
A household-based Human Development Index

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Motivation

- HDI tries to operationalize capability approach at cross-national level.
- HDI measures the average achievement in a country in three basic dimensions of human development:
 - A long and healthy life (L)
 - Education (E)
 - Standard of living (Y)

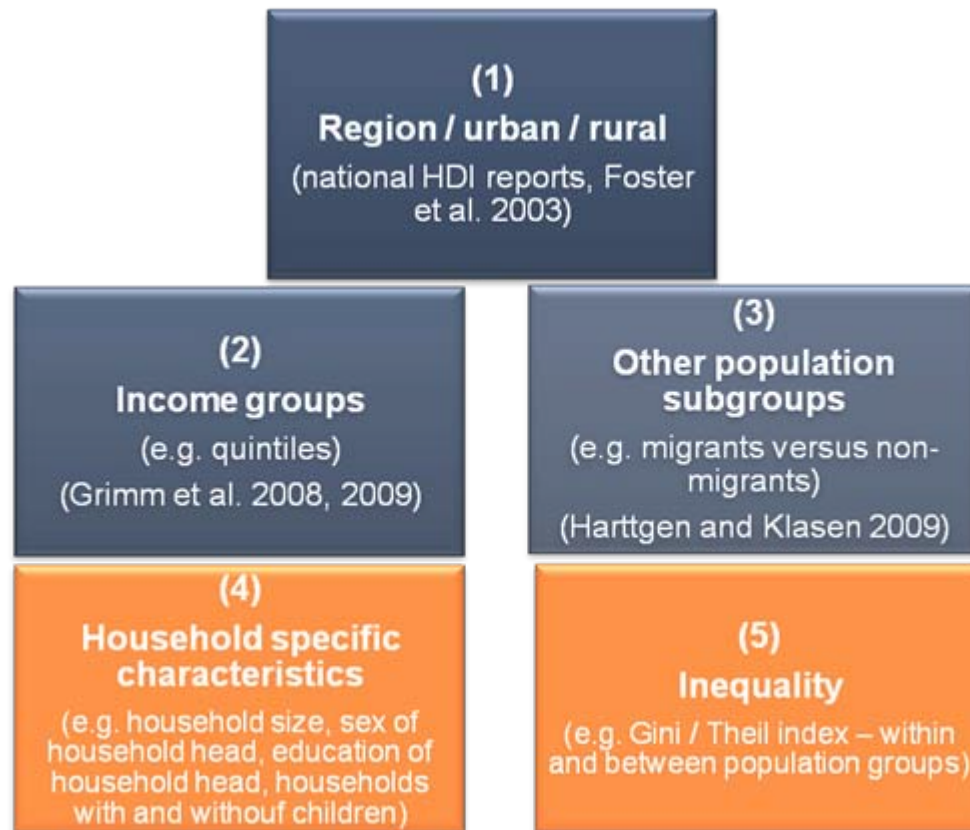
$$HDI = 1/3 L + 1/3 E + 1/3 Y$$

- HDI is today widely used in *academia*, the *media* and in *policy circles* to measure and compare progress in human development between countries and over time.
- The 2010 *Human Development Report* will revisit the concept and measurement of human development and the HDI in particular

Transparent and simple,... but also some major drawbacks:

1. **It neglects several other dimensions of human well-being** (e.g. human rights, security and political participation, see e.g. Anand and Sen (1992), Ranis, Stewart and Samman (2006));
2. **It implies substitution possibilities between the three dimension indices and it uses an arbitrary weighting scheme** (see e.g. Kelley (1991), Srinivasan (1994) and Ravallion (1997));
3. **It only looks at average achievements** (see e.g. Sagar and Najam (1998). It does not take into account inequalities between socioeconomic subgroups within countries (Foster et al. 2003; Grimm et al. (2009); Harttgen and Klasen (2009));
4. *So far, there have only been ad hoc ways to measure inequality in human development (either inequality itself, e.g. Hicks 1997; Foster et al. 2003) ; or along some other dimension of human development, e.g. Grimm et al. (2008, 2009), Harttgen and Klasen (2009), but it always remains an aggregate (not household-level) analysis.*

- A household specific HDI would allow a broad range of new analyses, including the existing *ad hoc* analyses, but much more than that !



