Penalty
3	Switzerland	0.936	0.010	131	Côte d'Ivoire	0.278	0.141
1	Norway	0.947	0.016	120	Togo	0.370	0.142
2	Australia	0.937	0.018	85	Oman	0.639	0.142
7	Finland	0.923	0.018	119	Pakistan	0.370	0.158
8	Denmark	0.921	0.020	129	Yemen	0.288	0.201

Source: Author's calculations using HDR 2005 data.

Norway ranks first with a total penalty of 0.016 and a HDI-G of 0.947, and Niger ranks last with a penalty of 0.059 and a HDI-G of 0.223. Table 6.3 shows HDI-Gs for the countries with the smallest and largest HDI-G Penalties. The largest penalty assigned, 0.201, is to Yemen where the HDI-G is 0.288. (For HDI-G results for all 140 countries see Table 6.3.) The HDI-G method of taking into account the impact that female deprivations in human development have on a whole society's well-being avoids several of the pitfalls of GDI. The meaning of the HDI-G is clear: a measure of human development reduced by female deprivations in well-being. The formula for HDI-G is transparent: the penalty assigned is exactly the size of the gap between women and men's well-being in each component index. As for HDI-G's legitimacy, its relationship with gender-inequality-neutral HDI fits the basic *a priori* assumptions discussed above: HDI-G is always smaller than HDI; the gender-equality penalty is apparent in the three available significant figures; and there is a relationship between the level of HDI and the size of the penalty such that countries with higher human development levels tend to have smaller gender inequality penalties (see Figure 6.12).

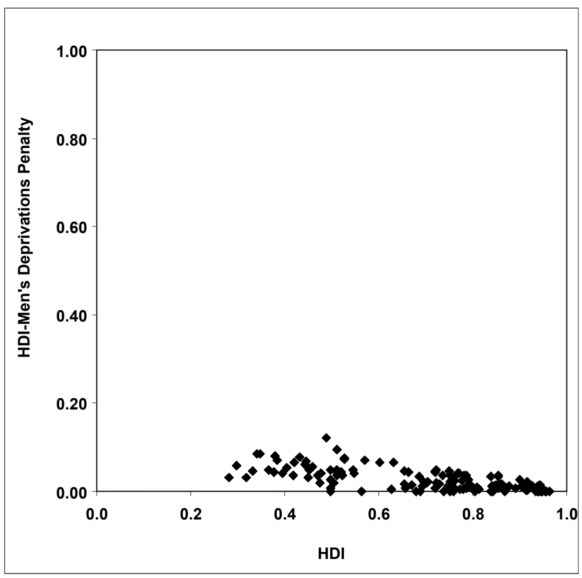


Source: Author's calculation using HDR 2005 data.

Figure 6.12: HDI-G Penalty versus HDI (2003)

6.4.4 Deprivations in men's well-being: Negative gender gaps

Finally, many countries have one or more indicators – life expectancy, adult literacy, or school enrollment – in which men score worse than women. HDI-G, the alternative to GDI proposed above, ignores these cases by counting them as having no gender inequality in that component. The cases in which men's index measures are lower than women's are both important and interesting, and they deserve close examination. But including these cases as "gender disparity" in the HDI-G would not aid researchers' or policy-makers' ability to look closely at these particular cases or at the nature of gender inequality more generally. If our concern is gender inequality as it is most commonly used to mean advantages to men, then lumping together women's and men's disparities only muddies the waters. If instead our concern is those cases in which men's well-being has fallen behind women's, then a HDI can be tailored to that specific issue by only counting the absolute value of negative gaps using the HDI-G formula, and ignoring positive gaps. The final measure in the series of replacements for GDI is the HDI-Men's Deprivations (see Figure 6.13).



Source: Author's calculation using HDR 2005 data. In calculating HDI-Men's Deprivations the EW for Luxembourg was capped at 1.000; no other component indices exceeded this level.

Figure 6.13: HDI-G Penalty versus HDI (2003)

6.5 Conclusions

Before we can eliminate female disadvantages in human development, we need to be able to systematically and accurately identify and measure these disadvantages. Eleven years ago we had no tools to accomplish this in an international context. Since 1995, the most commonly available tool, the GDI – while a good and important beginning – has contained serious biases, has been difficult to understand, and has seldom been used.

This chapter has introduced a series of common-sense measures, which together act as a replacement for GDI. The proposed replacements for GDI are: Female and Male-HDIs; Absolute and Relative Gender Gaps (AGG and RGG); and the HDI-G and HDI-Men's Deprivations, which are computationally simpler than GDI and have the attractive quality of equal weighting, that is, their penalties are the same size in percentage terms as each actual gap between female and male well-being. All of these alternative measures are easily computed using data published annually in the *HDR*s. Simple, costless changes like these would render the *Human Development Reports* account of gender inequality clearer in its meaning, more transparent in its interpretation or use, and more legitimate it its ability to depict the circumstances of our daily lives.[8]

Notes

[1] HDI is the mean of component indices for health (based on average life expectancy), education (based on literacy and school enrollment rates), and income (based on purchasing-power-parity (PPP) adjusted Gross Domestic Product (GDP) per capita.

[2] Since the stylized range for literacy and school enrollment is 0 to 100, their index values are simply the rates divided by 100.

[3] For a description of this class of inequality measures see Atkinson (1970), and Grün and Klasen (2003).

[4] The choice of 200 as an example of a higher value for ε was made, in part, because basic statistical software cannot calculate the ED formula using $\varepsilon > 200$. The largest gaps between female and male index values are the first to create calculation problems, but as ε approaches 1000, a standard spreadsheet program will return errors for all countries. Creating a GDI that can only be calculated by experts using highly technical (and expensive) computer programs would run counter to this chapter's call for greater transparency.

[5] See Appendix K for a full proof.

[6] In the five cases where male estimated earned income is greater than (PPP) US$40,000, the level of income used in the Income Index formula has not been capped at $40,000. Instead, these index values are greater than 1.000. Capping these values at $40,000 would greatly reduce the gap between male and female income in these countries.

[7] The $\text{Penalty}^{\text{HDI-G}} = 1 - (\text{GGap}/\text{Index}^{\text{HDI}})$, where $\text{EW-Index}^{\text{HDI-G}} = \text{Index}^{\text{HDI}} * \text{Penalty}$, for each component. To simplify, $\text{EW-Index}^{\text{HDI-G}} = \text{Index}^{\text{HDI}} - \text{GGap}$. Compared to GDI where $\text{ED-Index} = \text{Index}^{\text{HDI}} - [(\frac{1}{2}\text{GGap})^2/ \text{Index}^{\text{HDI}}]$, assuming equal population shares.

CHAPTER 7

CONCLUSIONS

HDI has played two key roles in the field of applied development economics: 1) as a tool to popularize human development as a new understanding of well-being, and 2) as an alternative to GDP per capita to measure levels of development for comparison across both countries and time. The importance of these dual roles cannot be over-emphasized. HDI, as reported in the *Human Development Reports* along with its companion indicators, makes it possible for policy-makers and development professionals world-wide to gauge both moments and trends in the progress of human development and to tailor public action to suit current and future social and economic conditions. Yet in praising HDI it is important to recall that its strength originates, at least in part, from the fact that UNDP has not used a static formula, but instead has introduced refinements over time. Further revisions can continue to refine HDI in the future, to correct technical problems as they come to light, and to permit HDI to evolve towards the best possible measure of human capabilities and human development – a measure that can and should take account of the distributions of key capabilities.

The existence and extent of inequalities in well-being can be addressed either by changes to HDI or by the addition of new inequality-related companion measures to the HDI. This dissertation makes three contributions to this task. It: 1) presents a systematic critique of GDI, the only inequality-sensitive measure of human well-being published regularly in the UNDP's *Human Development Reports*; 2) demonstrates a way to use the current HDI formula to illuminate within country distribution through disaggregation by important subnational groups; and 3) proposes a new series of inequality-sensitive measures of aggregate well-being.

7.1 Critiquing the Gender-related Development Index

The UNDP's Gender-related Development Index (GDI) is a valuable, but flawed, tool. This dissertation has endeavored to critically examine GDI's shortcomings in its role as a measure of human development penalized for the extent of gender inequality. My main critiques are summarized here:

- GDI suffers from lack of a data that has made necessary numerous assumptions in place of actual data values. For most of the source data, these assumed data values are the exception, but in the case of the data used to estimate female and male earned incomes, it may be that more assumed values are used than actual data.
- Life expectancy, literacy, school enrollment, and income may not be the best collection of capabilities with which to observe gender disparities. Other possible components that might be more appropriate to the task include: access to fuel and water; property rights; incidents of violence against women; gender bias in education choices; the quality of education; access to employment, training, and job advancement; and access to leisure time.
- The method used to estimate female and male earned incomes ignores: the existence of self-employment; biases in women and men's access to full-time paid work; and the complex nature of intrahousehold distribution of money, goods, and labor.
- The diminishing marginal utility of income is represented in GDI by a cap on income at $40,000 that is binding for one country, but not to others, and by taking

the natural logarithm of income. The log of income is taken before the gender inequality penalty is calculated, whereas in HDI taking the log comes in the final step. This difference in the order of operations between HDI and GDI creates a hidden and unintended bias in GDI.

- Life expectancy, education, and income do not make up equal shares of the value of GDI. Instead, gender disparities in income dominate the GDI penalty.
- While GDI ranks differ somewhat from those based on HDI, GDI values are very nearly the same as HDI values. A measure of human development adjusted for gender inequality that is barely distinguishable from a measure of human development that is neutral to gender inequality seems deeply flawed.
- In the calculation of GDI, society is assumed to have an aversion to inequality (or, at least, to gender inequality) that is equal, on average, to one percent of the value of HDI. This implicit assessment of gender inequality's significance to human well-being seems out of step with the UNDP's own rhetoric regarding the importance of disparities between women and men.
- Female and male disadvantages in capabilities are treated identically in GDI, so that penalties for female deprivations are added to penalties for male deprivations to form a final gender inequality penalty. The meaning of gender inequality in this sense is difficult to understand, and cannot be at all obvious to the casual user of GDI.
- GDI contains a "missing women" or gender-mortality bias. The fewer women in a given country, the less the deprivation of those remaining women counts in GDI's method of measuring human development.

- GDI requires a specialist to calculate and interpret it. A simpler, more straightforward measure would be preferable for the purposes of policy-makers and development professionals.

Several of the critiques advanced in this dissertation are new contributions to the human development literature. These new critiques include detailed accounting of data assumptions used in calculating GDI, and the demonstrations of the inconsistent use of income caps, the hidden penalty resulting from a reversal in the order of operations, and the gender mortality bias introduced through the female and male population shares.

The following steps are recommended towards improving the resolution of gender inequality in the *Human Development Reports*. First, GDI's component index formula should be changed. Several suggestions for doing so have been advanced in this dissertation. Second, GDI should be supplemented by measures of gender inequality, and of women's and men's levels of human development so as to give a more complete picture of human development. Finally, these new formulas should be reported in the *Human Development Reports* and evaluated both by academics and by development professionals for clarity and usefulness as tools for demonstrating the existence of, observing changes in, and finally disassembling systems of gender disparities in human development.

7.2 Disaggregating the Human Development Index

Inequalities in health, education, and income matter to social welfare because of the intrinsic value of equity, as well as their instrumental effects on other welfare-relevant variables, like environmental degradation or social cohesion. These inequalities would matter to social welfare even if they were randomly distributed across important subnational groups, but inequality's impact on social welfare may be even greater when health, education, and income are unequally distributed along the lines of gender, race/ethnicity, or region. While HDI is most often presented at the national level, it also can be disaggregated for subnational groups using the normal HDI formula.

This dissertation demonstrates the usefulness of disaggregating HDI to subnational groups using the example of the United States. Disaggregation of the U.S. HDI by gender, race/ethnicity, and state provides a wealth of information about U.S. social welfare that is not at all apparent in the aggregate U.S. measure. This exercise reveals that the well-being of U.S. residents differs dramatically based on their gender, race/ethnicity, and state of residence. Blacks are worse off than any other racial/ethnic group in the U.S., and the residents of Washington, D.C. – 58 percent of whom are Black – are worse off than those of any state (U.S. Census Bureau 2000). Subnational HDIs, like the ones presented in this dissertation, provide a good tool for policy-makers and social activists to analyze the effects of public policy and advocate for change.

The results of the disaggregation of the U.S. HDI reveal an additional interesting pattern: in every U.S. race/ethnicity, women fare better than men – at least, they do so according the HDI rankings. Several effects contribute to this result. First, on average women around the world have a five-year advantage in life expectancy over that of men; a possible refinement of the technique used here would be to compare women and men's life expectancies to each gender's own life expectancy range. Second, U.S. college students are disproportionately female. Third, following the example of Luxemburg's treatment in the UNDP's HDI, U.S. White, Asian, and Pacific Islander men have had their incomes capped at $40,000 in this study; had their incomes remained uncapped, their HDIs would surpass those of women for U.S. Asians and Pacific Islanders, and closely approach that of women for Whites. This raises the question of whether or not HDI as currently constituted adequately captures welfare differences between women and men.

The exercise of disaggregating the U.S. HDI draws attention to the horizontal inequalities that are concealed in every national HDI. The distribution of well-being is not just vertically unequal: it is also unequal along the "horizontal" lines of gender, race/ethnicity or other culturally important designations, and region. Disaggregations of other national populations would not only allow for comparison among the subnational groups within each country, but could also – to the extent that that subnational and international HDIs can be made consistent – shed light on disparities in well-being among sub-groups across different countries.

7.3 Alternative Measures of Inequality-Sensitive Human Development

This dissertation introduces an Inequality-adjusted Human Development Index. It also introduces several new measures of gender and development, which taken together act as a replacement for GDI: Female and Male-HDIs; Absolute and Relative Gender Gaps; and the HDI-G and HDI-Men's Deprivations. To compute the Inequality-adjusted Human Development Index for most countries would require data not currently reported in international sources, but which may well be available in national data sets. The measures related to gender inequality are easily computed using data published annually in the *Human Development Reports*.

7.3.1 Inequality-adjusted Human Development Index

The Inequality-adjusted Human Development Index (IHDI) incorporates several new elements that make HDI more sensitive to inequality. First, social welfare functions with respect to health, education, and income are modeled as the average of the natural logs of these variables, as opposed to the average of the variables or (in the case of income) the natural log of the average. This method captures the aggregation effects of inequality, which arise from the proposition that individual welfare is concave with respect to these variables. Moving from binary classifications for literacy and school enrollment to the continuous variable of educational attainment makes it easier to identify inequality in education.

Second, IHDI introduces the possibility of varying the weights on individuals in calculating social welfare, via a parameter adjustment to reflect the degree of emphasis on equality. The higher the parameter α, the greater the weight placed on the well-being of the least well-off. This option is important for two reasons:

- The relationship between the component variables (health, education, and income) and individual welfare may be even more concave than the logarithmic transformation specifies. Does an extra $100 for someone with an annual income of $100 really make the same contribution to social welfare as extra $1 million to someone with an annual income of $1 million? Assigning values of 1 or higher to α would (in effect) increase the degree of concavity in underlying individual welfare functions.
- If inequality is indeed considered bad for social welfare (that is, if the mapping of health, education, and income into welfare space is indeed concave), then a social

planner attempting to maximize social welfare would choose higher values for α with the goal of prioritizing increases to the well-being of the least well-off and reducing inequality.

Third, Gini coefficients are used to adjust the resulting composite indices – in a way that maintains balance among the components – to take into account further instrumental and intrinsic costs of inequality beyond the aggregation effect.

Among the 46 countries for which data needed to calculate IHDI are currently available, Norway ranks first by the IHDI and Guatemala ranks last. The inequality adjustments in IHDI yield significant differences from HDI in terms of countries' rankings; five countries kept the same rank, 22 had worse ranks by IHDI, and the remaining 19 had better ranks. The average (absolute value) change in rank was 3.3, which is quite large considering that these are rank changes among only 46 countries.

GDP per capita and HDI are commonly used as measures of social welfare to indicate which countries' policies have been the most effective in providing the best quality of life. When social welfare is measured without reference to inequality, these rankings incorporate conceptual flaws. HDI thus ranks less unequal countries, like the Republic of Korea, too unfavorably, and more unequal ones, like Brazil, too favorably.

By the same token, when distributional inequalities are omitted from HDI, significant progress in improving social welfare may be overlooked – as may certain kinds of deterioration of social welfare. IHDI can both provide a better ranking of countries at any given time and better illuminate changes in social welfare over time. While the data necessary to calculate IHDI are not yet available for the full set of countries covered in the *Human Development Reports*, this dissertation provides a roadmap to a more robust measure of social welfare for use in both international and inter-temporal comparisons.

7.3.2 Female- and male-Human Development Indices

The first two indices in the series designed to replace GDI are separate measures of women's human development and men's human development, these calculate separate HDIs as if each gender were its own country. Female and Male-HDIs have different ranges of life expectancies: 27.5 to 87.5 years for women, and 22.5 to 82.5 years for men. Adult literacy and school enrollment indices are calculated as in HDI, but using gendered data. In the absence of a good measure of how household income is distributed, the UNDP's "estimated earned income" is used to calculated female and male Income Indices. Differences in rank by Female-HDI and Male-HDI are as large as 34 in Oman (where Male-HDI is higher) and 25 in Belarus (where Female-HDI is higher).

7.3.3 Absolute and relative gender gaps

The next two indices in the series proposed to replace GDI are measures of inequality in well-being between women and men. Using the Female and Male-HDIs described above, two simple measures of gender inequality – or of women's relative human development – can be constructed: the absolute gap between Female and Male-HDI (the Absolute Gender Gap or AGG), and the gender gap as a percentage of HDI (the Relative Gender Gap or RGG). Using either measure, the first six countries by rank have higher Female HDIs than Male HDIs. Yemen ranks lowest with an AGG of 0.201 and RGG of 41.2 percent.

7.3.4 HDI-G and HDI-men's deprivations

The final two measures proposed for a complete picture of gender disparity in human development are direct alternatives to GDI – measures of human development penalized for the extent that an entire country's well-being suffers as a result of deprivations to women, and a separate measure that addresses the deprivations of men. The measure of overall human development adjusted for the extent of deprivations to women that is proposed here is called the HDI-G to emphasize the necessity of including measures of distribution – including gender distribution – in HDI itself, rather than merely adding an additional measure while maintaining the gender-inequality-neutral HDI as the primary indicator.

HDI-G adjusts each HDI component for the extent of gender inequality in that component, but unlike GDI it uses an equal weighting (EW) procedure, so that the size of the component penalty is equal to the size of the component gap in percentage terms. In those cases in which the gender gap is negative (where a female index is greater than a male index), the gap is entered into the EW formula as zero. HDI-G measures human development penalized for the extent of deprivations to women, but not the extent of the deprivations to men. Norway ranks first in HDI-G with a total penalty of 0.016 and a HDI-G of 0.947, and Niger ranks last with a penalty of 0.059 and a HDI-G of 0.223. The largest penalty assigned, 0.201, is to Yemen where HDI-G is 0.288.

Many countries have one or more indicators – life expectancy, adult literacy, or school enrollment – in which men score lower than women. HDI-G, the alternative to GDI proposed above, ignores these cases by counting no gender inequality in that component. The cases in which men's index measures are lower than women's are both important and interesting, and they deserve close examination. But including these cases as gender-neutral "gender disparity" in the HDI-G would not aid researchers' or policy-makers' ability to look closely at these particular cases, or at the nature of gender inequalities more generally. If our concern is gender inequality as it is most commonly used to mean advantages to men relative to women, then lumping together women's and men's disparities muddies the waters. If, instead, our concern is those cases in which men's well-being has fallen behind women's, then a HDI can be tailored to this specific issue, by counting only the absolute value of negative gaps using the HDI-G formula and ignoring positive gaps: The resulting formula is the HDI-Men's Deprivations. Moreover, they have the attractive quality of equal weighting: That is, their penalties are the same size, in percentage terms, as each actual gap between female and male well-being.