Main challenge: overcome data problems using household survey data

- No availability of mortality, education *and* income in **one** survey
- Life expectancy and aggregate statistics: difficult to be measured at the household level
- Education indicators with lots of noise depending on presence and age of children
- Availability of income data

Outline

- Introduction
- Methodology
- Results
- Outlook and further steps

Methodology: calculating GDP component

- **Rely on data where information of mortality and education are available**
 - Demographic and Health Surveys (DHS)
- Problem: The DHS do not contain information on income or expenditure
- Approach: combine an asset index based approach with an income simulation approach (Filmer and Pritchett (2001), Harttgen and Vollmer (2010))
- **First step: Calculate an asset index**
 - Identification of a set of household assets: radio, TV, fridge, bicycle, motorized vehicle, housing characteristics, ...
 - Aggregation into one single metric index for each household using principal component analysis
 - Derive the log normal distribution
- **Assumption:**

Ownership of assets is a good proxy for income (e.g. Stewart and Simaline (2005), Filmer and Scott (2008))

Methodology: calculating GDP component

- **Fourth step: Calculate the household specific GDP component**
 - Conversion of the simulated household income per capita y_i calculated from the DHS in USD PPP
 - *Rescaling*

$$y_s^{i,PPP} = y^{i,PPP} \times \left[\frac{GDPPC^{PPP}}{\bar{y}^{PPP}} \right]$$

$$Y^i = \frac{\log \bar{y}_s^{i,PPP} - \log(100)}{\log(40,000) - \log(100)} \quad \forall i = 1, \dots, K.$$

Methodology: calculating education component

- Problems
 1. Missing data on enrolment in households without children
 2. Problem: Enrolment strongly depends on age of children

- Possible solutions:
 1. **Use only information on literacy to calculate the education component of the HDI**
 - Advantage: no imputation of missing values necessary*
 - Shortcomings:*
 - *overstates education index because literacy rate are often higher than enrolment rate*
 - *loss of one education sub-component*

 2. **Use a regression based approach to predict missing values (single deterministic and stochastic regression)**
 - Advantage: no loss of missing values*
 - Shortcomings:*
 - *strong assumptions on fit of model*
 - *issue of interpretation: generates HDI not for particular household (e.g. household number 102467) but for a hypothetical household with those characteristics)*

Methodology: calculating education component

Impute missing values

- Regression based approach: use stochastic regression method to impute missing values (e.g. Landerman et al. 1997, Allison 2007)
 - missing values are replaced by a regression-predicted score based on a set of covariates plus a residual error term

$$\tilde{x}_i = a + X_i b + u_i^*, \quad i = 1, \dots, K.$$

x_i =value of imputed value (enrolment rate) of household i

X_i =vector of covariates

b =vector of regression coefficients

u_i^* =estimated residual from the regression of x on X

Major drawback: all single imputation methods suffer from a possible underestimation of standard errors

Possible solution: multiple imputation

- A more sophisticated way to impute the missing values is multiple imputation (Rubin, 1998; Schäfer, 1997, Allison, 2007)

Methodology: calculating education component

- Literacy index (adults above the age 15)

$$A^i = \frac{a^i - 0}{1 - 0} \quad \forall i = 1, \dots, K. \quad \Rightarrow A_s^i = A^i \times \left[\frac{A^{HDR}}{\bar{A}} \right]$$

- Gross enrolment index (youth 5-23)

$$G^i = \frac{g^i - 0}{1 - 0} \quad \forall i = 1, \dots, K. \quad \Rightarrow G_s^i = G^i \times \left[\frac{G^{HDR}}{\bar{G}} \right]$$

- Education index

$$E^i = \frac{2}{3} \cdot A_s^i + \frac{1}{3} \cdot G_s^i \quad \forall i = 1, \dots, K.$$

Methodology: calculating life expectancy component

- Combining information on child mortality with model life tables.
- Calculating under five child mortality rates for each household, q_0^i , and for the whole sample.