7.4 Inequality and the Human Development Index

Over the years, the UNDP has been exceptionally receptive to criticism regarding HDI. On some points, the UNDP has changed HDI significantly in response to its critics. In so doing, it has lived up to the promise made in early *Human Development Reports*: "The HDI should be seen as evolving and improving rather than as something cast in stone. It is also an exercise in which as many of its users as possible should actively participate."(UNDP 1993: 104) This dissertation has advocated further changes in HDI that would make it more sensitive to the distribution of key capabilities. It is my hope that this work will have some effect on the measurement of social welfare in general, and on the UNDP's presentation of measures of human development in its *Human Development Reports*, in particular.

APPENDIX A

CHAPTER 3 DATA

The distributional data for health, education, and income used in this study are described an analyzed below.

A.1 Health

The health data come from the World Health Organization's Mortality Database, "Table 1: Number of registered deaths, by cause, sex, and age." These data provide the number of deaths in a given year for each of ten age groups and the total number of individuals in each group: (1) under 1 year; (2) 1 to 4 years; (3) 5 to 14 years; (4) 15 to 24 years; (5) 25 to 34 years; (6) 35 to 44 years; (7) 45 to 54 years; (8) 55 to 64 years; (9) 65 to 74 years; and (10) 75 years or more. The ratio of the number of deaths in a given year to the total number of individuals is the death rate for each group. In order to have distributional data for health outcomes for a large set of countries it is necessary to use data for the years 1996 to 2003; for each country, I use only data for the most recent year available.

In order to calculate the distribution of life-years in each country, I created a simple computer model of a cohort of 100,000 people all born in the same year. The death rate for the under 1 year-olds was applied to this cohort to determine the number of deaths in the first year; the second round begins with a cohort size equal to 100,000 less those who died in the first year. On average, for all 81 countries for which data are available, approximately 1 percent of the cohort died before reaching their first birthday, but this ranges from 0.2 percent in Singapore to 4 percent in Mongolia.

This same procedure was repeated for each of 99 years (using the death rates from the corresponding age group), and in the 100th year all of the remaining members of the cohort were assumed to die. The number of life-years for each individual is the age to which they live (for those who die before reaching age one, this is assumed to be 0.5 years); the number of life-years for each of the 101 groups created by the computer model is the age to which that group lives multiplied by the number of individuals in that group. The total number of life years for an entire country is the sum of the 101 groups' life years.[1]

The Gini coefficient for health was calculated using each group's cumulative share of the population and each group's cumulative share of total life years. Among the sample of 46 countries, Sweden had the lowest Health Gini, 0.096, indicating the most equal distribution of lifespans; Guatemala had the highest, 0.174, indicating the least equal distribution; and Croatia (along with Slovenia) has the median Health Gini, 0.112. Figure A.1 below is a scatterplot of Health Ginis versus average life expectancies. Figure A.2, shows Lorenz curves for Sweden, Guatemala, and Croatia. Years of data, death rates, and Health Ginis for all 46 countries are reported in Table A.1.

A.2 Education

In calculating IHDI, the binary classifications used to measure education in HDI (literacy and school enrollment) are replaced with a continuous variable, educational attainment measured as years of schooling.[2] The data for education come from two sources. The percentage of the population in each country that has reached a given level of education (but no higher), and the average years of schooling come from the World

Bank, EdStats, Thematic Data, “Education Attainment in the Adult Population” (also called the Barro-Lee Data Set) for 2000. This source reports seven levels of achievement: (1) no schooling; (2) some primary school; (3) completed primary school; (4) some secondary school; (5) completed secondary school; (6) some tertiary school; and (7) completed tertiary school. Data on the duration of primary and secondary school come from the World Bank, EdStats, Global Country Data, “Duration of Education Primary and Secondary” for 2000.

These data provide the share of each country’s population in the seven groups described above and the average number of years of schooling for three of the groups – no schooling, completed primary, and completed secondary. In order to estimate the average number of years of schooling by country for the four remaining groups, the following assumptions were made:

1) The duration of tertiary school is four years in every country.
2) The average years of schooling for each country is equal to the sum of the average years of schooling in each of its seven groups weighted by that group’s share of the population.
3) Since the duration of schooling for those students who began but did not complete the primary, secondary, or tertiary levels is unknown, I assume that, within each country, the ratio of “some” years of schooling to “completed” years of schooling is equal for the primary, secondary, and tertiary levels, and thus solve for a single ratio of “some” to “completed” for each country.[3]

The Gini coefficient for education was calculated using the cumulative share of each country's population in each of seven groups and the cumulative share of each group's total years of schooling. Among the 46 countries in the sample, Norway had the lowest Education Gini, 0.115, indicating the most equal distribution of schooling; Guatemala had the highest, 0.527, indicating the least equal distribution; and France (together with Uruguay) has the median Education Gini, 0.271. Figure A.3 is a scatterplot of Education Ginis versus average years of schooling. Figure A.4 shows Lorenz curves for Norway, Guatemala, and France. Cumulative shares of the population, cumulative total years of schooling, and Education Ginis for all 46 countries are presented in Table A.2.

A.3 Income

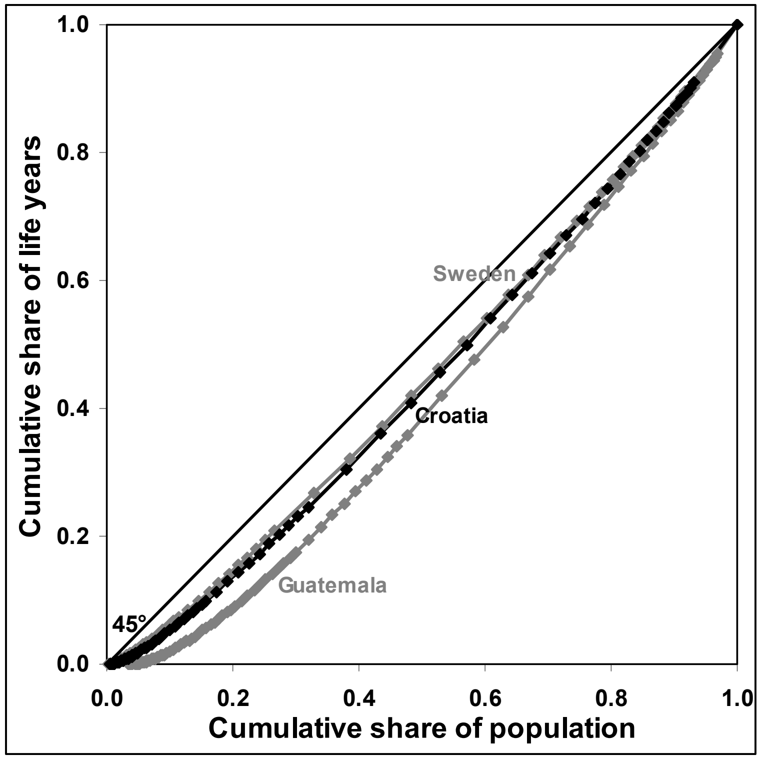
The income data come from the World Bank's World Development Indicators 2006, "Table 2.8: Distribution of income or consumption." These data provide the share of income in a given year for each of seven groups ranked by income, starting from the decile with the least income; the percentiles in each group are: (1) 0 to 10; (2) 10 to 20; (3) 20 to 40; (4) 40 to 60; (5) 60 to 80; (6) 80 to 90; and (7) 90 to 100. In order to have distributional data for income shares for a large set of countries it was necessary to use data for 1994 to 2003; for each country, again only the data for the most recent year available were used.[4]

Among the 46 countries in the sample, Czech Republic had the lowest Income Gini, 0.244, indicating the most equal distribution of income; (once again) Guatemala had the highest, 0.572, indicating the least equal distribution; and Israel (together with

Ireland) had the median Income Gini, 0.341. Figure A5 below is a scatterplot of Income Ginis versus PPP-adjusted GDP per capita. Figure A6 presents Lorenz curves for Czech Republic, Guatemala, and Israel. Years of data, cumulative shares of the population, cumulative shares of income, and Income Ginis for all 46 countries can be found in Table A.3.

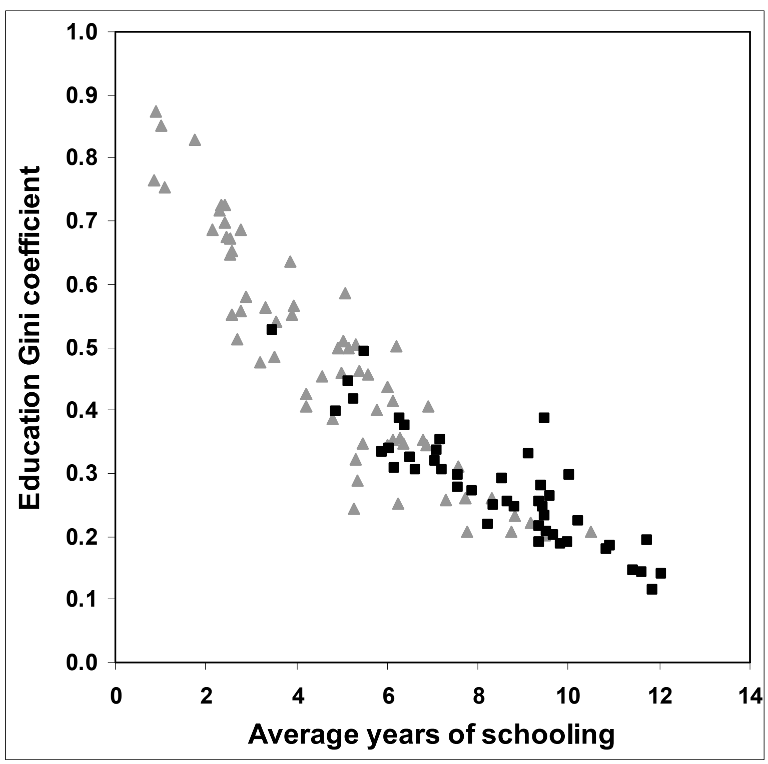
Note: Black squares indicate one of the 46 coinciding countries; gray triangles indicates one of the countries not in that sample.

Figure A.1: Health Gini Coefficient versus Life Expectancy



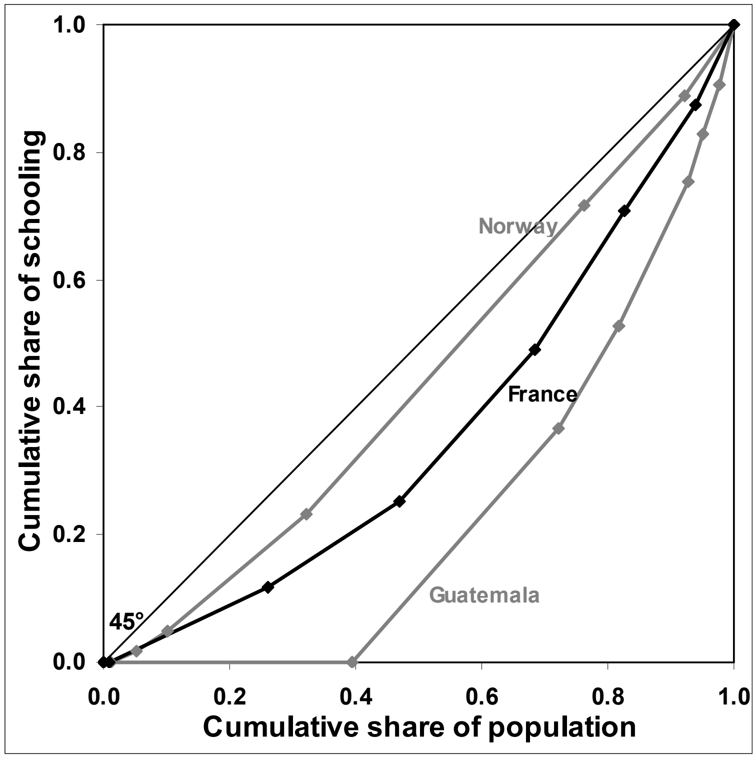
Source: Author's calculations using data from the current study.

Figure A.2: Lorenz Curve for Health for Selected Countries



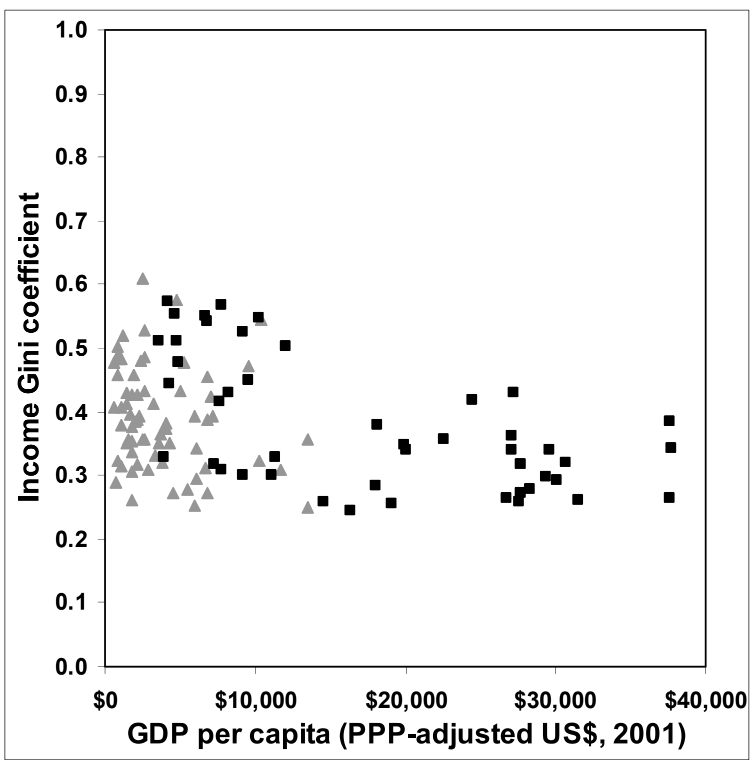
Note: Black squares indicate one of the 46 coinciding countries; gray triangles indicates one of the countries not in that sample.

Figure A.3: Education Gini Coefficient versus Average Years of Schooling (2000)



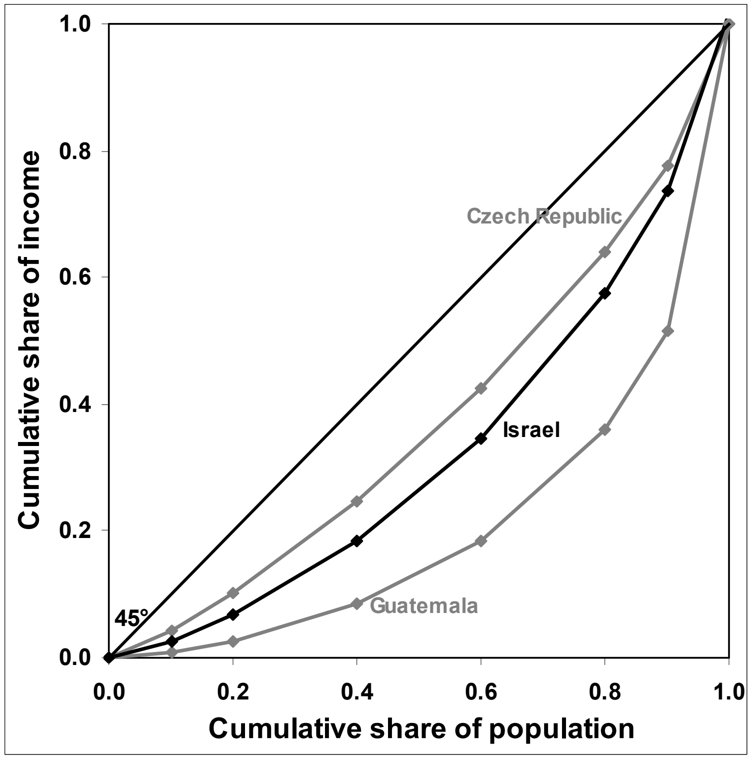
Source: Author's calculations using data from the current study.

Figure A.4: Lorenz Curves for Education for Selected Countries (2000)



Note: Black squares indicate one of the 46 coinciding countries; gray triangles indicates one of the countries not in that sample.

Figure A.5: Income Gini Coefficient versus GDP per capita



Source: Author's calculations using data from the current study.

Figure A.6: Lorenz Curves for Income for Selected Countries

Table A.1: Distributional Data for Life Years

		Group death rate										
Country	**Data year**	**Under 1**	**1 to 4**	**5 to 14**	**15 to 24**	**25 to 34**	**35 to 44**	**45 to 54**	**55 to 64**	**65 to 74**	**75+**	**Health Gini coefficient**
Argentina	2001	0.016	0.001	0.000	0.001	0.001	0.002	0.005	0.012	0.027	0.090	0.128
Australia	2001	0.005	0.000	0.000	0.001	0.001	0.001	0.002	0.006	0.018	0.070	0.104
Austria	2002	0.004	0.000	0.000	0.001	0.001	0.001	0.004	0.008	0.020	0.081	0.104
Belgium	1997	0.006	0.000	0.000	0.001	0.001	0.002	0.004	0.009	0.023	0.092	0.107
Brazil	2000	0.019	0.001	0.000	0.001	0.002	0.003	0.006	0.013	0.029	0.094	0.142
Bulgaria	2002	0.013	0.001	0.000	0.001	0.001	0.003	0.007	0.015	0.035	0.111	0.124
Canada	2000	0.005	0.000	0.000	0.001	0.001	0.001	0.003	0.008	0.020	0.073	0.105
Chile	2001	0.008	0.000	0.000	0.001	0.001	0.002	0.004	0.010	0.025	0.083	0.115
Colombia	1999	0.016	0.001	0.000	0.002	0.002	0.003	0.004	0.010	0.025	0.069	0.145
Costa Rica	2002	0.010	0.000	0.000	0.001	0.001	0.002	0.003	0.008	0.019	0.067	0.118
Croatia	2002	0.007	0.000	0.000	0.001	0.001	0.002	0.005	0.012	0.031	0.098	0.112
Czech Republic	2002	0.004	0.000	0.000	0.001	0.001	0.002	0.005	0.012	0.029	0.097	0.108
Denmark	1999	0.004	0.000	0.000	0.001	0.001	0.002	0.004	0.011	0.029	0.091	0.108
Ecuador	2000	0.019	0.002	0.001	0.001	0.002	0.003	0.005	0.009	0.021	0.084	0.141
Egypt	2000	0.026	0.002	0.001	0.001	0.001	0.002	0.007	0.017	0.039	0.109	0.144
El Salvador	1999	0.011	0.001	0.000	0.002	0.002	0.004	0.006	0.011	0.022	0.080	0.143
Finland	2002	0.003	0.000	0.000	0.001	0.001	0.002	0.004	0.008	0.020	0.084	0.105
France	2000	0.005	0.000	0.000	0.001	0.001	0.002	0.004	0.008	0.018	0.076	0.110
Germany	2001	0.004	0.000	0.000	0.000	0.001	0.001	0.004	0.009	0.021	0.082	0.104
Greece	2001	0.005	0.000	0.000	0.001	0.001	0.001	0.003	0.007	0.019	0.081	0.103
Guatemala	1999	0.034	0.004	0.001	0.002	0.003	0.005	0.008	0.013	0.029	0.107	0.174
Hong Kong	2000	0.002	0.000	0.000	0.000	0.000	0.001	0.002	0.007	0.019	0.062	0.100
Hungary	2002	0.007	0.000	0.000	0.001	0.001	0.003	0.009	0.016	0.034	0.098	0.126
Ireland	2001	0.006	0.000	0.000	0.001	0.001	0.001	0.003	0.008	0.025	0.094	0.104
Israel	1999	0.006	0.000	0.000	0.000	0.001	0.001	0.003	0.008	0.022	0.083	0.103
Italy	2001	0.005	0.000	0.000	0.001	0.001	0.001	0.003	0.007	0.018	0.075	0.102
Korea	2002	0.005	0.000	0.000	0.000	0.001	0.002	0.004	0.009	0.023	0.086	0.108
Mexico	2001	0.016	0.001	0.000	0.001	0.001	0.002	0.005	0.011	0.025	0.080	0.133
Netherlands	2003	0.005	0.000	0.000	0.000	0.001	0.001	0.003	0.008	0.021	0.088	0.099
New Zealand	2000	0.006	0.000	0.000	0.001	0.001	0.001	0.003	0.008	0.021	0.075	0.110
Norway	2001	0.004	0.000	0.000	0.001	0.001	0.001	0.003	0.007	0.020	0.086	0.100
Panama	2000	0.016	0.001	0.000	0.001	0.001	0.002	0.003	0.008	0.018	0.069	0.130
Paraguay	2000	0.011	0.001	0.000	0.001	0.001	0.002	0.004	0.010	0.025	0.094	0.117
Philippines	1998	0.014	0.002	0.001	0.001	0.002	0.004	0.007	0.015	0.033	0.120	0.138
Poland	2002	0.007	0.000	0.000	0.001	0.001	0.002	0.006	0.013	0.029	0.089	0.121
Portugal	2002	0.005	0.000	0.000	0.001	0.001	0.002	0.004	0.008	0.021	0.088	0.111
Romania	2002	0.017	0.001	0.000	0.001	0.001	0.003	0.008	0.017	0.036	0.109	0.135
Russia	2002	0.014	0.001	0.000	0.002	0.004	0.008	0.014	0.027	0.048	0.111	0.167
Singapore	2001	0.002	0.000	0.000	0.000	0.001	0.001	0.003	0.008	0.022	0.072	0.102
Slovenia	2002	0.004	0.000	0.000	0.001	0.001	0.002	0.005	0.011	0.025	0.083	0.112
Sweden	2001	0.004	0.000	0.000	0.000	0.001	0.001	0.003	0.007	0.019	0.084	0.096
Thailand	2000	0.005	0.001	0.001	0.002	0.004	0.005	0.006	0.013	0.028	0.097	0.145
United Kingdom	2002	0.005	0.000	0.000	0.000	0.001	0.001	0.003	0.008	0.022	0.088	0.103
Uruguay	2000	0.013	0.001	0.000	0.001	0.001	0.002	0.005	0.012	0.026	0.085	0.126
USA	2000	0.007	0.000	0.000	0.001	0.001	0.002	0.004	0.010	0.024	0.082	0.117
Venezuela	2000	0.017	0.001	0.000	0.002	0.002	0.003	0.005	0.010	0.024	0.078	0.142