- **Problems:**
 1. Calculation of household specific mortality rate (means); mortality is a discrete event at the household level; mortality rate will be highly discontinuous
 2. Households without children

- **Approach:**
 - Regress child mortality on socioeconomic characteristics and calculate the mean household mortality rates based on the predicted rates (regression-based imputation)

 - Impute child household specific child mortality rates for all households based on the regression prediction

- Regression approach for child mortality:
 - hazard model to control for censoring

- *Using q_5^i and modified model life tables to compute household specific life expectancy e_0^i (Murray et al. 2003) .*

Methodology: calculating life expectancy component

Modified logit life table system (Murray et al. 2003)

$$\text{Logit}(l_x^i) = \alpha_i + \beta_i * \text{Logit}(l_x^s) + \gamma_x \left[1 - \left(\frac{\text{Logit}(l_5^i)}{\text{Logit}(l_5^s)} \right) \right] + \theta_x \left[1 - \left(\frac{\text{Logit}(l_{60}^i)}{\text{Logit}(l_{60}^s)} \right) \right]$$

γ_x, θ_x Age specific – Standard Life Table

α_i, β_i Country specific

l_x, l_5, l_{60} Survival probability from 0 to x, 5, 60

... for every household $i \quad \forall i = 1, \dots, K$.

... iterative method to estimate l_5^Q and l_{60}^Q , the life table l_x ($x=1, \dots, 85$), which best fits to ${}_5q_0$ and ${}_{45}q_{15}$

■ Calculating the household specific life expectancy index:

$$L^i = \frac{\hat{e}_0^i - 25}{85 - 25} \quad \forall i = 1, \dots, K. \quad \Rightarrow L_s^i = L^i \times \left[\frac{L^{HDR}}{\bar{L}} \right]$$

Calculating the household specific HDI

$$H(D)_{household} = \mu[\mu(y), \mu(e), \mu(h)]$$

Sample of countries

- Illustrate the approach for 15 countries using Demographic and Health Surveys (DHS)

Armenia (2005)
Burkina Faso (2003)
Bolivia (2003)
Egypt (2007)
Ethiopia (2005)
India (2005)
Indonesia (2003)
Kyrgyz Republic (1997)

Nicaragua (2000)
Nigeria (2003)
Pakistan (2007)
Peru (2005)
Senegal (2005)
Vietnam (2002)
Zambia (2002)

Household specific Human Development Index

Country	HDI	HDI 2	HDI 3	GDP index	Life index	Education index (only literacy)	Education index (regression approach)	Education index (years of education)
Armenia (2005)	0.827	0.783	0.699	0.623	0.891	0.967	0.835	0.581
Egypt (2007)	0.711	0.693	0.642	0.639	0.802	0.690	0.639	0.483
Peru (2005)	0.706	0.682	0.625	0.595	0.726	0.796	0.724	0.551
Indonesia (2003)	0.709	0.680	0.610	0.568	0.784	0.777	0.690	0.476
Vietnam (2002)	0.700	0.679	0.615	0.481	0.861	0.758	0.695	0.501
Kyrgyz Republic (1997)	0.718	0.669	0.606	0.478	0.724	0.953	0.805	0.615
India (2005)	0.616	0.623	0.569	0.525	0.848	0.474	0.496	0.331
Nicaragua (2000)	0.584	0.587	0.537	0.478	0.742	0.531	0.540	0.387
Bolivia (2003)	0.614	0.583	0.528	0.447	0.678	0.715	0.624	0.453
Pakistan (2007)	0.537	0.530	0.478	0.520	0.634	0.458	0.435	0.280
Zambia (2002)	0.523	0.490	0.434	0.326	0.545	0.696	0.598	0.423
Nigeria (2003)	0.459	0.462	0.412	0.343	0.507	0.526	0.538	0.386
Senegal (2005)	0.439	0.462	0.419	0.460	0.586	0.271	0.339	0.212
Ethiopia (2005)	0.347	0.380	0.352	0.356	0.502	0.185	0.281	0.194
Burkina Faso (2003)	0.348	0.370	0.344	0.367	0.539	0.140	0.204	0.123

Source: Demographic and Health Surveys; own calculations.

Note: HDI 1 is based only on literacy; HDI 2 is based on the regression based approach for literacy and enrolment. HDI 3 is based on years of education and imputed enrolment.

Household specific Human Development Index – by HDI deciles

Country	Year	HDI										Total	Ratio	Ratio	
		1	2	3	4	5	6	7	8	9	10		10:1	10:medi an	median: 1
Armenia	2005	0.615	0.702	0.735	0.758	0.780	0.799	0.817	0.839	0.865	0.917	0.783	1.491	1.161	1.285
Egypt	2007	0.456	0.560	0.607	0.646	0.678	0.710	0.741	0.772	0.809	0.872	0.693	1.911	1.239	1.543
Peru	2005	0.399	0.509	0.569	0.617	0.658	0.695	0.730	0.766	0.805	0.867	0.682	2.174	1.235	1.760
Indonesia	2003	0.450	0.562	0.614	0.650	0.681	0.708	0.735	0.763	0.796	0.847	0.680	1.883	1.217	1.547
Vietnam	2002	0.451	0.557	0.609	0.649	0.682	0.710	0.734	0.758	0.788	0.851	0.679	1.887	1.221	1.545
Kyrgyz Republic	1997	0.483	0.565	0.607	0.640	0.667	0.691	0.717	0.740	0.768	0.826	0.669	1.710	1.218	1.403
India	2005	0.412	0.528	0.573	0.608	0.640	0.670	0.702	0.736	0.774	0.832	0.623	2.017	1.324	1.523
Nicaragua	2000	0.284	0.400	0.460	0.506	0.548	0.590	0.630	0.677	0.730	0.812	0.587	2.858	1.358	2.104
Bolivia	2003	0.292	0.414	0.480	0.530	0.575	0.614	0.654	0.695	0.743	0.819	0.583	2.808	1.364	2.058
Pakistan	2007	0.285	0.385	0.437	0.479	0.517	0.552	0.589	0.628	0.674	0.743	0.530	2.602	1.385	1.879
Zambia	2002	0.236	0.327	0.378	0.421	0.458	0.494	0.532	0.577	0.636	0.714	0.490	3.030	1.461	2.073
Nigeria	2003	0.159	0.268	0.351	0.411	0.463	0.508	0.554	0.603	0.651	0.724	0.462	4.542	1.513	3.001
Senegal	2005	0.208	0.301	0.353	0.395	0.430	0.464	0.502	0.546	0.603	0.701	0.462	3.370	1.529	2.205
Ethiopia	2005	0.189	0.258	0.302	0.337	0.370	0.405	0.438	0.480	0.545	0.675	0.380	3.567	1.815	1.965
Burkina Faso	2003	0.159	0.239	0.288	0.326	0.358	0.386	0.415	0.449	0.511	0.641	0.370	4.018	1.752	2.293