Table A.2: Distributional Data for Years of Schooling (2000)

	Cumulative Pop Share							Cumulative share of value							
Country	No schooling	Some primary	Complete primary	Some secondary	Complete secondary	Some tertiary	Complete tertiary	No schooling	Some primary	Complete primary	Some secondary	Complete secondary	Some tertiary	Complete tertiary	Education Gini coefficient
Argentina	0.04	0.21	0.49	0.70	0.80	0.92	1.00	0.00	0.10	0.29	0.53	0.67	0.86	1.00	0.248
Australia	0.02	0.10	0.20	0.50	0.68	0.85	1.00	0.00	0.04	0.10	0.36	0.57	0.76	1.00	0.184
Austria	0.03	0.14	0.28	0.64	0.85	0.95	1.00	0.00	0.04	0.11	0.47	0.77	0.90	1.00	0.249
Belgium	0.06	0.24	0.41	0.68	0.79	0.87	1.00	0.00	0.11	0.21	0.52	0.66	0.78	1.00	0.256
Brazil	0.16	0.66	0.78	0.88	0.93	0.96	1.00	0.00	0.37	0.47	0.68	0.78	0.89	1.00	0.397
Bulgaria	0.06	0.17	0.44	0.69	0.82	0.88	1.00	0.00	0.04	0.17	0.41	0.58	0.68	1.00	0.385
Canada	0.01	0.05	0.16	0.33	0.46	0.90	1.00	0.00	0.02	0.07	0.22	0.35	0.86	1.00	0.144
Chile	0.07	0.42	0.51	0.74	0.86	0.93	1.00	0.00	0.20	0.28	0.55	0.73	0.85	1.00	0.297
Colombia	0.20	0.54	0.63	0.82	0.90	0.96	1.00	0.00	0.22	0.31	0.60	0.77	0.87	1.00	0.418
Costa Rica	0.10	0.54	0.66	0.78	0.82	0.91	1.00	0.00	0.29	0.42	0.55	0.63	0.79	1.00	0.339
Croatia	0.11	0.36	0.51	0.77	0.91	0.94	1.00	0.00	0.10	0.20	0.53	0.79	0.85	1.00	0.387
Czech Republic	0.02	0.20	0.30	0.69	0.90	0.93	1.00	0.00	0.07	0.13	0.55	0.83	0.88	1.00	0.233
Denmark	0.00	0.16	0.36	0.44	0.81	0.92	1.00	0.00	0.07	0.20	0.27	0.74	0.86	1.00	0.201
Ecuador	0.15	0.48	0.61	0.78	0.85	0.92	1.00	0.00	0.21	0.33	0.55	0.68	0.81	1.00	0.375
Egypt	0.36	0.50	0.57	0.80	0.91	0.96	1.00	0.00	0.10	0.17	0.56	0.77	0.88	1.00	0.492
El Salvador	0.28	0.66	0.77	0.88	0.90	0.96	1.00	0.00	0.35	0.48	0.69	0.73	0.89	1.00	0.447
Finland	0.00	0.14	0.30	0.44	0.78	0.91	1.00	0.00	0.06	0.16	0.28	0.69	0.86	1.00	0.190
France	0.01	0.26	0.47	0.68	0.83	0.94	1.00	0.00	0.12	0.25	0.49	0.71	0.87	1.00	0.271
Germany	0.04	0.13	0.23	0.60	0.84	0.92	1.00	0.00	0.03	0.07	0.46	0.76	0.87	1.00	0.223
Greece	0.05	0.15	0.47	0.60	0.86	0.91	1.00	0.00	0.05	0.27	0.40	0.77	0.83	1.00	0.254
Guatemala	0.40	0.72	0.82	0.93	0.95	0.98	1.00	0.00	0.37	0.53	0.75	0.83	0.91	1.00	0.527
Hong Kong	0.11	0.23	0.37	0.56	0.87	0.94	1.00	0.00	0.06	0.15	0.35	0.79	0.89	1.00	0.279
Hungary	0.02	0.27	0.46	0.75	0.88	0.90	1.00	0.00	0.10	0.20	0.53	0.75	0.78	1.00	0.332
Ireland	0.04	0.14	0.28	0.62	0.79	0.92	1.00	0.00	0.06	0.17	0.47	0.71	0.85	1.00	0.192
Israel	0.11	0.24	0.31	0.57	0.73	0.90	1.00	0.00	0.07	0.11	0.39	0.59	0.83	1.00	0.264
Italy	0.12	0.31	0.47	0.74	0.86	0.95	1.00	0.00	0.09	0.20	0.52	0.74	0.88	1.00	0.352
Korea	0.07	0.07	0.18	0.32	0.74	0.88	1.00	0.00	0.00	0.07	0.19	0.65	0.82	1.00	0.180
Mexico	0.10	0.34	0.52	0.74	0.89	0.96	1.00	0.00	0.14	0.29	0.54	0.81	0.90	1.00	0.304
Netherlands	0.04	0.15	0.29	0.65	0.78	0.91	1.00	0.00	0.06	0.15	0.51	0.68	0.84	1.00	0.215
New Zealand	0.00	0.13	0.28	0.47	0.59	0.86	1.00	0.00	0.06	0.14	0.32	0.45	0.80	1.00	0.195
Norway	0.01	0.05	0.10	0.32	0.76	0.92	1.00	0.00	0.02	0.05	0.23	0.72	0.89	1.00	0.115
Panama	0.09	0.27	0.45	0.61	0.81	0.90	1.00	0.00	0.10	0.23	0.40	0.68	0.81	1.00	0.292
Paraguay	0.06	0.48	0.68	0.81	0.92	0.96	1.00	0.00	0.26	0.45	0.60	0.83	0.88	1.00	0.309
Philippines	0.03	0.20	0.36	0.54	0.77	0.88	1.00	0.00	0.09	0.21	0.38	0.65	0.80	1.00	0.219
Poland	0.02	0.06	0.36	0.72	0.90	0.94	1.00	0.00	0.03	0.21	0.62	0.84	0.90	1.00	0.186
Portugal	0.12	0.38	0.61	0.78	0.86	0.96	1.00	0.00	0.15	0.38	0.57	0.74	0.89	1.00	0.332
Romania	0.04	0.17	0.25	0.69	0.93	0.95	1.00	0.00	0.05	0.08	0.58	0.88	0.92	1.00	0.206
Russia	0.01	0.12	0.33	0.66	0.84	0.89	1.00	0.00	0.03	0.12	0.46	0.70	0.77	1.00	0.296
Singapore	0.16	0.32	0.55	0.80	0.90	0.96	1.00	0.00	0.12	0.31	0.65	0.80	0.92	1.00	0.319
Slovenia	0.02	0.29	0.45	0.73	0.87	0.91	1.00	0.00	0.10	0.19	0.50	0.74	0.81	1.00	0.335
Sweden	0.02	0.10	0.17	0.34	0.78	0.89	1.00	0.00	0.04	0.07	0.24	0.71	0.85	1.00	0.146
Thailand	0.13	0.47	0.74	0.85	0.89	0.93	1.00	0.00	0.26	0.51	0.67	0.75	0.83	1.00	0.326
United Kingdom	0.03	0.22	0.39	0.69	0.80	0.91	1.00	0.00	0.10	0.20	0.54	0.69	0.84	1.00	0.246
Uruguay	0.05	0.39	0.50	0.77	0.85	0.93	1.00	0.00	0.20	0.28	0.60	0.73	0.85	1.00	0.278
USA	0.01	0.05	0.09	0.32	0.52	0.76	1.00	0.00	0.02	0.04	0.22	0.42	0.67	1.00	0.141
Venezuela	0.10	0.44	0.54	0.76	0.86	0.95	1.00	0.00	0.22	0.31	0.57	0.74	0.88	1.00	0.305

Table A.3: Distributional Data for Income

			Cumulative share of pop								**Cumulative shares of income**								
Country	**Data year**		**0-10**	**10-20**	**20-40**	**40-60**	**60-80**	**80-90**	**90-100**		**0-10**	**10-20**	**20-40**	**40-60**	**60-80**	**80-90**	**90-100**		**Income Gini coefficient**
Argentina	2001		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.10	0.23	0.44	0.61	1.00		0.504
Australia	1994		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.06	0.18	0.35	0.59	0.75	1.00		0.341
Austria	1997		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.21	0.39	0.62	0.77	1.00		0.292
Belgium	1998		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.22	0.40	0.63	0.77	1.00		0.277
Brazil	2001		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.02	0.08	0.19	0.37	0.53	1.00		0.567
Bulgaria	2001		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.07	0.20	0.38	0.61	0.76	1.00		0.309
Canada	1998		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.07	0.20	0.37	0.60	0.75	1.00		0.320
Chile	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.10	0.20	0.38	0.53	1.00		0.547
Colombia	1999		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.09	0.20	0.38	0.54	1.00		0.551
Costa Rica	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.04	0.13	0.27	0.49	0.65	1.00		0.449
Croatia	2001		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.21	0.38	0.60	0.76	1.00		0.301
Czech Republic	1996		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.04	0.10	0.25	0.42	0.64	0.78	1.00		0.244
Denmark	1997		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.23	0.41	0.64	0.79	1.00		0.262
Ecuador	1998		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.11	0.23	0.42	0.58	1.00		0.512
Egypt	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.04	0.09	0.21	0.36	0.56	0.70	1.00		0.330
El Salvador	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.10	0.23	0.43	0.59	1.00		0.511
Finland	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.04	0.10	0.24	0.41	0.63	0.77	1.00		0.259
France	1995		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.07	0.20	0.37	0.60	0.75	1.00		0.317
Germany	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.09	0.22	0.40	0.63	0.78	1.00		0.274
Greece	1998		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.07	0.19	0.34	0.56	0.72	1.00		0.350
Guatemala	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.09	0.18	0.36	0.52	1.00		0.572
Hong Kong	1996		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.05	0.15	0.29	0.49	0.65	1.00		0.430
Hungary	2002		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.04	0.10	0.23	0.41	0.63	0.78	1.00		0.259
Ireland	1996		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.07	0.19	0.35	0.57	0.72	1.00		0.344
Israel	1997		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.07	0.18	0.35	0.58	0.74	1.02		0.341
Italy	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.06	0.18	0.35	0.58	0.73	1.00		0.341
Korea	1998		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.21	0.39	0.63	0.78	1.00		0.284
Mexico	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.10	0.22	0.41	0.57	1.00		0.524
Netherlands	1999		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.08	0.21	0.38	0.61	0.77	1.00		0.299
New Zealand	1997		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.06	0.18	0.34	0.56	0.72	1.00		0.357
Norway	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.04	0.10	0.24	0.41	0.63	0.77	1.00		0.265
Panama	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.02	0.09	0.20	0.40	0.57	1.00		0.542
Paraguay	2002		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.02	0.08	0.20	0.39	0.55	1.00		0.554
Philippines	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.05	0.14	0.27	0.48	0.64	1.00		0.443
Poland	2002		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.20	0.36	0.58	0.73	1.00		0.329
Portugal	1997		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.06	0.17	0.32	0.54	0.70	1.00		0.380
Romania	2002		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.20	0.37	0.59	0.74	1.00		0.318
Russia	2002		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.08	0.21	0.38	0.61	0.76	1.00		0.300
Singapore	1998		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.05	0.14	0.29	0.51	0.67	1.00		0.420
Slovenia	1999		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.04	0.09	0.23	0.41	0.64	0.79	1.00		0.256
Sweden	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.04	0.09	0.23	0.41	0.63	0.78	1.00		0.265
Thailand	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.03	0.06	0.16	0.29	0.50	0.66	1.00		0.416
United Kingdom	1999		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.06	0.18	0.34	0.56	0.72	1.00		0.362
Uruguay	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.05	0.14	0.28	0.50	0.66	1.00		0.430
USA	2000		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.02	0.05	0.16	0.32	0.54	0.70	1.00		0.386
Venezuela	1998		0.10	0.20	0.40	0.60	0.80	0.90	1.00		0.01	0.03	0.11	0.25	0.47	0.64	1.00		0.477

[1] For the purposes of this paper, I relied only on the World Health Organization's age specific mortality data, but in principle it would be possible to construct data for most countries using census data on birthrates and the age structure of the population, making these data available for a larger set of countries.

[2] By dropping literacy, IHDI misses adult literacy programs and other forms of informal education. If this loss of information were perceived as a serious limitation it would be possible to develop survey methodology to produce data on educational attainment regardless of formal or informal schooling.

[3] For four countries – Bulgaria, Hungary, India, and Russia – the ratio described above was greater than one, indicating that the reported average years of schooling for those four countries was not a weighted mean of average years of schooling for that group, that is, that some error occurred in the World Banks' reporting of these data. Only increasing the assumed duration of tertiary school to ten to 14 years made the value of "some" equal to or less than "completed" in these countries. For these four countries the ratio of "some" to "completed" was instead assumed to be the average ratio for the other 106 countries, 0.71.

[4] The individual values of income used to calculate IHDI combine this information with purchasing-power-parity (PPP) adjusted GDP per capita for 2003 from HDI 2005.

APPENDIX B

CHAPTER 3 RESULTS

Table B.1: IHDI Results with comparisons to HDI and Hicks' HDI^{B*} (2003)

IHDI rank	Country	IHDI	HDI	Hicks' HDI^{B*}	HDI rank less IHDI rank	HDI rank less HDI^{B*} rank
1	Norway	0.682	0.963	0.808	0	0
2	Sweden	0.646	0.949	0.787	1	1
3	Canada	0.636	0.949	0.769	1	1
4	USA	0.616	0.944	0.737	3	-4
5	Finland	0.610	0.941	0.765	4	5
6	Australia	0.608	0.955	0.753	-4	-4
7	Denmark	0.596	0.941	0.758	3	5
8	Germany	0.588	0.930	0.745	8	8
9	New Zealand	0.583	0.933	0.726	6	1
10	Netherlands	0.580	0.943	0.749	-2	1
11	Ireland	0.580	0.946	0.741	-6	-4
12	Korea	0.568	0.901	0.731	11	10
13	Belgium	0.557	0.945	0.740	-7	-4
14	Austria	0.556	0.936	0.733	-1	1
15	United Kingdom	0.542	0.939	0.715	-4	-5
16	Czech Republic	0.537	0.874	0.701	8	7
17	France	0.529	0.938	0.720	-5	-3
18	Hong Kong	0.515	0.916	0.670	-1	-6
19	Israel	0.515	0.915	0.699	-1	0
20	Greece	0.515	0.912	0.698	-1	0
21	Poland	0.498	0.858	0.677	6	5
22	Slovenia	0.476	0.904	0.690	-1	1
23	Italy	0.476	0.934	0.687	-9	-7
24	Singapore	0.452	0.907	0.651	-4	-6
25	Hungary	0.436	0.862	0.652	1	1
26	Romania	0.419	0.792	0.621	10	9
27	Portugal	0.408	0.904	0.654	-5	-2
28	Argentina	0.402	0.863	0.611	-3	-5
29	Croatia	0.381	0.841	0.614	0	1
30	Uruguay	0.378	0.840	0.611	0	1
31	Bulgaria	0.371	0.808	0.585	2	-1
32	Chile	0.365	0.854	0.589	-4	-4
33	Costa Rica	0.355	0.838	0.593	-2	0
34	Russian	0.343	0.795	0.589	1	2
35	Panama	0.343	0.804	0.557	-1	-2
36	Mexico	0.335	0.814	0.556	-4	-5
37	Philippines	0.334	0.758	0.567	5	7
38	Thailand	0.323	0.778	0.547	1	1
39	Venezuela	0.291	0.772	0.544	1	1
40	Paraguay	0.281	0.755	0.520	3	3
41	Ecuador	0.241	0.759	0.512	0	0
42	Colombia	0.238	0.785	0.497	-4	-5
43	Brazil	0.229	0.792	0.502	-6	-5
44	El Salvador	0.215	0.722	0.463	0	0
45	Egypt	0.201	0.659	0.455	1	1
46	Guatemala	0.098	0.663	0.385	-1	-1

Note: For the purposes of this comparison, HDI was reranked out of just the 46 countries in this sample.

APPENDIX C

CHAPTER 4 DATA

C.1 Life Expectancy

- UNDP (2004) data: U.S. life expectancy at birth for the 2000-2005 birth cohort. Reported source: *2002 Revisions of World Population Prospects,* United Nations (2003).
- Study data used: life expectancy at birth for 2002. Sources: Vital Statistics Reports 53:6, Center for Disease Control (2004); *Projections for the Population by Age, Race, and Hispanic Origin for the United States: 1995 to 2050*, Census Bureau (1996); *U.S. Decennial Life Tables for 1989-91* 1:3, Center for Disease Control (1999).

C.2 Adult Literacy

- UNDP (2004) data: adult literacy for 2002. Reported source: national statistics.
- Study data used: adult literacy for 1992. Sources: Prose Level 2 for 1992 from *Adult Literacy in America 1992*, National Center for Education Statistics (2002); Levels 2 through 5 of average score for Prose, Document, and Quantitative literacy, synthetic estimates of literacy from NCES 2002 and 2000 Census data from National Center for Education Statistics (2002).

C.3 School Enrollment

- UNDP (2004) data: combined gross school enrollment for primary, secondary and tertiary schools for 2001-2002. Reported source: national 'administrative' sources.
- Study data used: combined gross school enrollment for primary, secondary and tertiary schools for 2000 through 2004. Sources: *School Enrollment – Social and Economic Characteristics of Students, 2003*, CPS 2004 March Supplement, Table 1, Census Bureau, (October 2004); 2000 Census, Census Bureau (2005); American Community Survey 2004, Census Bureau (2004).

C.4 Income

- UNDP (2004) data: PPP-adjusted GDP per capita for 2002; Reported source: *International Comparison Program Survey*, World Bank.
- Study data used: per capita income for 2002. Sources: 2004, CPS 2005 March Supplement, Census Bureau, (October 2005); American Community Survey 2004, Census Bureau (2004).

C.5 Adjustment to Income per Capita

U.S. GDP per capita differs by a factor of 1.49 from the per capita income reported by the U.S. Census Bureau. If per capita income is multiplied by the population, total income is $6.7 trillion. The U.S.' $10.0 trillion GDP less supplements to wages and salaries, taxes on corporate profits, undistributed profits, consumption of capital, and business current transfer payments approximates this measure of total income (see Table C.1 below).

Table C.1: Adjustment to Income per Capita

2003 GDP (BEA NIPA)	$10,024,200,000,000
2003 Population (Census Bureau CPS)	288,280,000
GDP/capita	*$34,772*
2003 Per capita income (Census Bureau CPS)	$23,276
2003 Population	288,280,000
Total income	*$6,710,005,280,000*
2003 GDP	$10,024,200,000,000
less supplements to wages and salaries	$1,210,000,000,000
less taxes on corporate profits	$232,100,000,000
less undistributed profits	$376,500,000,000
less consumption of capital	$1,331,300,000,000
less business current transfer payments	$81,600,000,000
Net	*$6,792,700,000,000*
GDP/capita	**$34,772**
divided by per capita income	**$23,276**
Adjustment to per capita income	**1.4939**

Source: Author's calculations using data from BEA's National Income and Product Accounts (2006) and Census Bureau's current population survey (2005).

APPENDIX D

CHAPTER 4 RESULTS

Table D.1: U.S. HDI by State (2002), selected states

HDI Rank	State	H-Index	E-Index	Y-Index	HDI
1	Minnesota	0.879	0.848	0.996	0.908
2	New Hampshire	0.862	0.856	1.000	0.906
3	Colorado	0.866	0.841	0.995	0.901
4	Connecticut	0.865	0.833	1.000	0.900
5	Vermont	0.859	0.848	0.987	0.898
6	Hawaii	0.887	0.821	0.985	0.898
7	Massachusetts	0.862	0.825	1.000	0.896
8	Washington	0.864	0.833	0.990	0.896
9	Utah	0.878	0.859	0.948	0.895
10	Alaska	0.831	0.861	0.992	0.894
11	Wisconsin	0.865	0.839	0.977	0.894
12	Nebraska	0.865	0.847	0.966	0.893
13	Iowa	0.872	0.839	0.967	0.892
14	Wyoming	0.854	0.840	0.982	0.892
15	Kansas	0.863	0.841	0.972	0.892
16	Rhode Island	0.859	0.825	0.989	0.891
17	North Dakota	0.877	0.831	0.961	0.890
18	Maine	0.856	0.839	0.974	0.890
19	Oregon	0.857	0.824	0.969	0.884
20	Idaho	0.865	0.840	0.945	0.883
21	South Dakota	0.865	0.825	0.958	0.883
22	Virginia	0.837	0.804	1.000	0.880
23	Delaware	0.829	0.814	0.998	0.880
24	New Jersey	0.840	0.798	1.000	0.879
25	Maryland	0.830	0.805	1.000	0.878
26	Michigan	0.834	0.821	0.979	0.878
27	Arizona	0.852	0.814	0.968	0.878
28	Montana	0.854	0.828	0.948	0.877
29	California	0.848	0.789	0.991	0.876
30	Nevada	0.820	0.823	0.981	0.875
31	Illinois	0.832	0.801	0.990	0.874
32	Ohio	0.839	0.810	0.972	0.874
33	Indiana	0.840	0.815	0.965	0.873
34	Missouri	0.838	0.813	0.969	0.873
35	Pennsylvania	0.840	0.799	0.978	0.872
36	New York	0.828	0.781	1.000	0.870
37	New Mexico	0.846	0.807	0.953	0.869
38	Florida	0.847	0.771	0.978	0.866
39	Oklahoma	0.835	0.805	0.949	0.863
40	North Carolina	0.825	0.791	0.964	0.860
41	Texas	0.836	0.776	0.965	0.859
42	Kentucky	0.823	0.801	0.950	0.858
43	Tennessee	0.822	0.779	0.962	0.854
44	Georgia	0.810	0.765	0.973	0.850
45	West Virginia	0.821	0.789	0.934	0.848
46	Arkansas	0.822	0.776	0.940	0.846
47	South Carolina	0.809	0.754	0.966	0.843
48	Alabama	0.811	0.759	0.955	0.842
49	Louisiana	0.801	0.736	0.948	0.828
50	Mississippi	0.801	0.725	0.933	0.819
51	District of Columbia	0.717	0.680	1.000	0.799

Source: Author's calculations using data described in Appendix A.

Table D.2: U.S. HDIs for Subnational Groups and Country HDIs (2002)

HDI Rank	Country	H-Index	E-Index	Y-Index	HDI
22	Israel	0.90	0.94	0.88	0.908
23	**Minnesota**	**0.88**	**0.85**	**1.00**	**0.908**
24	**White Women**	**0.93**	**0.84**	**0.95**	**0.907**
25	**New Hampshire**	**0.86**	**0.86**	**1.00**	**0.906**
26	Hong Kong, China (SAR)	0.91	0.86	0.93	0.903
27	**All Whites**	**0.87**	**0.84**	**1.00**	**0.902**
28	Greece	0.89	0.95	0.87	0.902
29	Singapore	0.88	0.91	0.92	0.902
30	**Colorado**	**0.87**	**0.84**	**0.99**	**0.901**
31	**Connecticut**	**0.87**	**0.83**	**1.00**	**0.900**
32	**Vermont**	**0.86**	**0.85**	**0.99**	**0.898**
33	**Hawaii**	**0.89**	**0.82**	**0.99**	**0.898**
34	Portugal	0.85	0.97	0.87	0.897
35	**Massachusetts**	**0.86**	**0.83**	**1.00**	**0.896**
36	**Washington**	**0.86**	**0.83**	**0.99**	**0.896**
37	**Utah**	**0.88**	**0.86**	**0.95**	**0.895**
38	Slovenia	0.85	0.96	0.87	0.895
39	**Alaska**	**0.83**	**0.86**	**0.99**	**0.894**
40	**Wisconsin**	**0.86**	**0.84**	**0.98**	**0.894**
41	**Nebraska**	**0.87**	**0.85**	**0.97**	**0.893**
42	**Iowa**	**0.87**	**0.84**	**0.97**	**0.892**
43	**Wyoming**	**0.85**	**0.84**	**0.98**	**0.892**
44	**Kansas**	**0.86**	**0.84**	**0.97**	**0.892**
45	**Rhode Island**	**0.86**	**0.82**	**0.99**	**0.891**
46	**North Dakota**	**0.88**	**0.83**	**0.96**	**0.890**
47	**Maine**	**0.86**	**0.84**	**0.97**	**0.890**
48	**White Men**	**0.83**	**0.84**	**1.00**	**0.889**
49	Korea, Rep. of	0.84	0.97	0.86	0.888
50	Barbados	0.87	0.95	0.84	0.888
51	**All Asians**	**0.95**	**0.71**	**1.00**	**0.888**
52	**Asian Women**	**1.01**	**0.71**	**0.94**	**0.885**
53	**Oregon**	**0.86**	**0.82**	**0.97**	**0.884**
54	**Idaho**	**0.86**	**0.84**	**0.95**	**0.883**
55	Cyprus	0.89	0.89	0.87	0.883
56	**South Dakota**	**0.87**	**0.83**	**0.96**	**0.883**
57	**All Women**	**0.92**	**0.80**	**0.93**	**0.881**
58	**Pacific Islander Women**	**1.01**	**0.71**	**0.93**	**0.881**
59	**All Pacific Islanders**	**0.95**	**0.71**	**0.98**	**0.881**
60	**Virginia**	**0.84**	**0.80**	**1.00**	**0.880**
61	**Delaware**	**0.83**	**0.81**	**1.00**	**0.880**
62	**New Jersey**	**0.84**	**0.80**	**1.00**	**0.879**
63	**Asian Men**	**0.92**	**0.72**	**1.00**	**0.878**
64	**Pacific Islander Men**	**0.92**	**0.72**	**1.00**	**0.878**
65	**Maryland**	**0.83**	**0.80**	**1.00**	**0.878**
66	**Michigan**	**0.83**	**0.82**	**0.98**	**0.878**
67	**Arizona**	**0.85**	**0.81**	**0.97**	**0.878**
68	**Montana**	**0.85**	**0.83**	**0.95**	**0.877**
69	**California**	**0.85**	**0.79**	**0.99**	**0.876**
70	Malta	0.89	0.87	0.86	0.875
71	**Nevada**	**0.82**	**0.82**	**0.98**	**0.875**
72	**Illinois**	**0.83**	**0.80**	**0.99**	**0.874**
73	**United States total**	**0.85**	**0.79**	**0.98**	**0.874**
74	**Ohio**	**0.84**	**0.81**	**0.97**	**0.874**
75	**Indiana**	**0.84**	**0.82**	**0.96**	**0.873**
76	**Missouri**	**0.84**	**0.81**	**0.97**	**0.873**
77	**Pennsylvania**	**0.84**	**0.80**	**0.98**	**0.872**
78	**New York**	**0.83**	**0.78**	**1.00**	**0.870**
79	**New Mexico**	**0.85**	**0.81**	**0.95**	**0.869**
80	Czech Republic	0.84	0.92	0.84	0.868
81	Brunei Darussalam	0.85	0.87	0.88	0.867
82	**Florida**	**0.85**	**0.77**	**0.98**	**0.866**
83	**Oklahoma**	**0.84**	**0.81**	**0.95**	**0.863**
84	**All Men**	**0.81**	**0.78**	**1.00**	**0.863**
85	**North Carolina**	**0.82**	**0.79**	**0.96**	**0.860**
86	**Texas**	**0.84**	**0.78**	**0.96**	**0.859**
87	**Kentucky**	**0.82**	**0.80**	**0.95**	**0.858**
88	**American Indian Women**	**0.94**	**0.77**	**0.86**	**0.856**

Table D.2 (continued): U.S. HDIs for Subnational Groups and Country HDIs (2002)

HDI Rank	Country	H-Index	E-Index	Y-Index	HDI
89	**Tennessee**	**0.82**	**0.78**	**0.96**	**0.854**
90	Argentina	0.82	0.96	0.78	0.853
91	Seychelles	0.80	0.90	0.87	0.853
92	Estonia	0.78	0.98	0.80	0.853
93	Poland	0.81	0.96	0.78	0.850
94	**Georgia**	**0.81**	**0.77**	**0.97**	**0.850**
95	Hungary	0.78	0.95	0.82	0.848
96	**West Virginia**	**0.82**	**0.79**	**0.93**	**0.848**
97	**Arkansas**	**0.82**	**0.78**	**0.94**	**0.846**
98	Saint Kitts and Nevis	0.75	0.98	0.80	0.844
99	Bahrain	0.81	0.85	0.86	0.843
100	**South Carolina**	**0.81**	**0.75**	**0.97**	**0.843**
101	Lithuania	0.79	0.96	0.77	0.842
102	Slovakia	0.81	0.91	0.81	0.842
103	**Alabama**	**0.81**	**0.76**	**0.96**	**0.842**
104	**All American Indians**	**0.85**	**0.76**	**0.91**	**0.840**
105	Chile	0.85	0.90	0.77	0.839
106	Kuwait	0.86	0.81	0.85	0.838
107	Costa Rica	0.88	0.87	0.75	0.834
108	Uruguay	0.84	0.94	0.73	0.833
109	Qatar	0.78	0.83	0.88	0.833
110	**American Indian Men**	**0.79**	**0.76**	**0.94**	**0.833**
111	Croatia	0.82	0.90	0.77	0.830
112	**Louisiana**	**0.80**	**0.74**	**0.95**	**0.828**
113	United Arab Emirates	0.83	0.74	0.90	0.824
114	Latvia	0.76	0.95	0.75	0.823
115	**Mississippi**	**0.80**	**0.72**	**0.93**	**0.819**
116	Bahamas	0.70	0.88	0.86	0.815
117	Cuba	0.86	0.91	0.66	0.809
118	Mexico	0.81	0.85	0.75	0.802
119	**Black Women**	**0.83**	**0.68**	**0.90**	**0.801**
120	Trinidad and Tobago	0.77	0.87	0.76	0.801
121	Antigua and Barbuda	0.82	0.80	0.78	0.800
122	**Latino Women**	**0.97**	**0.59**	**0.84**	**0.799**
123	**District of Columbia**	**0.72**	**0.68**	**1.00**	**0.799**
124	Bulgaria	0.77	0.91	0.71	0.796
125	Russian Federation	0.69	0.95	0.74	0.795
126	Libyan Arab Jamahiriya	0.79	0.87	0.72	0.794
127	Malaysia	0.80	0.83	0.75	0.793
128	Macedonia, TFYR	0.81	0.87	0.70	0.793
129	Panama	0.83	0.86	0.69	0.791
130	Belarus	0.75	0.95	0.67	0.790
131	**All Latinos**	**0.89**	**0.58**	**0.89**	**0.788**
132	Tonga	0.72	0.93	0.71	0.787
133	Mauritius	0.78	0.79	0.78	0.785
134	**Latino Men**	**0.84**	**0.58**	**0.93**	**0.784**
135	Albania	0.81	0.89	0.65	0.781
136	Bosnia and Herzegovina	0.82	0.84	0.68	0.781
137	Suriname	0.77	0.87	0.70	0.780
138	Venezuela	0.81	0.86	0.67	0.778
139	Romania	0.76	0.88	0.70	0.778
140	Ukraine	0.74	0.94	0.65	0.777
141	Saint Lucia	0.79	0.88	0.66	0.777
142	Brazil	0.72	0.88	0.73	0.775
143	**All Blacks**	**0.73**	**0.68**	**0.92**	**0.774**
144	Colombia	0.78	0.84	0.69	0.773
145	Oman	0.79	0.71	0.82	0.770
146	Samoa (Western)	0.75	0.89	0.67	0.769
147	Thailand	0.74	0.86	0.71	0.768
148	Saudi Arabia	0.79	0.71	0.81	0.768
149	Kazakhstan	0.69	0.93	0.68	0.766
150	Jamaica	0.84	0.83	0.61	0.764
151	Lebanon	0.81	0.84	0.63	0.758
152	Fiji	0.74	0.86	0.67	0.758
153	Armenia	0.79	0.90	0.57	0.754
154	Philippines	0.75	0.89	0.62	0.753
155	**Black Men**	**0.65**	**0.68**	**0.93**	**0.752**
156	Maldives	0.70	0.91	0.65	0.752

Source: Author's calculations using data described in Appendix A.

APPENDIX E

CHAPTER 5 DATA

Table E.1: Data used in calculating GDI (2003)

HDI		Population Share		Life Expectancy		Literacy		Enrollment		Earned Income	
rank	Country	F	M	F	M	F	M	F	M	F	M
1	Norway	0.503	0.497	81.9	76.8	99.0	99.0	100	97	$32,272	$43,148
2	Australia	0.506	0.494	82.8	77.7	99.0	99.0	100	100	$24,827	$34,446
3	Iceland	0.500	0.500	82.6	78.7	99.0	99.0	100	91	$25,411	$36,908
4	Sweden	0.504	0.496	82.4	77.9	99.0	99.0	100	100	$21,842	$31,722
5	Canada	0.504	0.496	82.4	77.4	99.0	99.0	96	92	$23,922	$37,572
6	Switzerland	0.516	0.484	83.2	77.6	99.0	99.0	88	92	$28,972	$32,149
7	Luxembourg	0.507	0.493	81.5	75.2	99.0	99.0	89	88	$34,890	$40,000
8	United States	0.508	0.492	80.0	74.6	99.0	99.0	97	89	$29,017	$46,456
9	Belgium	0.509	0.491	82.0	75.7	99.0	99.0	100	100	$19,951	$37,019
10	Finland	0.510	0.490	81.7	75.1	99.0	99.0	100	100	$23,211	$32,250
11	Netherlands	0.504	0.496	81.1	75.7	99.0	99.0	99	99	$20,512	$38,389
12	Ireland	0.503	0.497	80.3	75.1	99.0	99.0	97	89	$22,125	$53,549
13	Denmark	0.505	0.495	79.4	74.8	99.0	99.0	100	97	$26,587	$36,430
14	Japan	0.512	0.488	85.4	78.4	99.0	99.0	83	85	$17,795	$38,612
15	United Kingdom	0.512	0.488	80.6	76.0	99.0	99.0	100	100	$20,790	$33,713
16	France	0.513	0.487	83.0	75.9	99.0	99.0	94	90	$20,642	$35,123
17	Italy	0.515	0.485	83.1	76.9	99.0	99.0	89	85	$17,176	$37,670
18	New Zealand	0.509	0.491	81.3	76.8	99.0	99.0	100	94	$18,379	$26,960
19	Austria	0.511	0.489	81.8	76.0	99.0	99.0	90	88	$15,878	$45,174
20	Germany	0.512	0.488	81.5	75.7	99.0	99.0	88	90	$19,534	$36,258
21	Spain	0.509	0.491	83.2	75.9	99.0	99.0	96	91	$13,854	$31,322
22	Israel	0.505	0.495	81.7	77.6	95.6	98.3	93	89	$14,159	$25,969
23	Hong Kong, China (SAR)	0.524	0.476	84.6	78.7	89.6	96.9	73	74	$19,593	$35,037
24	Greece	0.506	0.494	80.9	75.6	99.0	99.0	93	91	$12,531	$27,591
25	Slovenia	0.512	0.488	80.0	72.7	99.0	99.0	99	92	$14,751	$23,779
26	Portugal	0.517	0.483	80.6	73.9	99.0	99.0	97	90	$12,853	$23,829
27	Korea, Rep. of	0.499	0.501	80.6	73.3	99.0	99.0	87	100	$11,698	$24,167
28	Cyprus	0.514	0.486	81.1	76.1	95.1	98.6	79	78	$11,864	$25,260
29	Barbados	0.517	0.483	78.5	71.4	99.0	99.0	94	84	$11,976	$19,687
30	Czech Republic	0.513	0.487	78.7	72.3	99.0	99.0	81	80	$12,843	$20,051
31	Hungary	0.524	0.476	76.8	68.6	99.0	99.0	92	87	$11,287	$18,183
32	Malta	0.504	0.496	80.8	75.9	89.2	86.4	80	78	$9,893	$25,525
33	Poland	0.515	0.485	78.4	70.3	99.0	99.0	93	88	$8,769	$14,147
34	Argentina	0.511	0.489	78.2	70.7	97.2	97.2	99	91	$6,635	$17,800
35	Estonia	0.540	0.460	77.0	65.6	99.0	99.0	99	87	$10,745	$16,750
36	Lithuania	0.534	0.466	77.8	66.6	99.0	99.0	98	90	$9,595	$14,064
37	Slovakia	0.515	0.485	77.9	70.1	99.0	99.0	76	74	$10,681	$16,463
38	Chile	0.505	0.495	80.9	74.8	95.6	95.8	81	82	$5,753	$14,872
39	Kuwait	0.400	0.600	79.5	75.2	81.0	84.7	85	75	$8,448	$24,204
40	Croatia	0.519	0.481	78.4	71.4	97.1	99.0	76	74	$8,047	$14,351
41	Bahrain	0.430	0.570	75.9	73.1	83.0	92.5	85	77	$7,685	$24,909
42	Uruguay	0.515	0.485	79.0	71.7	98.1	97.3	93	83	$5,763	$10,950
43	Latvia	0.543	0.457	77.0	65.8	99.0	99.0	95	84	$8,050	$12,886
44	Costa Rica	0.492	0.508	80.6	75.9	95.9	95.7	69	67	$5,236	$14,000
45	Bulgaria	0.516	0.484	75.6	68.9	97.7	98.7	78	77	$6,212	$9,334
46	Mexico	0.511	0.489	77.5	72.6	88.7	92.0	76	74	$5,068	$13,506
47	Panama	0.496	0.504	77.4	72.3	91.2	92.5	82	76	$4,597	$9,069
48	Trinidad and Tobago	0.507	0.493	73.0	66.9	97.9	99.0	67	64	$6,792	$14,807
49	Macedonia, TFYR	0.501	0.499	76.3	71.3	94.1	98.2	71	69	$4,861	$8,725
50	Malaysia	0.492	0.508	75.6	70.9	85.4	92.0	73	68	$6,075	$12,869
51	Romania	0.513	0.487	75.0	67.8	96.3	98.4	73	70	$5,391	$9,261
52	Brazil	0.507	0.493	74.6	66.6	88.6	88.3	93	89	$4,704	$10,963
53	Belarus	0.533	0.467	74.0	62.4	99.0	99.0	91	86	$4,842	$7,418
54	Mauritius	0.504	0.496	75.7	68.8	80.5	88.2	71	71	$6,084	$16,606
55	Colombia	0.506	0.494	75.4	69.3	94.6	93.7	72	69	$4,557	$8,892
56	Albania	0.504	0.496	76.7	71.0	98.3	99.0	70	68	$3,266	$5,836
57	Thailand	0.509	0.491	73.8	66.3	90.5	94.9	72	72	$5,784	$9,452
58	Venezuela	0.498	0.502	75.9	70.0	92.7	93.3	76	73	$2,890	$6,929
59	Ukraine	0.541	0.459	72.5	60.1	99.0	99.0	87	84	$3,891	$7,329
60	Kazakhstan	0.521	0.479	69.0	57.8	99.0	99.0	87	83	$5,221	$8,217
61	Oman	0.438	0.562	75.7	72.8	65.4	82.0	63	63	$4,013	$21,614
62	Armenia	0.534	0.466	74.7	68.0	99.0	99.0	74	69	$3,026	$4,352
63	Philippines	0.497	0.503	72.5	68.3	92.7	92.5	83	80	$3,213	$5,409
64	China	0.486	0.514	73.5	69.9	86.5	95.1	68	70	$3,961	$5,976
65	Saudi Arabia	0.460	0.540	73.9	70.1	69.3	87.1	57	58	$4,440	$20,717
66	Sri Lanka	0.492	0.508	76.8	71.5	88.6	92.2	69	67	$2,579	$5,009
67	Peru	0.497	0.503	72.6	67.5	82.1	93.5	88	87	$2,231	$8,256
68	Lebanon	0.510	0.490	74.2	69.8	81.0	92.4	80	77	$2,430	$7,789
69	Tunisia	0.496	0.504	75.4	71.2	65.3	83.4	76	73	$3,840	$10,420
70	Fiji	0.492	0.508	70.1	65.7	91.4	94.5	73	73	$3,146	$8,525

Table E.1 (continued): Data used in calculating GDI (2003)

HDI rank		Population Share		Life Expectancy		Literacy		Enrollment		Earned Income	
	Country	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**
71	Turkey	0.496	0.504	71.1	66.5	81.1	95.7	62	74	$4,276	$9,286
72	Paraguay	0.496	0.504	73.2	68.7	90.2	93.1	74	73	$2,316	$7,000
73	Jordan	0.480	0.520	72.9	69.9	84.7	95.1	79	77	$2,004	$6,491
74	Dominican Republic	0.495	0.505	71.0	63.9	87.3	88.0	81	71	$3,608	$9,949
75	Jamaica	0.506	0.494	72.5	69.0	91.4	83.8	77	71	$3,279	$4,944
76	Belize	0.495	0.505	74.5	69.5	77.1	76.7	78	76	$2,695	$11,143
77	Azerbaijan	0.515	0.485	70.5	63.2	98.2	99.0	68	71	$2,683	$4,591
78	Iran, Islamic Rep. of	0.493	0.507	71.9	69.0	70.4	83.5	65	72	$3,094	$10,856
79	Guyana	0.515	0.485	66.1	60.0	98.2	99.0	78	77	$2,426	$6,152
80	El Salvador	0.508	0.492	73.9	67.8	77.1	82.4	67	68	$2,939	$6,689
81	Cape Verde	0.520	0.480	73.2	67.0	68.0	85.4	73	73	$3,392	$7,136
82	Algeria	0.496	0.504	72.4	69.8	60.1	79.5	72	76	$2,896	$9,244
83	Syrian Arab Republic	0.497	0.503	75.1	71.6	74.2	91.0	60	65	$1,584	$5,534
84	Viet Nam	0.501	0.499	72.6	68.6	86.9	93.9	61	67	$2,026	$2,964
85	Kyrgyzstan	0.508	0.492	71.1	62.7	98.1	99.0	83	81	$1,388	$2,128
86	Uzbekistan	0.503	0.497	69.8	63.4	98.9	99.6	74	77	$1,385	$2,099
87	Indonesia	0.501	0.499	68.8	64.9	83.4	92.5	65	67	$2,289	$4,434
88	Nicaragua	0.500	0.500	72.1	67.3	76.6	76.8	71	68	$2,018	$4,512
89	Bolivia	0.502	0.498	66.2	62.0	80.4	92.9	84	90	$1,615	$3,573
90	Mongolia	0.499	0.501	66.1	62.1	97.5	98.0	80	69	$1,478	$2,227
91	Moldova, Rep. of	0.522	0.478	71.3	63.9	95.0	97.5	64	60	$1,200	$1,850
92	South Africa	0.509	0.491	50.2	46.8	80.9	84.1	78	78	$6,505	$14,326
93	Tajikistan	0.504	0.496	66.3	61.0	99.0	99.0	69	82	$854	$1,367
94	Guatemala	0.513	0.487	71.0	63.6	63.3	75.4	59	63	$2,073	$6,197
95	Equatorial Guinea	0.505	0.495	43.9	42.6	76.4	92.1	60	71	$10,771	$27,053
96	Namibia	0.504	0.496	49.0	47.6	83.5	86.8	72	70	$4,201	$8,234
97	Morocco	0.503	0.497	71.9	67.5	38.3	63.3	54	62	$2,299	$5,699
98	India	0.487	0.513	65.0	61.8	47.8	73.4	56	64	$1,569	$4,130
99	Cambodia	0.517	0.483	59.8	52.4	64.1	84.7	54	64	$1,807	$2,368
100	Botswana	0.509	0.491	36.7	35.9	81.5	76.1	71	70	$6,617	$10,816
101	Comoros	0.498	0.502	65.4	61.1	49.1	63.5	42	51	$1,216	$2,206
102	Lao People's Dem. Rep.	0.500	0.500	55.9	53.4	60.9	77.0	55	67	$1,391	$2,129
103	Papua New Guinea	0.484	0.516	56.0	54.9	50.9	63.4	37	44	$1,896	$3,305
104	Ghana	0.494	0.506	57.3	56.3	45.7	62.9	43	48	$1,915	$2,567
105	Bangladesh	0.489	0.511	63.7	62.1	31.4	50.3	54	52	$1,245	$2,289
106	Nepal	0.505	0.495	62.0	61.2	34.9	62.7	55	66	$949	$1,868
107	Pakistan	0.485	0.515	63.2	62.8	35.2	61.7	31	43	$1,050	$3,082
108	Congo	0.504	0.496	53.2	50.7	77.1	88.9	44	52	$689	$1,238
109	Uganda	0.500	0.500	47.6	46.9	59.2	78.8	72	75	$1,169	$1,751
110	Sudan	0.497	0.503	57.9	54.9	49.9	69.2	35	41	$918	$2,890
111	Zimbabwe	0.504	0.496	36.5	37.3	86.3	93.8	51	54	$1,751	$3,042
112	Togo	0.506	0.494	56.3	52.4	38.3	68.5	52	76	$1,092	$2,318
113	Cameroon	0.503	0.497	46.5	45.1	59.8	77.0	50	60	$1,310	$2,940
114	Lesotho	0.535	0.465	37.7	34.6	90.3	73.7	67	65	$1,480	$3,759
115	Swaziland	0.518	0.482	32.9	32.1	78.1	80.4	58	61	$2,669	$6,927
116	Madagascar	0.503	0.497	56.8	54.1	65.2	76.4	40	41	$603	$1,017
117	Kenya	0.499	0.501	46.3	48.1	70.2	77.7	50	53	$1,001	$1,078
118	Mauritania	0.506	0.494	54.3	51.1	43.4	59.5	43	47	$1,269	$2,284
119	Gambia	0.504	0.496	57.1	54.3	30.9	45.0	45	50	$1,391	$2,339
120	Senegal	0.508	0.492	56.9	54.5	29.2	51.1	37	43	$1,175	$2,131
121	Yemen	0.493	0.507	61.9	59.3	28.5	69.5	41	69	$413	$1,349
122	Rwanda	0.515	0.485	45.6	42.1	58.8	70.5	53	58	$985	$1,583
123	Nigeria	0.494	0.506	43.6	43.1	59.4	74.4	57	71	$614	$1,495
124	Angola	0.507	0.493	42.3	39.3	53.8	82.1	27	32	$1,797	$2,897
125	Eritrea	0.509	0.491	55.7	51.8	45.6	68.2	30	40	$579	$1,125
126	Benin	0.496	0.504	54.7	53.2	22.6	46.4	43	66	$910	$1,316
127	Tanzania, U. Rep. of	0.503	0.497	46.3	45.5	62.2	77.5	40	42	$516	$725
128	Côte d'Ivoire	0.492	0.508	46.7	45.2	38.2	60.1	34	50	$792	$2,142
129	Malawi	0.504	0.496	39.6	39.8	54.0	74.9	69	75	$486	$717
130	Zambia	0.499	0.501	36.9	37.9	59.7	76.1	45	50	$629	$1,130
131	Congo, Dem. Rep. of the	0.504	0.496	44.1	42.1	51.9	79.8	24	31	$500	$903
132	Burundi	0.512	0.488	44.5	42.6	51.9	66.8	31	40	$545	$758
133	Mozambique	0.516	0.484	42.7	41.1	31.4	62.3	38	48	$910	$1,341
134	Ethiopia	0.503	0.497	48.7	46.6	33.8	49.2	29	42	$487	$931
135	Guinea-Bissau	0.506	0.494	46.2	43.2	24.7	55.2	29	45	$466	$960
136	Mali	0.502	0.498	48.5	47.2	11.9	26.7	27	38	$742	$1,247
137	Chad	0.505	0.495	44.7	42.5	12.7	40.6	28	48	$902	$1,525
138	Burkina Faso	0.497	0.503	48.2	46.8	8.1	18.5	20	27	$986	$1,357
139	Sierra Leone	0.507	0.493	42.1	39.4	20.5	39.8	38	52	$325	$783
140	Niger	0.489	0.511	44.4	44.3	9.4	19.6	17	25	$601	$1,056

Sources: UNDP, HDR 2005 Table 25; UNDP, World Population Prospects: The 2004 Revision Population Database.

APPENDIX F

CHAPTER 5 REPLICATION

The component indices, penalties, and GDI values used throughout this chapter are taken from the author's best replication of GDI and not directly from *HDR 2005*. The use of a replication is necessary because the UNDP does not report component indices or penalty values. After comparing several replications, one stood out as the "best" replication because it most closely approximated the GDI values reported in *HDR 2005*. The following data and assumptions were used to calculate this replication:

- Since the *HDR 2005* does not report population shares by gender or cite the source of the population share data, projected female and male population shares for 2005 were taken from the UN's World Population Prospects: The 2004 Revision Population Database. While data for 2003 were available, the 2005 data resulted in a closer approximation of the UNDP's GDI values. (These data are reported in Appendix Table A.)
- It is assumed that the UNDP has assigned the Czech Republic male and female adult literacy rates of 99.0%. No male and female adult literacy rates are reported for the Czech Republic, and there is no indication in *HDR 2005* that a value of 99.0% will be assumed. The UNDP nonetheless, includes the Czech Republic in all of the *HDR 2005* GDI calculations.
- Combined gross school enrollment rates higher than 100 percent have been rounded down to 100 percent. There is no notation of this assumption in *HDR 2005*, but, based on footnotes to past years' GDIs and footnotes to the HDI in *HDR 2005* Table 1, it appears to be the UNDP's practice.

Table F.1: GDI best replication (2003)

UNDP's GDI rank	Replication rank	HDI rank	Country	EDH	EDE	EDY	UNDP's GDI	GDI replication	UNDP's GDI less replication
1	1	1	Norway	0.906	0.988	0.988	0.960	0.961	-0.001
2	2	3	Australia	0.921	0.993	0.947	0.954	0.954	0.000
3	3	2	Iceland	0.927	0.978	0.954	0.953	0.953	0.000
4	4	6	Sweden	0.919	0.993	0.929	0.947	0.947	0.000
5	5	5	Canada	0.915	0.973	0.950	0.946	0.946	0.000
6	6	7	Switzerland	0.923	0.960	0.954	0.946	0.946	0.000
7	7	4	Luxembourg	0.889	0.955	0.988	0.944	0.944	0.000
8	8	10	United States	0.872	0.970	0.983	0.942	0.942	0.000
9	9	9	Belgium	0.898	0.993	0.932	0.941	0.941	0.000
10	10	13	Finland	0.890	0.993	0.935	0.940	0.940	0.000
11	12	8	Ireland	0.878	0.970	0.969	0.939	0.939	0.000
12	11	12	Netherlands	0.890	0.990	0.938	0.939	0.939	0.000
13	13	14	Denmark	0.868	0.988	0.957	0.938	0.938	0.000
14	14	11	Japan	0.948	0.940	0.923	0.937	0.937	0.000
15	15	15	United Kingdom	0.888	0.993	0.928	0.937	0.937	0.000
16	16	16	France	0.908	0.967	0.931	0.935	0.935	0.000
17	18	19	New Zealand	0.901	0.983	0.900	0.929	0.928	0.001
18	17	18	Italy	0.917	0.950	0.918	0.928	0.928	0.000
19	19	17	Austria	0.898	0.957	0.923	0.926	0.926	0.000
20	20	20	Germany	0.893	0.957	0.928	0.926	0.926	0.000
21	21	21	Spain	0.909	0.972	0.885	0.922	0.922	0.000
22	23	22	Hong Kong, China (SAR)	0.944	0.865	0.925	0.912	0.911	0.001
23	22	23	Israel	0.911	0.950	0.874	0.911	0.911	0.000
24	24	24	Greece	0.888	0.967	0.866	0.907	0.907	0.000
25	25	25	Slovenia	0.856	0.978	0.871	0.901	0.902	-0.001
26	26	26	Portugal	0.871	0.972	0.857	0.900	0.900	0.000
27	27	27	Korea, Rep. of	0.865	0.971	0.851	0.896	0.896	0.000
28	28	28	Cyprus	0.893	0.907	0.854	0.884	0.885	-0.001
29	29	29	Barbados	0.833	0.957	0.837	0.876	0.875	0.001
30	30	30	Czech Republic	0.842	0.928	0.845	0.872	0.872	0.000
31	31	33	Hungary	0.795	0.959	0.825	0.860	0.860	0.000
32	32	31	Malta	0.889	0.849	0.838	0.858	0.859	-0.001
33	33	34	Poland	0.822	0.962	0.783	0.856	0.856	0.000
34	34	32	Argentina	0.824	0.965	0.772	0.854	0.854	0.000
35	35	36	Estonia	0.772	0.971	0.813	0.852	0.852	0.000
36	36	37	Lithuania	0.787	0.974	0.790	0.851	0.850	0.001
37	37	38	Slovakia	0.817	0.910	0.813	0.847	0.847	0.000
38	38	35	Chile	0.881	0.910	0.746	0.846	0.846	0.000
39	39	40	Kuwait	0.874	0.818	0.837	0.843	0.843	0.000
40	41	39	Bahrain	0.827	0.857	0.825	0.837	0.836	0.001
41	40	41	Croatia	0.832	0.904	0.776	0.837	0.837	0.000
42	42	42	Uruguay	0.839	0.945	0.725	0.836	0.836	0.000
43	43	44	Latvia	0.774	0.960	0.766	0.834	0.833	0.001
44	44	43	Costa Rica	0.888	0.865	0.735	0.829	0.829	0.000
45	45	46	Bulgaria	0.788	0.913	0.720	0.807	0.807	0.000
46	46	45	Mexico	0.834	0.852	0.726	0.804	0.804	0.000
47	47	47	Panama	0.831	0.876	0.691	0.800	0.799	0.001
48	48	48	Trinidad and Tobago	0.749	0.875	0.763	0.796	0.796	0.000
49	49	49	Macedonia, TFYR	0.813	0.874	0.694	0.794	0.794	0.000
50	50	50	Malaysia	0.804	0.826	0.744	0.791	0.791	0.000
51	51	52	Romania	0.773	0.887	0.707	0.789	0.789	0.000
52	52	51	Brazil	0.760	0.893	0.705	0.786	0.786	0.000
53	53	54	Belarus	0.719	0.955	0.679	0.785	0.785	0.000
54	54	53	Mauritius	0.787	0.798	0.760	0.781	0.782	-0.001
55	55	55	Colombia	0.789	0.863	0.688	0.780	0.780	0.000
56	56	57	Albania	0.814	0.888	0.626	0.776	0.776	0.000
57	57	58	Thailand	0.751	0.857	0.715	0.774	0.774	0.000
58	58	59	Venezuela	0.799	0.868	0.626	0.765	0.765	0.000
59	59	61	Ukraine	0.688	0.945	0.655	0.763	0.763	0.000
60	61	56	Oman	0.823	0.704	0.748	0.759	0.758	0.001
61	60	63	Kazakhstan	0.638	0.944	0.694	0.759	0.759	0.000
62	62	65	Armenia	0.773	0.899	0.596	0.756	0.756	0.000
63	63	66	Philippines	0.757	0.889	0.620	0.755	0.755	0.000
64	64	67	China	0.778	0.835	0.647	0.754	0.754	0.000
65	65	60	Saudi Arabia	0.784	0.713	0.750	0.749	0.749	0.000
66	66	73	Sri Lanka	0.819	0.829	0.594	0.747	0.747	0.000
67	67	62	Peru	0.751	0.876	0.609	0.745	0.745	0.000
68	68	64	Lebanon	0.783	0.838	0.613	0.745	0.745	0.000
69	69	69	Tunisia	0.805	0.740	0.683	0.743	0.743	0.000
70	72	68	Paraguay	0.766	0.856	0.604	0.742	0.742	0.000

Table F.1 (continued): GDI best replication (2003)

UNDP's GDI rank	Replication rank	HDI rank	Country	EDH	EDE	EDY	UNDP's GDI	GDI replication	UNDP's GDI less replication
71	70	72	Fiji	0.715	0.863	0.650	0.742	0.743	-0.001
72	71	74	Turkey	0.730	0.811	0.686	0.742	0.742	0.000
73	73	70	Jordan	0.774	0.859	0.586	0.740	0.740	0.000
74	74	75	Dominican Republic	0.707	0.837	0.673	0.739	0.739	0.000
75	75	76	Jamaica	0.762	0.830	0.614	0.736	0.735	0.001
76	76	71	Belize	0.783	0.769	0.648	0.734	0.734	0.000
77	77	78	Azerbaijan	0.698	0.889	0.589	0.725	0.725	0.000
78	78	77	Iran, Islamic Rep. of	0.757	0.738	0.663	0.719	0.719	0.000
79	79	83	Guyana	0.634	0.916	0.598	0.716	0.716	0.000
80	80	80	El Salvador	0.764	0.756	0.624	0.715	0.715	0.000
81	81	81	Cape Verde	0.752	0.748	0.642	0.714	0.714	0.000
82	82	79	Algeria	0.768	0.705	0.645	0.706	0.706	0.000
83	83	82	Syrian Arab Republic	0.806	0.754	0.547	0.702	0.702	0.000
84	84	84	Viet Nam	0.760	0.815	0.532	0.702	0.702	0.000
85	85	85	Kyrgyzstan	0.698	0.930	0.471	0.700	0.700	0.000
86	86	87	Uzbekistan	0.693	0.913	0.471	0.692	0.692	0.000
87	87	86	Indonesia	0.697	0.805	0.572	0.691	0.692	-0.001
88	88	88	Nicaragua	0.745	0.743	0.561	0.683	0.683	0.000
89	89	89	Bolivia	0.652	0.864	0.522	0.679	0.679	0.000
90	90	90	Mongolia	0.652	0.900	0.481	0.677	0.678	-0.001
91	91	91	Moldova, Rep. of	0.710	0.848	0.446	0.668	0.668	0.000
92	92	93	South Africa	0.391	0.810	0.756	0.652	0.652	0.000
93	93	95	Tajikistan	0.644	0.911	0.393	0.650	0.649	0.001
94	94	92	Guatemala	0.705	0.661	0.581	0.649	0.649	0.000
95	95	94	Equatorial Guinea	0.301	0.773	0.850	0.641	0.641	0.000
96	96	97	Namibia	0.386	0.804	0.675	0.621	0.622	-0.001
97	97	96	Morocco	0.745	0.514	0.589	0.616	0.616	0.000
98	98	98	India	0.640	0.590	0.530	0.586	0.587	-0.001
99	99	99	Cambodia	0.518	0.679	0.504	0.567	0.567	0.000
100	100	100	Botswana	0.181	0.760	0.738	0.559	0.560	-0.001
101	101	101	Comoros	0.637	0.523	0.462	0.541	0.541	0.000
102	102	102	Lao People's Dem. Rep.	0.493	0.655	0.472	0.540	0.540	0.000
103	103	105	Papua New Guinea	0.506	0.512	0.535	0.518	0.518	0.000
104	104	106	Ghana	0.528	0.506	0.516	0.517	0.517	0.000
105	105	107	Bangladesh	0.631	0.442	0.467	0.514	0.514	0.000
106	106	104	Nepal	0.608	0.503	0.424	0.511	0.512	-0.001
107	107	103	Pakistan	0.632	0.423	0.468	0.508	0.508	0.000
108	108	109	Congo	0.448	0.709	0.364	0.507	0.507	0.000
109	109	111	Uganda	0.367	0.698	0.442	0.502	0.502	0.000
110	110	108	Sudan	0.523	0.514	0.447	0.495	0.494	0.001
111	111	112	Zimbabwe	0.186	0.774	0.519	0.493	0.493	0.000
112	112	110	Togo	0.489	0.533	0.453	0.491	0.491	0.000
113	113	115	Cameroon	0.344	0.630	0.487	0.487	0.487	0.000
114	114	116	Lesotho	0.183	0.766	0.511	0.487	0.487	0.000
115	115	114	Swaziland	0.114	0.726	0.615	0.485	0.485	0.000
116	116	113	Madagascar	0.507	0.604	0.338	0.483	0.483	0.000
117	117	119	Kenya	0.361	0.663	0.391	0.472	0.472	0.000
118	118	118	Mauritania	0.461	0.485	0.467	0.471	0.471	0.000
119	119	120	Gambia	0.511	0.403	0.478	0.464	0.464	0.000
120	120	121	Senegal	0.510	0.383	0.455	0.449	0.449	0.000
121	121	117	Yemen	0.593	0.446	0.308	0.448	0.449	-0.001
122	122	123	Rwanda	0.313	0.611	0.416	0.447	0.447	0.000
123	123	122	Nigeria	0.302	0.652	0.363	0.439	0.439	0.000
124	124	124	Angola	0.262	0.531	0.518	0.438	0.437	0.001
125	125	125	Eritrea	0.479	0.477	0.339	0.431	0.432	-0.001
126	126	126	Benin	0.481	0.379	0.397	0.419	0.419	0.000
127	127	128	Tanzania, U. Rep. of	0.345	0.597	0.299	0.414	0.414	0.000
128	128	127	Côte d'Ivoire	0.347	0.448	0.414	0.403	0.403	0.000
129	129	129	Malawi	0.237	0.660	0.293	0.396	0.396	0.000
130	130	130	Zambia	0.195	0.605	0.349	0.383	0.383	0.000
131	131	131	Congo, Dem. Rep. of the	0.299	0.509	0.310	0.373	0.373	0.000
132	132	133	Burundi	0.306	0.504	0.307	0.373	0.373	0.000
133	133	132	Mozambique	0.278	0.421	0.397	0.365	0.365	0.000
134	134	134	Ethiopia	0.376	0.381	0.309	0.355	0.355	0.000
135	135	135	Guinea-Bissau	0.327	0.346	0.305	0.326	0.326	0.000
136	136	137	Mali	0.378	0.217	0.373	0.323	0.323	0.000
137	137	136	Chad	0.308	0.251	0.406	0.322	0.322	0.000
138	138	138	Burkina Faso	0.373	0.154	0.407	0.311	0.311	0.000
139	139	139	Sierra Leone	0.261	0.328	0.249	0.279	0.279	0.000
140	140	140	Niger	0.318	0.154	0.341	0.271	0.271	0.000

Source: HDR 2005, and author's calculations using HDR 2005 data.

APPENDIX G

CHAPTER 5 HIDDEN PENALTY

The impact of the order of operations is demonstrated in Tables G.1 and G.2. In Table C.1, first a weighted average of log female and male income is taken; this is the order of calculations in Weighted HDI (Column 5):

(20) A = [FemalePopShare * ln(Female-Y)] + [MalePopShare * ln(Male-Y)]

Then a log is taken of the weighted average of the female and male incomes; this is the order of calculations in HDI (Column 6):

(21) B = ln[(FemalePopShare * Female-Y) + (MalePopShare * Male-Y)]

As long as female and male incomes are not equal, different orders of operation achieve different results.

Table G.1: Demonstration of impact of the order of calculations for income

Female Share	Male Share	Female Value	Male Value	Weighted Average of Log Value (A)	Log Value of Weighted Average (B)	Difference
0.50	0.50	$100	$100	4.61	4.61	0.00
0.50	0.50	$100	$200	4.95	5.01	-0.06
0.50	0.50	$100	$1,000	5.76	6.31	-0.55
0.50	0.50	$100	$10,000	6.91	8.53	-1.62
0.45	0.55	$100	$100	4.61	4.61	0.00
0.45	0.55	$100	$200	4.99	5.04	-0.06
0.45	0.55	$100	$1,000	5.87	6.39	-0.52
0.45	0.55	$100	$10,000	7.14	8.62	-1.48
0.55	0.45	$100	$100	4.61	4.61	0.00
0.55	0.45	$100	$200	4.92	4.98	-0.06
0.55	0.45	$100	$1,000	5.64	6.22	-0.58
0.55	0.45	$100	$10,000	6.68	8.42	-1.75

Source: Author's calculations.

In the health and education components, HDI's first weighted average then normalization order of operations returns a much more similar result to Weighted-HDI's normalization then average; but taking a log at a different stage of the calculation, as occurs in the income component, makes a much larger difference. For EDH, as long as female and male population shares are equal, then the order of operations is irrelevant. If the female population share is less than the male, there is a bonus to the Weighted-HDI on the order of one-tenth of one percent as compared to HDI, but if the female population share is greater, there is a penalty to Weighted-HDI on the same order of magnitude. For EDE, regardless of balance of the population shares, there is a somewhat larger penalty to Weighted-HDI, on the order of magnitude of one to ten percent of HDI. Table G.2 demonstrates these results.

Table G.2: Demonstration of impact of the order of calculations in health and education

	Female Share	Male Share	Female Value	Male Value	Weighted Average of Normalized Index	Normalization of Weighted Average	Difference
Health	0.50	0.50	50	50	0.417	0.417	0.000
	0.50	0.50	60	50	0.500	0.500	0.000
	0.50	0.50	80	50	0.667	0.667	0.000
	0.50	0.50	40	50	0.333	0.333	0.000
	0.48	0.52	50	50	0.418	0.417	0.002
	0.48	0.52	60	50	0.498	0.497	0.002
	0.48	0.52	80	50	0.658	0.657	0.002
	0.48	0.52	40	50	0.338	0.337	0.002
	0.52	0.48	50	50	0.415	0.417	-0.002
	0.52	0.48	60	50	0.502	0.503	-0.002
	0.52	0.48	80	50	0.675	0.677	-0.002
	0.52	0.48	40	50	0.328	0.330	-0.002
Education	0.50	0.50	70	70	0.700	0.750	-0.050
	0.50	0.50	70	90	0.800	0.917	-0.117
	0.50	0.50	70	100	0.850	1.000	-0.150
	0.50	0.50	70	60	0.650	0.667	-0.017
	0.48	0.52	70	70	0.700	0.750	-0.050
	0.48	0.52	70	90	0.804	0.923	-0.119
	0.48	0.52	70	100	0.856	1.010	-0.154
	0.48	0.52	70	60	0.648	0.663	-0.015
	0.52	0.48	70	70	0.700	0.750	-0.050
	0.52	0.48	70	90	0.796	0.910	-0.114
	0.52	0.48	70	100	0.844	0.990	-0.146
	0.52	0.48	70	60	0.652	0.670	-0.018

Source: Author's calculations.

APPENDIX H

CHAPTER 5 VALUING GENDER EQUALITY

Table H.1: Rankings of GDIs with higher penalty factors (2003)

Rank	Weighted HDI	GDI	GDI ε = 10	GDI ε = 100
1	Norway	Norway	Norway	Norway
2	Australia	Australia	Australia	Australia
3	Iceland	Iceland	Iceland	Switzerland
4	Sweden	Sweden	Sweden	Iceland
5	Canada	Canada	Switzerland	Luxembourg
6	Switzerland	Switzerland	Canada	Sweden
7	Luxembourg	Luxembourg	Luxembourg	Canada
8	U.S.	U.S.	U.S.	Denmark
9	Belgium	Belgium	Finland	Finland
10	Ireland	Finland	Belgium	U.S.
11	Netherlands	Netherlands	Denmark	U.K.
12	Finland	Ireland	Netherlands	Belgium
13	Japan	Denmark	U.K.	Netherlands
14	Denmark	Japan	Ireland	France
15	U.K.	U.K.	France	N.Zealand
16	France	France	Japan	Ireland
17	Italy	Italy	N.Zealand	Japan
18	Austria	N.Zealand	Italy	Germany
19	N.Zealand	Austria	Germany	Italy
20	Germany	Germany	Austria	Austria
21	Spain	Spain	Spain	Spain
22	Israel	Israel	Israel	Israel
23	Hong Kong	Hong Kong	Hong Kong	Hong Kong
24	Greece	Greece	Greece	Greece
25	Slovenia	Slovenia	Slovenia	Slovenia
26	Portugal	Portugal	Portugal	Portugal
27	S.Korea	S.Korea	S.Korea	S.Korea
28	Cyprus	Cyprus	Cyprus	Cyprus
29	Barbados	Barbados	Barbados	Czech Rep.
30	Czech Rep.	Czech Rep.	Czech Rep.	Barbados
31	Malta	Hungary	Hungary	Hungary
32	Hungary	Malta	Poland	Poland
33	Poland	Poland	Malta	Malta
34	Argentina	Argentina	Estonia	Slovakia
35	Estonia	Estonia	Lithuania	Lithuania
36	Lithuania	Lithuania	Slovakia	Argentina
37	Chile	Slovakia	Argentina	Chile
38	Slovakia	Chile	Chile	Estonia
39	Kuwait	Kuwait	Croatia	Croatia
40	Bahrain	Croatia	Kuwait	Uruguay
41	Croatia	Bahrain	Uruguay	Kuwait
42	Uruguay	Uruguay	Latvia	Costa Rica
43	Latvia	Latvia	Bahrain	Latvia
44	Costa Rica	Costa Rica	Costa Rica	Bahrain
45	Bulgaria	Bulgaria	Bulgaria	Bulgaria
46	Mexico	Mexico	Mexico	Panama
47	Panama	Panama	Panama	Mexico
48	Trin. & Tob.	Trin. & Tob.	Macedonia	Macedonia
49	Macedonia	Macedonia	Trin. & Tob.	Trin. & Tob.
50	Malaysia	Malaysia	Romania	Romania
51	Romania	Romania	Malaysia	Malaysia
52	Brazil	Brazil	Belarus	Colombia
53	Belarus	Belarus	Brazil	Albania
54	Mauritius	Mauritius	Colombia	Brazil
55	Colombia	Colombia	Albania	Belarus
56	Albania	Albania	Thailand	Thailand
57	Thailand	Thailand	Mauritius	Mauritius
58	Oman	Venezuela	Venezuela	Armenia
59	Venezuela	Ukraine	Armenia	Venezuela
60	Ukraine	Kazakhstan	Ukraine	Philippines
61	Kazakhstan	Oman	Philippines	China
62	Saudi Arabia	Armenia	Kazakhstan	Kazakhstan
63	Armenia	Philippines	China	Sri Lanka
64	Philippines	China	Sri Lanka	Ukraine
65	China	Saudi Arabia	Fiji	Fiji
66	Peru	Sri Lanka	Jamaica	Paraguay
67	Lebanon	Peru	Lebanon	Jamaica
68	Sri Lanka	Lebanon	Turkey	Lebanon
69	Tunisia	Tunisia	Paraguay	Dominican R.
70	Paraguay	Fiji	Dominican R.	Azerbaijan
71	Turkey	Turkey	Oman	Peru
72	Fiji	Paraguay	Tunisia	Turkey
73	Jordan	Jordan	Peru	Tunisia
74	Dominican R.	Dominican R.	Jordan	Belize
75	Belize	Jamaica	Saudi Arabia	Jordan
76	Jamaica	Belize	Azerbaijan	Oman
77	Azerbaijan	Azerbaijan	Belize	Guyana
78	Iran	Iran	El Salvador	Saudi Arabia
79	Guyana	Guyana	Guyana	El Salvador
80	El Salvador	El Salvador	Cape Verde	Viet Nam
81	Cape Verde	Cape Verde	Iran	Kyrgyzstan
82	Algeria	Algeria	Viet Nam	Cape Verde
83	Syria	Syria	Kyrgyzstan	Uzbekistan
84	Viet Nam	Viet Nam	Uzbekistan	Iran
85	Kyrgyzstan	Kyrgyzstan	Indonesia	Indonesia
86	Indonesia	Uzbekistan	Algeria	Nicaragua
87	Uzbekistan	Indonesia	Syria	Mongolia
88	Nicaragua	Nicaragua	Nicaragua	Algeria
89	Bolivia	Bolivia	Mongolia	Syria
90	Mongolia	Mongolia	Bolivia	Moldova
91	Moldova	Moldova	Moldova	Bolivia
92	Guatemala	South Africa	South Africa	Tajikistan
93	South Africa	Tajikistan	Tajikistan	South Africa
94	Tajikistan	Guatemala	Guatemala	Guatemala
95	Eq. Guinea	Eq. Guinea	Eq. Guinea	Namibia
96	Morocco	Namibia	Namibia	Eq. Guinea
97	Namibia	Morocco	Morocco	Morocco
98	India	India	India	Botswana
99	Cambodia	Cambodia	Cambodia	India
100	Botswana	Botswana	Botswana	Cambodia
101	Comoros	Comoros	Laos	Comoros
102	Laos	Laos	Comoros	Laos
103	Pakistan	Papua N.G.	Papua N.G.	Ghana
104	Nepal	Ghana	Ghana	Papua N.G.
105	Papua N.G.	Bangladesh	Bangladesh	Bangladesh
106	Ghana	Nepal	Congo	Congo
107	Bangladesh	Pakistan	Uganda	Uganda
108	Congo	Congo	Nepal	Zimbabwe
109	Uganda	Uganda	Zimbabwe	Nepal
110	Togo	Sudan	Madagascar	Madagascar
111	Sudan	Zimbabwe	Pakistan	Swaziland
112	Zimbabwe	Togo	Lesotho	Kenya
113	Cameroon	Cameroon	Swaziland	Lesotho
114	Lesotho	Lesotho	Sudan	Sudan
115	Swaziland	Swaziland	Cameroon	Pakistan
116	Madagascar	Madagascar	Kenya	Cameroon
117	Yemen	Kenya	Togo	Togo
118	Mauritania	Mauritania	Mauritania	Mauritania
119	Kenya	Gambia	Gambia	Gambia
120	Gambia	Senegal	Rwanda	Rwanda
121	Senegal	Yemen	Senegal	Senegal
122	Rwanda	Rwanda	Angola	Angola
123	Nigeria	Nigeria	Nigeria	Eritrea
124	Angola	Angola	Eritrea	Nigeria
125	Eritrea	Eritrea	Tanzania	Yemen
126	Benin	Benin	Yemen	Tanzania
127	Tanzania	Tanzania	Benin	Benin
128	Côte d'Ivoire	Côte d'Ivoire	Malawi	Malawi
129	Malawi	Malawi	Côte d'Ivoire	Côte d'Ivoire
130	Zambia	Zambia	Zambia	Burundi
131	Congo, D.R.	Congo, D.R.	Burundi	Zambia
132	Mozambique	Burundi	Congo, D.R.	Congo, D.R.
133	Burundi	Mozambique	Mozambique	Mozambique
134	Ethiopia	Ethiopia	Ethiopia	Ethiopia
135	Guinea-Bissau	Guinea-Bissau	Mali	Mali
136	Chad	Mali	Burkina Faso	Burkina Faso
137	Mali	Chad	Chad	Chad
138	Burkina Faso	Burkina Faso	Guinea-Bissau	Guinea-Bissau
139	Sierra Leone	Sierra Leone	Niger	Sierra Leone
140	Niger	Niger	Sierra Leone	Niger

Source: Author's calculations using HDR 2005 data.

APPENDIX I

CHAPTER 5 REGARDING THE DIRECTION OF PENALTIES

Table I.1: Female versus male component indices and HDIs for selected countries (2003)

GDI rank	Country	H Index			E Index			Y Index			HDI		
		Female	Male	Gap	Female	Male	Gap	Female	Male	Gap	Female	Male	Gap
1	Norway	0.907	0.905	0.002	0.993	0.983	0.010	0.964	1.013	-0.048	0.955	0.967	-0.012
2	Australia	0.922	0.920	0.002	0.993	0.993	0.000	0.920	0.975	-0.055	0.945	0.963	-0.018
3	Iceland	0.918	0.937	-0.018	0.993	0.963	0.030	0.924	0.987	-0.062	0.945	0.962	-0.017
4	Sweden	0.915	0.923	-0.008	0.993	0.993	0.000	0.899	0.961	-0.062	0.936	0.959	-0.024
5	Canada	0.915	0.915	0.000	0.980	0.967	0.013	0.914	0.990	-0.075	0.936	0.957	-0.021
6	Switzerland	0.928	0.918	0.010	0.953	0.967	-0.013	0.946	0.964	-0.017	0.943	0.950	-0.007
7	Luxembourg	0.900	0.878	0.022	0.957	0.953	0.003	0.977	1.000	-0.023	0.945	0.944	0.001
8	United States	0.875	0.868	0.007	0.983	0.957	0.027	0.946	1.025	-0.079	0.935	0.950	-0.015
9	Belgium	0.908	0.887	0.022	0.993	0.993	0.000	0.884	0.987	-0.103	0.929	0.956	-0.027
10	Finland	0.903	0.877	0.027	0.993	0.993	0.000	0.909	0.964	-0.055	0.935	0.945	-0.009
11	Netherlands	0.893	0.887	0.007	0.990	0.990	0.000	0.889	0.993	-0.105	0.924	0.957	-0.033
12	Ireland	0.880	0.877	0.003	0.983	0.957	0.027	0.901	1.049	-0.148	0.921	0.961	-0.039
13	Denmark	0.865	0.872	-0.007	0.993	0.983	0.010	0.932	0.984	-0.053	0.930	0.946	-0.016
14	Japan	0.965	0.932	0.033	0.937	0.943	-0.007	0.865	0.994	-0.129	0.922	0.956	-0.034
15	United Kingdom	0.885	0.892	-0.007	0.993	0.993	0.000	0.891	0.971	-0.081	0.923	0.952	-0.029
16	France	0.925	0.890	0.035	0.973	0.960	0.013	0.890	0.978	-0.089	0.929	0.943	-0.013
17	Italy	0.927	0.907	0.020	0.957	0.943	0.013	0.859	0.990	-0.131	0.914	0.947	-0.033
18	New Zealand	0.897	0.905	-0.008	0.993	0.973	0.020	0.870	0.934	-0.064	0.920	0.937	-0.017
19	Austria	0.905	0.892	0.013	0.960	0.953	0.007	0.846	1.020	-0.175	0.904	0.955	-0.052
20	Germany	0.900	0.887	0.013	0.953	0.960	-0.007	0.880	0.984	-0.103	0.911	0.943	-0.032
21	Spain	0.928	0.890	0.038	0.980	0.963	0.017	0.823	0.959	-0.136	0.910	0.938	-0.027
23	Hong Kong, China (SAR)	0.952	0.937	0.015	0.841	0.893	-0.052	0.881	0.978	-0.097	0.891	0.936	-0.045
24	Greece	0.890	0.885	0.005	0.970	0.963	0.007	0.806	0.938	-0.132	0.889	0.929	-0.040
25	Slovenia	0.875	0.837	0.038	0.990	0.967	0.023	0.834	0.913	-0.080	0.900	0.906	-0.006
26	Portugal	0.885	0.857	0.028	0.983	0.960	0.023	0.811	0.914	-0.103	0.893	0.910	-0.017
27	Korea, Rep. of	0.885	0.847	0.038	0.950	0.993	-0.043	0.795	0.916	-0.121	0.877	0.919	-0.042
28	Cyprus	0.893	0.893	0.000	0.897	0.917	-0.020	0.797	0.923	-0.126	0.863	0.911	-0.049
29	Barbados	0.850	0.815	0.035	0.973	0.940	0.033	0.799	0.882	-0.083	0.874	0.879	-0.005
30	Czech Republic	0.853	0.830	0.023	0.930	0.927	0.003	0.810	0.885	-0.074	0.865	0.880	-0.016
31	Hungary	0.822	0.768	0.053	0.967	0.950	0.017	0.789	0.868	-0.080	0.859	0.862	-0.003
32	Malta	0.888	0.890	-0.002	0.861	0.836	0.025	0.767	0.925	-0.158	0.839	0.884	-0.045
33	Poland	0.848	0.797	0.052	0.970	0.953	0.017	0.747	0.827	-0.080	0.855	0.859	-0.004
34	Argentina	0.845	0.803	0.042	0.978	0.951	0.027	0.700	0.865	-0.165	0.841	0.873	-0.032
35	Estonia	0.825	0.718	0.107	0.990	0.950	0.040	0.781	0.855	-0.074	0.865	0.841	0.024
36	Lithuania	0.838	0.735	0.103	0.987	0.960	0.027	0.762	0.826	-0.064	0.862	0.840	0.022
37	Slovakia	0.840	0.793	0.047	0.913	0.907	0.007	0.780	0.852	-0.072	0.844	0.851	-0.006
38	Chile	0.890	0.872	0.018	0.907	0.912	-0.005	0.676	0.835	-0.159	0.825	0.873	-0.048
39	Kuwait	0.867	0.878	-0.012	0.823	0.815	0.009	0.740	0.916	-0.176	0.810	0.870	-0.060
40	Croatia	0.848	0.815	0.033	0.901	0.907	-0.006	0.732	0.829	-0.097	0.827	0.850	-0.023
42	Uruguay	0.858	0.820	0.038	0.964	0.925	0.039	0.677	0.784	-0.107	0.833	0.843	-0.010
43	Latvia	0.825	0.722	0.103	0.977	0.940	0.037	0.732	0.811	-0.079	0.845	0.824	0.020
44	Costa Rica	0.885	0.890	-0.005	0.869	0.861	0.008	0.661	0.825	-0.164	0.805	0.859	-0.054
45	Bulgaria	0.802	0.773	0.028	0.911	0.915	-0.003	0.689	0.757	-0.068	0.801	0.815	-0.014
47	Panama	0.832	0.830	0.002	0.881	0.870	0.011	0.639	0.752	-0.113	0.784	0.817	-0.033
48	Trinidad and Tobago	0.758	0.740	0.018	0.876	0.873	0.003	0.704	0.834	-0.130	0.779	0.816	-0.036
49	Macedonia, TFYR	0.813	0.813	0.000	0.864	0.885	-0.021	0.648	0.746	-0.098	0.775	0.815	-0.039
51	Romania	0.792	0.755	0.037	0.885	0.889	-0.004	0.665	0.756	-0.090	0.781	0.800	-0.019
52	Brazil	0.785	0.735	0.050	0.901	0.885	0.015	0.643	0.784	-0.141	0.776	0.801	-0.025
53	Belarus	0.775	0.665	0.110	0.963	0.947	0.017	0.648	0.719	-0.071	0.795	0.777	0.018
54	Mauritius	0.803	0.772	0.032	0.773	0.825	-0.051	0.686	0.853	-0.168	0.754	0.817	-0.062
55	Colombia	0.798	0.780	0.018	0.871	0.855	0.016	0.637	0.749	-0.112	0.769	0.795	-0.026
56	Albania	0.820	0.808	0.012	0.889	0.887	0.002	0.582	0.679	-0.097	0.764	0.791	-0.028
57	Thailand	0.772	0.730	0.042	0.843	0.873	-0.029	0.677	0.759	-0.082	0.764	0.787	-0.023
58	Venezuela	0.807	0.792	0.015	0.871	0.865	0.006	0.561	0.707	-0.146	0.746	0.788	-0.042
59	Ukraine	0.750	0.627	0.123	0.950	0.940	0.010	0.611	0.717	-0.106	0.770	0.761	0.009
60	Kazakhstan	0.692	0.588	0.103	0.950	0.937	0.013	0.660	0.736	-0.076	0.767	0.754	0.014
62	Armenia	0.787	0.758	0.028	0.907	0.890	0.017	0.569	0.630	-0.061	0.754	0.759	-0.005
63	Philippines	0.750	0.763	-0.013	0.895	0.883	0.011	0.579	0.666	-0.087	0.741	0.771	-0.030
66	Sri Lanka	0.822	0.817	0.005	0.821	0.838	-0.017	0.542	0.653	-0.111	0.728	0.769	-0.041
67	Peru	0.752	0.750	0.002	0.841	0.913	-0.073	0.518	0.737	-0.218	0.704	0.800	-0.096
74	Dominican Republic	0.725	0.690	0.035	0.852	0.823	0.029	0.598	0.768	-0.169	0.725	0.760	-0.035
75	Jamaica	0.750	0.775	-0.025	0.866	0.795	0.071	0.583	0.651	-0.069	0.733	0.740	-0.008
76	Belize	0.783	0.783	0.000	0.774	0.765	0.009	0.550	0.787	-0.237	0.702	0.778	-0.076
77	Azerbaijan	0.717	0.678	0.038	0.881	0.897	-0.015	0.549	0.639	-0.090	0.716	0.738	-0.022
79	Guyana	0.643	0.625	0.018	0.915	0.917	-0.002	0.532	0.688	-0.155	0.697	0.743	-0.046
80	El Salvador	0.773	0.755	0.018	0.737	0.776	-0.039	0.564	0.702	-0.137	0.692	0.744	-0.053
81	Cape Verde	0.762	0.742	0.020	0.697	0.813	-0.116	0.588	0.712	-0.124	0.682	0.756	-0.073
85	Kyrgyzstan	0.727	0.670	0.057	0.931	0.930	0.001	0.439	0.510	-0.071	0.699	0.703	-0.005
86	Uzbekistan	0.705	0.682	0.023	0.906	0.921	-0.015	0.439	0.508	-0.069	0.683	0.703	-0.020
88	Nicaragua	0.743	0.747	-0.003	0.747	0.739	0.009	0.501	0.636	-0.134	0.664	0.707	-0.043
90	Mongolia	0.643	0.660	-0.017	0.917	0.883	0.033	0.450	0.518	-0.068	0.670	0.687	-0.017
91	Moldova, Rep. of	0.730	0.690	0.040	0.847	0.850	-0.003	0.415	0.487	-0.072	0.664	0.676	-0.012
93	Tajikistan	0.647	0.642	0.005	0.890	0.933	-0.043	0.358	0.436	-0.079	0.632	0.670	-0.039
94	Guatemala	0.725	0.685	0.040	0.619	0.713	-0.094	0.506	0.689	-0.183	0.617	0.695	-0.079
99	Cambodia	0.538	0.498	0.040	0.607	0.778	-0.171	0.483	0.528	-0.045	0.543	0.602	-0.059
100	Botswana	0.153	0.223	-0.070	0.780	0.741	0.039	0.700	0.782	-0.082	0.544	0.582	-0.038
114	Lesotho	0.170	0.202	-0.032	0.825	0.708	0.117	0.450	0.605	-0.156	0.482	0.505	-0.023

Source: Author's calculations using HDR 2005 data; shading indicates female greater than male indices

APPENDIX J

CHAPTER 5 REWARDING GENDER MORTALITY BIAS

Each section of rows in Table J.1 illustrates how the component index value for a given country changes when different gender population shares are applied. (The shaded row in each section indicates the country's actual population shares.) The range of female population shares in Table F (0.550 to 0.400) approximates the actual range among the countries for which GDI calculations are reported in *HDR 2005*.

For Belgium's income component, the penalty (or difference between using $\varepsilon = 0$ and $\varepsilon = 2$) stays the same when the population shares are varied, but the value of EDY ($\varepsilon = 2$) increases as the female population share shrinks – the less women living in Belgium, the higher the EDY. Similarly, for Estonia's life expectancy component – where, in contrast to Belgium's income component, the female index is larger than the male index – the penalty again stays the same and the EDH decreases as the female population share declines. For Algeria's income component – where the gap between the female and male indices is twice the size of those in the previous two examples – the same type of results holds. Finally, in extreme cases like Yemen's education component, where the gap between female and male indices is at its largest, as female population share decreases, not only does the EDY increase, but the size of the penalty itself also increases.

Table J.1: Demonstration of gender mortality bias in GDI (2003)

	Population Shares		Gendered Index		ED Index		
	Female	Male	Female	Male	ε = 0	ε = 2	Penalty
Belgium Income	0.550	0.450	0.884	0.987	0.930	0.928	0.003
	0.509	0.491	0.884	0.987	0.935	0.932	0.003
	0.505	0.495	0.884	0.987	0.935	0.932	0.003
	0.500	0.500	0.884	0.987	0.936	0.933	0.003
	0.450	0.550	0.884	0.987	0.941	0.938	0.003
	0.400	0.600	0.884	0.987	0.946	0.943	0.003
Estonia Health	0.550	0.450	0.825	0.718	0.777	0.773	0.004
	0.540	0.460	0.825	0.718	0.776	0.772	0.004
	0.505	0.495	0.825	0.718	0.772	0.768	0.004
	0.500	0.500	0.825	0.718	0.772	0.768	0.004
	0.450	0.550	0.825	0.718	0.766	0.763	0.004
	0.400	0.600	0.825	0.718	0.761	0.757	0.004
Algeria Income	0.550	0.450	0.562	0.756	0.649	0.635	0.014
	0.505	0.495	0.562	0.756	0.658	0.643	0.014
	0.500	0.500	0.562	0.756	0.659	0.644	0.014
	0.496	0.504	0.562	0.756	0.660	0.645	0.014
	0.450	0.550	0.562	0.756	0.668	0.654	0.014
	0.400	0.600	0.562	0.756	0.678	0.664	0.014
Yemen Education	0.550	0.450	0.327	0.693	0.492	0.429	0.063
	0.505	0.495	0.327	0.693	0.508	0.443	0.066
	0.500	0.500	0.327	0.693	0.510	0.444	0.066
	0.493	0.507	0.327	0.693	0.513	0.446	0.066
	0.450	0.550	0.327	0.693	0.528	0.461	0.068
	0.400	0.600	0.327	0.693	0.547	0.478	0.068

Source: Author's calculations using HDR 2005 data.

APPENDIX K

CHAPTER 6 PROOFS

Proof #1: Formula for component penalties

Where F and M are the female and male indices for a given component:

$$\text{(i) ED Index} = \frac{1}{\frac{0.5}{F} + \frac{0.5}{M}} = \frac{2FM}{F + M}$$

$$\text{(ii) ED Index} = \frac{4FM + F^2 - F^2 + M^2 - M^2}{2(F + M)} = \frac{(F^2 + 2FM + M^2) - (M^2 - 2FM + F^2)}{2(F + M)}$$

$$\text{(iii) ED Index} = \frac{(F + M)^2 - (M - F)^2}{2(F+M)} = \frac{F + M}{2} - \left[\frac{(M - F)^2}{4} * \frac{2}{F + M} \right]$$

$$\text{(iii) ED Index} = \frac{F + M}{2} - \left[(\tfrac{1}{2}(M - F))^2 * \frac{1}{\frac{F + M}{2}} \right]$$

And if the respective component index in HDI and gap between female and male component indices are:

$$\text{(iv) Index}^{HDI} = \frac{F + M}{2}$$

$$\text{(v) GGap} = M - F$$

Then it follows that:

$$\text{(vi) ED Index} = \text{Index}^{HDI} - \left[\frac{(\tfrac{1}{2}\text{GGap})^2}{\text{Index}^{HDI}} \right]$$

and that the component penalty is:

$$\text{(vii) Penalty}^{Component} = \left[\frac{(\tfrac{1}{2}\text{GGap})^2}{\text{Index}^{HDI}} \right]$$

Proof #2: Formula for component penalties using percentage gap

Where:

$$\text{(viii) PercentageGGap} = \frac{\text{GGap}}{\text{Index}^{\text{HDI}}}$$

it follows that:

$$\text{(ix) GGap} = \text{PercentageGGap} * \text{Index}^{\text{HDI}}$$

Therefore:

$$\text{(x) Penalty}^{\text{Component}} = \frac{(\tfrac{1}{2} * \text{PercentageGGap} * \text{Index}^{\text{HDI}})^2}{\text{Index}^{\text{HDI}}}$$

$$\text{(xi) Penalty}^{\text{Component}} = (\tfrac{1}{2}\text{PercentageGGap})^2 * \text{Index}^{\text{HDI}}$$

APPENDIX L

CHAPTER 6 RESULTS

Table L.1: Female and Male HDIs ranked together (2003)

Rank	Country		HDI
1	Male	Luxembourg	0.989
2	Male	Norway	0.967
3	Male	Australia	0.963
4	Male	Iceland	0.962
5	Male	Ireland	0.961
6	Male	Sweden	0.959
7	Male	Canada	0.957
8	Male	Netherlands	0.957
9	Male	Japan	0.956
10	Male	Belgium	0.956
11	Male	Austria	0.955
12	Female	Norway	0.955
13	Male	United Kingdom	0.952
14	Male	United States	0.950
15	Male	Switzerland	0.950
16	Male	Italy	0.947
17	Male	Denmark	0.946
18	Female	Iceland	0.945
19	Female	Australia	0.945
20	Male	Finland	0.945
21	Female	Luxembourg	0.945
22	Male	Germany	0.943
23	Male	France	0.943
24	Female	Switzerland	0.943
25	Male	Spain	0.938
26	Male	New Zealand	0.937
27	Female	Canada	0.936
28	Female	Sweden	0.936
29	Male	Hong Kong, China (SAR)	0.936
30	Female	Finland	0.935
31	Female	United States	0.935
32	Male	Israel	0.933
33	Female	Denmark	0.930
34	Female	France	0.929
35	Male	Greece	0.929
36	Female	Belgium	0.929
37	Female	Netherlands	0.924
38	Female	United Kingdom	0.923
39	Female	Japan	0.922
40	Female	Ireland	0.921
41	Female	New Zealand	0.920
42	Male	Korea, Rep. of	0.919
43	Female	Italy	0.914
44	Male	Cyprus	0.911
45	Female	Germany	0.911
46	Female	Spain	0.910
47	Male	Portugal	0.910
48	Male	Slovenia	0.906
49	Female	Austria	0.904
50	Female	Slovenia	0.900
51	Female	Portugal	0.893
52	Female	Israel	0.892
53	Female	Hong Kong, China (SAR)	0.891
54	Female	Greece	0.889
55	Male	Malta	0.884
56	Male	Czech Republic	0.880
57	Male	Bahrain	0.879
58	Male	Barbados	0.879
59	Female	Korea, Rep. of	0.877
60	Female	Barbados	0.874
61	Male	Argentina	0.873
62	Male	Chile	0.873
63	Male	Kuwait	0.870
64	Female	Estonia	0.865
65	Female	Czech Republic	0.865
66	Female	Cyprus	0.863
67	Male	Hungary	0.862
68	Female	Lithuania	0.862
69	Female	Hungary	0.859
70	Male	Poland	0.859
71	Male	Costa Rica	0.859
72	Female	Poland	0.855
73	Male	Slovakia	0.851
74	Male	Croatia	0.850
75	Female	Latvia	0.845
76	Female	Slovakia	0.844
77	Male	Uruguay	0.843
78	Female	Argentina	0.841
79	Male	Estonia	0.841
80	Male	Lithuania	0.840
81	Female	Malta	0.839
82	Male	Mexico	0.838
83	Female	Uruguay	0.833
84	Male	Oman	0.831
85	Female	Croatia	0.827
86	Female	Chile	0.825
87	Male	Latvia	0.824
88	Male	Saudi Arabia	0.819
89	Male	Malaysia	0.819
90	Male	Panama	0.817
91	Male	Mauritius	0.817
92	Male	Trinidad and Tobago	0.816
93	Male	Bulgaria	0.815
94	Male	Macedonia, TFYR	0.815
95	Female	Kuwait	0.810
96	Female	Costa Rica	0.805
97	Male	Brazil	0.801
98	Female	Bulgaria	0.801
99	Male	Romania	0.800
100	Male	Peru	0.800
101	Male	Lebanon	0.796
102	Male	Tunisia	0.795
103	Female	Belarus	0.795
104	Male	Colombia	0.795
105	Male	Jordan	0.792
106	Male	Turkey	0.791
107	Male	Albania	0.791
108	Female	Bahrain	0.789
109	Male	Venezuela	0.788
110	Male	Thailand	0.787
111	Male	Iran, Islamic Rep. of	0.785
112	Female	Panama	0.784
113	Male	Paraguay	0.781
114	Female	Romania	0.781
115	Male	China	0.780
116	Female	Trinidad and Tobago	0.779
117	Male	Fiji	0.778
118	Male	Belize	0.778
119	Female	Mexico	0.778
120	Male	Belarus	0.777
121	Female	Brazil	0.776
122	Male	Algeria	0.776
123	Female	Macedonia, TFYR	0.775
124	Male	Philippines	0.771
125	Male	Syrian Arab Republic	0.771
126	Female	Ukraine	0.770
127	Male	Sri Lanka	0.769
128	Female	Colombia	0.769
129	Female	Kazakhstan	0.767
130	Female	Malaysia	0.767
131	Female	Thailand	0.764
132	Female	Albania	0.764
133	Male	Ukraine	0.761
134	Male	Dominican Republic	0.760
135	Male	Armenia	0.759
136	Male	Cape Verde	0.756
137	Female	Armenia	0.754
138	Female	Mauritius	0.754
139	Male	Kazakhstan	0.754
140	Female	Venezuela	0.746

Table L.1 (continued): Female and Male HDIs ranked together (2003)

Rank	Country		HDI
141	Male	El Salvador	0.744
142	Male	Guyana	0.743
143	Female	Philippines	0.741
144	Male	Jamaica	0.740
145	Male	Azerbaijan	0.738
146	Female	Jamaica	0.733
147	Female	Sri Lanka	0.728
148	Female	China	0.728
149	Male	Viet Nam	0.728
150	Male	Indonesia	0.727
151	Female	Dominican Republic	0.725
152	Male	Bolivia	0.725
153	Female	Azerbaijan	0.716
154	Female	Fiji	0.713
155	Female	Paraguay	0.711
156	Male	Nicaragua	0.707
157	Male	Equatorial Guinea	0.707
158	Female	Lebanon	0.706
159	Female	Peru	0.704
160	Male	Uzbekistan	0.703
161	Male	Kyrgyzstan	0.703
162	Female	Belize	0.702
163	Female	Turkey	0.700
164	Female	Kyrgyzstan	0.699
165	Female	Tunisia	0.699
166	Female	Guyana	0.697
167	Male	Guatemala	0.695
168	Female	Jordan	0.695
169	Female	El Salvador	0.692
170	Female	Oman	0.689
171	Male	Mongolia	0.687
172	Female	Saudi Arabia	0.686
173	Male	South Africa	0.685
174	Male	Morocco	0.684
175	Female	Uzbekistan	0.683
176	Female	Cape Verde	0.682
177	Female	Viet Nam	0.679
178	Male	Moldova, Rep. of	0.676
179	Male	Tajikistan	0.670
180	Female	Mongolia	0.670
181	Female	Iran, Islamic Rep. of	0.666
182	Female	Nicaragua	0.664
183	Female	Moldova, Rep. of	0.664
184	Female	Indonesia	0.661
185	Male	India	0.660
186	Male	Namibia	0.656
187	Female	Algeria	0.650
188	Female	Syrian Arab Republic	0.650
189	Female	Bolivia	0.642
190	Female	Tajikistan	0.632
191	Female	South Africa	0.625
192	Female	Guatemala	0.617
193	Male	Cambodia	0.602
194	Male	Pakistan	0.600
195	Female	Namibia	0.593
196	Male	Nepal	0.591
197	Female	Equatorial Guinea	0.588
198	Male	Lao People's Dem. Rep.	0.587
199	Male	Comoros	0.584
200	Male	Botswana	0.582
201	Male	Yemen	0.580
202	Male	Togo	0.578
203	Male	Sudan	0.566
204	Female	Morocco	0.566
205	Male	Papua New Guinea	0.564
206	Male	Bangladesh	0.564
207	Male	Ghana	0.561
208	Male	Uganda	0.553
209	Male	Congo	0.552
210	Male	Cameroon	0.551

Rank	Country		HDI
211	Female	Botswana	0.544
212	Female	Cambodia	0.543
213	Male	Zimbabwe	0.541
214	Male	Swaziland	0.536
215	Female	India	0.530
216	Male	Madagascar	0.520
217	Male	Mauritania	0.517
218	Male	Senegal	0.509
219	Male	Nigeria	0.509
220	Male	Gambia	0.508
221	Male	Kenya	0.506
222	Female	Comoros	0.505
223	Male	Lesotho	0.505
224	Female	Lao People's Dem. Rep.	0.501
225	Male	Angola	0.499
226	Male	Eritrea	0.493
227	Male	Benin	0.490
228	Male	Côte d'Ivoire	0.486
229	Male	Rwanda	0.484
230	Female	Lesotho	0.482
231	Female	Ghana	0.479
232	Female	Papua New Guinea	0.476
233	Female	Bangladesh	0.471
234	Female	Congo	0.470
235	Female	Uganda	0.460
236	Female	Zimbabwe	0.458
237	Male	Tanzania, U. Rep. of	0.457
238	Female	Nepal	0.456
239	Male	Malawi	0.455
240	Female	Madagascar	0.452
241	Female	Swaziland	0.451
242	Male	Zambia	0.445
243	Female	Kenya	0.444
244	Male	Congo, Dem. Rep. of the	0.443
245	Female	Sudan	0.442
246	Female	Pakistan	0.442
247	Male	Mozambique	0.440
248	Female	Cameroon	0.437
249	Female	Togo	0.436
250	Female	Mauritania	0.434
251	Female	Gambia	0.430
252	Female	Rwanda	0.417
253	Male	Burundi	0.417
254	Male	Ethiopia	0.414
255	Male	Guinea-Bissau	0.413
256	Female	Senegal	0.406
257	Male	Chad	0.406
258	Female	Angola	0.392
259	Female	Eritrea	0.389
260	Female	Nigeria	0.386
261	Male	Mali	0.379
262	Female	Yemen	0.379
263	Female	Tanzania, U. Rep. of	0.378
264	Female	Benin	0.372
265	Male	Sierra Leone	0.355
266	Female	Malawi	0.352
267	Male	Burkina Faso	0.351
268	Female	Côte d'Ivoire	0.344
269	Female	Burundi	0.339
270	Female	Zambia	0.337
271	Female	Congo, Dem. Rep. of the	0.324
272	Male	Niger	0.324
273	Female	Mozambique	0.319
274	Female	Ethiopia	0.313
275	Female	Mali	0.285
276	Female	Burkina Faso	0.283
277	Female	Chad	0.277
278	Female	Guinea-Bissau	0.277
279	Female	Sierra Leone	0.234
280	Female	Niger	0.233

Source: Author's calculations using HDR 2005 data.

Table L.2: Absolute Gender Gap and Relative Gender Gap (2003)

AGG	Rank	Value		RGG	Rank	Value
Estonia	1	-0.024		Estonia	1	-2.84%
Lithuania	2	-0.022		Lithuania	2	-2.59%
Latvia	3	-0.020		Latvia	3	-2.45%
Belarus	4	-0.018		Belarus	4	-2.35%
Kazakhstan	5	-0.014		Kazakhstan	5	-1.79%
Ukraine	6	-0.009		Ukraine	6	-1.20%
Hungary	7	0.003		Hungary	7	0.37%
Poland	8	0.004		Poland	8	0.45%
Kyrgyzstan	9	0.005		Barbados	9	0.56%
Barbados	10	0.005		Kyrgyzstan	10	0.66%
Armenia	11	0.005		Slovenia	11	0.66%
Slovenia	12	0.006		Armenia	12	0.69%
Slovakia	13	0.006		Switzerland	13	0.73%
Switzerland	14	0.007		Slovakia	14	0.74%
Jamaica	15	0.008		Finland	15	1.00%
Finland	16	0.009		Jamaica	16	1.03%
Uruguay	17	0.010		Uruguay	17	1.20%
Moldova	18	0.012		Norway	18	1.27%
Norway	19	0.012		France	19	1.44%
France	20	0.013		USA	20	1.60%
Bulgaria	21	0.014		Denmark	21	1.74%
USA	22	0.015		Iceland	22	1.77%
Czech Republic	23	0.016		Moldova	23	1.77%
Denmark	24	0.016		Bulgaria	24	1.77%
Iceland	25	0.017		Czech Republic	25	1.82%
Portugal	26	0.017		Australia	26	1.85%
Mongolia	27	0.017		New Zealand	27	1.87%
New Zealand	28	0.017		Portugal	28	1.89%
Australia	29	0.018		Canada	29	2.18%
Romania	30	0.019		Romania	30	2.43%
Uzbekistan	31	0.020		Sweden	31	2.48%
Canada	32	0.021		Mongolia	32	2.54%
Azerbaijan	33	0.022		Croatia	33	2.74%
Croatia	34	0.023		Belgium	34	2.87%
Thailand	35	0.023		Spain	35	2.91%
Lesotho	36	0.023		Uzbekistan	36	2.92%
Sweden	37	0.024		Thailand	37	2.98%
Brazil	38	0.025		Azerbaijan	38	3.05%
Colombia	39	0.026		United Kingdom	39	3.10%
Spain	40	0.027		Brazil	40	3.19%
Belgium	41	0.027		Colombia	41	3.28%
Albania	42	0.028		Germany	42	3.46%
United Kingdom	43	0.029		Netherlands	43	3.46%
Philippines	44	0.030		Italy	44	3.49%
Argentina	45	0.032		Albania	45	3.56%
Germany	46	0.032		Japan	46	3.63%
Italy	47	0.033		Argentina	47	3.72%
Netherlands	48	0.033		Philippines	48	3.91%
Panama	49	0.033		Ireland	49	4.14%
Japan	50	0.034		Panama	50	4.16%
Dominican Republic	51	0.035		Greece	51	4.39%
Trinidad and Tobago	52	0.036		Israel	52	4.40%
Botswana	53	0.038		Trinidad and Tobago	53	4.54%
Tajikistan	54	0.039		Korea, Rep. of	54	4.67%
Ireland	55	0.039		Luxembourg	55	4.67%
Macedonia	56	0.039		Lesotho	56	4.69%
Greece	57	0.040		Dominican Republic	57	4.70%
Israel	58	0.040		Hong Kong	58	4.88%
Sri Lanka	59	0.041		Macedonia	59	4.95%
Venezuela	60	0.042		Malta	60	5.17%
Korea, Rep.	61	0.042		Venezuela	61	5.40%
Nicaragua	62	0.043		Sri Lanka	62	5.47%
Luxembourg	63	0.044		Cyprus	63	5.47%
Hong Kong	64	0.045		Austria	64	5.50%
Malta	65	0.045		Chile	65	5.65%
Guyana	66	0.046		Tajikistan	66	5.97%
Chile	67	0.048		Nicaragua	67	6.23%
Cyprus	68	0.049		Costa Rica	68	6.41%
Viet Nam	69	0.049		Guyana	69	6.43%
Austria	70	0.052		Malaysia	70	6.60%

Table L.2 (continued): Absolute Gender Gap and Relative Gender Gap (2003)

AGG	Rank	Value	RGG	Rank	Value
China	71	0.052	Botswana	71	6.65%
El Salvador	72	0.053	China	72	6.89%
Malaysia	73	0.053	Viet Nam	73	6.95%
Costa Rica	74	0.054	Kuwait	74	7.06%
Cambodia	75	0.059	El Salvador	75	7.28%
Kuwait	76	0.060	Mexico	76	7.40%
South Africa	77	0.060	Mauritius	77	7.89%
Mexico	78	0.060	Fiji	78	8.73%
Kenya	79	0.062	South Africa	79	9.11%
Mauritius	80	0.062	Paraguay	80	9.22%
Namibia	81	0.063	Indonesia	81	9.37%
Indonesia	82	0.065	Namibia	82	9.98%
Fiji	83	0.066	Belize	83	10.07%
Rwanda	84	0.066	Cape Verde	84	10.18%
Madagascar	85	0.068	Cambodia	85	10.26%
Burkina Faso	86	0.069	Bahrain	86	10.62%
Paraguay	87	0.070	Lebanon	87	11.88%
Cape Verde	88	0.073	Guatemala	88	11.90%
Belize	89	0.076	Bolivia	89	12.09%
Gambia	90	0.078	Turkey	90	12.15%
Tanzania	91	0.078	Peru	91	12.66%
Burundi	92	0.079	Tunisia	92	12.86%
Guatemala	93	0.079	Jordan	93	12.93%
Comoros	94	0.079	Kenya	94	13.06%
Congo	95	0.082	Madagascar	95	13.60%
Ghana	96	0.082	Comoros	96	14.45%
Mauritania	97	0.083	Rwanda	97	14.73%
Zimbabwe	98	0.083	Ghana	98	15.83%
Bolivia	99	0.083	Laos	99	15.90%
Swaziland	100	0.085	Congo	100	15.94%
Laos.	101	0.087	Iran	101	16.09%
Papua New Guinea	102	0.088	Zimbabwe	102	16.43%
Bahrain	103	0.090	Gambia	103	16.60%
Niger	104	0.090	Syria	104	16.76%
Lebanon	105	0.090	Papua New Guinea	105	16.85%
Turkey	106	0.091	Swaziland	106	17.04%
Bangladesh	107	0.093	Saudi Arabia	107	17.23%
Uganda	108	0.093	Algeria	108	17.38%
Mali	109	0.095	Mauritania	109	17.38%
Peru	110	0.096	Bangladesh	110	17.80%
Tunisia	111	0.097	Equatorial Guinea	111	18.15%
Jordan	112	0.097	Oman	112	18.21%
Ethiopia	113	0.101	Uganda	113	18.36%
Senegal	114	0.103	Morocco	114	18.75%
Malawi	115	0.104	Tanzania	115	18.77%
Eritrea	116	0.104	Burundi	116	20.82%
Angola	117	0.106	India	117	21.53%
Zambia	118	0.108	Burkina Faso	118	21.66%
Cameroon	119	0.114	Senegal	119	22.47%
Morocco	120	0.118	Cameroon	120	23.00%
Iran	121	0.118	Eritrea	121	23.51%
Benin	122	0.118	Angola	122	23.85%
Equatorial Guinea	123	0.119	Sudan	123	24.31%
Congo, D.R.	124	0.119	Malawi	124	25.65%
Sierra Leone	125	0.120	Nepal	125	25.67%
Mozambique	126	0.120	Nigeria	126	27.24%
Syria	127	0.121	Zambia	127	27.39%
Nigeria	128	0.123	Ethiopia	128	27.47%
Sudan	129	0.124	Benin	129	27.47%
Algeria	130	0.125	Togo	130	27.69%
Chad	131	0.129	Mali	131	28.39%
India	132	0.130	Pakistan	132	29.92%
Saudi Arabia	133	0.133	Congo, D.R.	133	31.00%
Nepal	134	0.135	Mozambique	134	31.72%
Guinea-Bissau	135	0.137	Niger	135	32.08%
Côte d'Ivoire	136	0.141	Côte d'Ivoire	136	33.63%
Togo	137	0.142	Chad	137	37.83%
Oman	138	0.142	Guinea-Bissau	138	39.33%
Pakistan	139	0.158	Sierra Leone	139	40.32%
Yemen	140	0.201	Yemen	140	41.19%
Source: Author's calculation using HDR 2005 data.					

Table L.3: HDI-G (2003)

HDI-G Rank	Country	HDI-G	HDI-G penalty	HDI-G Rank	Country	HDI-G	HDI-G penalty
1	Norway	0.947	0.016	71	Lebanon	0.691	0.068
2	Switzerland	0.941	0.006	72	Paraguay	0.690	0.064
3	Australia	0.937	0.018	73	Peru	0.689	0.073
4	Iceland	0.929	0.027	74	Cape Verde	0.680	0.041
5	Sweden	0.925	0.024	75	Saudi Arabia	0.679	0.092
6	Canada	0.923	0.025	76	Kyrgyzstan	0.678	0.024
7	Finland	0.923	0.018	77	El Salvador	0.677	0.046
8	Denmark	0.921	0.020	78	Viet Nam	0.677	0.027
9	Luxembourg	0.920	0.053	79	Jordan	0.677	0.076
10	USA	0.918	0.026	80	Oman	0.676	0.105
11	United Kingdom	0.910	0.029	81	Belize	0.674	0.079
12	Belgium	0.910	0.034	82	Uzbekistan	0.671	0.023
13	New Zealand	0.909	0.024	83	Guyana	0.668	0.052
14	France	0.908	0.030	84	Iran	0.655	0.082
15	Netherlands	0.908	0.035	85	Indonesia	0.654	0.043
16	Japan	0.900	0.043	86	Mongolia	0.650	0.028
17	Ireland	0.897	0.049	87	Moldova, Rep. of	0.647	0.024
18	Germany	0.896	0.034	88	Algeria	0.644	0.078
19	Italy	0.891	0.044	89	Nicaragua	0.643	0.046
20	Hong Kong	0.884	0.032	90	Syria	0.643	0.078
21	Spain	0.883	0.045	91	Bolivia	0.638	0.049
22	Austria	0.878	0.058	92	Tajikistan	0.628	0.026
23	Slovenia	0.877	0.027	93	South Africa	0.605	0.053
24	Israel	0.876	0.039	94	Guatemala	0.603	0.061
25	Portugal	0.869	0.034	95	Equatorial Guinea	0.583	0.072
26	Greece	0.869	0.044	96	Morocco	0.577	0.054
27	Korea, Rep.	0.861	0.040	97	Namibia	0.569	0.057
28	Barbados	0.850	0.028	98	Cambodia	0.556	0.015
29	Czech Republic	0.849	0.025	99	India	0.538	0.064
30	Cyprus	0.849	0.042	100	Botswana	0.514	0.051
31	Hungary	0.835	0.027	101	Comoros	0.510	0.037
32	Lithuania	0.832	0.021	102	Laos	0.507	0.038
33	Poland	0.831	0.027	103	Ghana	0.482	0.039
34	Estonia	0.830	0.025	104	Papua New Guinea	0.470	0.053
35	Slovakia	0.826	0.024	105	Bangladesh	0.467	0.053
36	Malta	0.814	0.053	106	Congo	0.466	0.046
37	Latvia	0.812	0.026	107	Nepal	0.466	0.061
38	Croatia	0.809	0.032	108	Togo	0.463	0.048
39	Argentina	0.808	0.055	109	Uganda	0.462	0.046
40	Uruguay	0.805	0.036	110	Madagascar	0.457	0.042
41	Chile	0.801	0.053	111	Zimbabwe	0.442	0.063
42	Bulgaria	0.786	0.023	112	Pakistan	0.442	0.085
43	Costa Rica	0.782	0.056	113	Sudan	0.437	0.075
44	Kuwait	0.781	0.062	114	Lesotho	0.435	0.062
45	Bahrain	0.768	0.078	115	Mauritania	0.435	0.043
46	Panama	0.766	0.038	116	Kenya	0.433	0.042
47	Macedonia	0.765	0.033	117	Cameroon	0.432	0.065
48	Romania	0.762	0.030	118	Gambia	0.429	0.041
49	Belarus	0.762	0.024	119	Swaziland	0.422	0.076
50	Trinidad and Tobago	0.759	0.043	120	Rwanda	0.415	0.035
51	Mexico	0.759	0.055	121	Senegal	0.411	0.048
52	Malaysia	0.754	0.043	122	Yemen	0.410	0.079
53	Thailand	0.750	0.027	123	Angola	0.407	0.038
54	Colombia	0.748	0.037	124	Eritrea	0.401	0.043
55	Albania	0.748	0.032	125	Benin	0.391	0.040
56	Brazil	0.746	0.047	126	Nigeria	0.378	0.075
57	Armenia	0.739	0.020	127	Tanzania	0.376	0.042
58	Mauritius	0.736	0.056	128	Malawi	0.354	0.051
59	Kazakhstan	0.735	0.025	129	Côte d'Ivoire	0.345	0.075
60	Ukraine	0.732	0.035	130	Burundi	0.342	0.036
61	Philippines	0.725	0.033	131	Mozambique	0.339	0.040
62	China	0.725	0.031	132	Congo, D.R.	0.335	0.050
63	Venezuela	0.724	0.049	133	Zambia	0.329	0.066
64	Sri Lanka	0.715	0.037	134	Ethiopia	0.315	0.052
65	Jamaica	0.707	0.031	135	Guinea-Bissau	0.296	0.051
66	Turkey	0.704	0.045	136	Chad	0.296	0.045
67	Azerbaijan	0.699	0.030	137	Mali	0.283	0.049
68	Tunisia	0.693	0.060	138	Burkina Faso	0.279	0.038
69	Fiji	0.693	0.059	139	Sierra Leone	0.236	0.062
70	Dominican Republic	0.692	0.056	140	Niger	0.223	0.059

Source: Author's calculations using HDR 2005 data.

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