Household specific Human Development Index – by income deciles

Country	Year	By income deciles										Total	Ratio 10:1	Ratio 10:median	Ratio median:1
		1	2	3	4	5	6	7	8	9	10				
Armenia	2005	0.723	0.746	0.753	0.758	0.775	0.787	0.792	0.801	0.825	0.862	0.783	1.193	1.092	1.092
Egypt	2007	0.551	0.598	0.628	0.646	0.669	0.690	0.722	0.747	0.780	0.843	0.693	1.529	1.197	1.278
Peru	2005	0.534	0.534	0.567	0.643	0.615	0.673	0.718	0.759	0.776	0.830	0.682	1.554	1.182	1.315
Indonesia	2003	0.561	0.595	0.615	0.647	0.674	0.692	0.712	0.731	0.760	0.787	0.680	1.402	1.131	1.240
Vietnam	2002	0.534	0.621	0.622	0.684	0.685	0.683	0.714	0.722	0.766	0.791	0.679	1.483	1.135	1.306
Kyrgyz Republic	1997	0.585	0.630	0.635	0.651	0.649	0.654	0.685	0.702	0.733	0.784	0.669	1.341	1.158	1.158
India	2005	0.559	0.560	0.561	0.606	0.620	0.640	0.673	0.718	0.727	0.774	0.623	1.385	1.232	1.124
Nicaragua	2000	0.386	0.438	0.437	0.504	0.573	0.559	0.631	0.664	0.706	0.772	0.587	1.999	1.292	1.546
Bolivia	2003	0.424	0.428	0.424	0.554	0.560	0.579	0.647	0.688	0.736	0.799	0.583	1.886	1.332	1.416
Pakistan	2007	0.388	0.422	0.441	0.478	0.533	0.545	0.593	0.605	0.634	0.677	0.530	1.745	1.263	1.382
Zambia	2002	0.346	0.375	0.398	0.422	0.441	0.461	0.499	0.550	0.609	0.677	0.490	1.959	1.385	1.415
Nigeria	2003	0.260	0.320	0.364	0.430	0.434	0.475	0.528	0.563	0.590	0.677	0.462	2.602	1.415	1.839
Senegal	2005	0.318	0.336	0.346	0.388	0.403	0.463	0.488	0.518	0.573	0.635	0.462	1.995	1.385	1.440
Ethiopia	2005	0.312	0.309	0.326	0.356	0.359	0.376	0.391	0.414	0.515	0.633	0.380	2.027	1.702	1.191
Burkina Faso	2003	0.255	0.283	0.298	0.322	0.336	0.354	0.380	0.402	0.489	0.612	0.370	2.399	1.674	1.433

Source: Demographic and Health Surveys; own calculations.

Household specific Human Development Index – by urban and rural areas

Country	Year	HDI			Ratio rural / urban
		Urban	Rural	Total	
Armenia	2005	0.797	0.762	0.783	0.957
Egypt	2007	0.755	0.659	0.701	0.873
Peru	2005	0.747	0.579	0.686	0.776
Vietnam	2002	0.767	0.668	0.684	0.871
Indonesia	2003	0.717	0.640	0.676	0.893
Kyrgyz Republic	1997	0.723	0.652	0.675	0.902
India	2005	0.696	0.596	0.622	0.857
Nicaragua	2000	0.676	0.487	0.600	0.720
Bolivia	2003	0.659	0.465	0.592	0.705
Pakistan	2007	0.611	0.486	0.529	0.794
Zambia	2002	0.583	0.413	0.475	0.709
Nigeria	2003	0.559	0.414	0.466	0.742
Senegal	2005	0.571	0.377	0.463	0.660
Ethiopia	2005	0.562	0.348	0.373	0.619
Burkina Faso	2003	0.549	0.324	0.366	0.590

Source: Demographic and Health Surveys; own calculations.

Household specific Human Development Index – by education of the household head

Country	Year	HDI					Ratio higer/ no education
		No education	Primary	Secondary	Higher	Total	
Armenia	2005	0.712	0.769	0.775	0.827	0.783	1.162
Egypt	2007	0.591	0.701	0.735	0.796	0.693	1.346
Peru	2005	0.519	0.628	0.719	0.786	0.682	1.515
Indonesia	2003	0.558	0.664	0.723	0.764	0.680	1.369
Vietnam	2002	0.554	0.634	0.713	0.784	0.679	1.416
Kyrgyz Republic	1997	0.584	0.617	0.668	0.713	0.669	1.222
India	2005	0.552	0.651	0.678	0.738	0.623	1.338
Nicaragua	2000	0.471	0.588	0.702	0.750	0.586	1.592
Bolivia	2003	0.439	0.535	0.645	0.736	0.582	1.675
Pakistan	2007	0.459	0.554	0.595	0.630	0.529	1.373
Zambia	2002	0.355	0.455	0.552	0.634	0.489	1.785
Nigeria	2003	0.340	0.525	0.551	0.596	0.461	1.754
Senegal	2005	0.413	0.557	0.608	0.655	0.456	1.586
Ehtiopia	2005	0.349	0.401	0.485	0.611	0.379	1.748
Burkina Faso	2003	0.341	0.482	0.590	0.640	0.369	1.875

Source: Demographic and Health Surveys; own calculations.

Household specific Human Development Index – by sex of household head

Country	Year	HDI			Ratio female / male
		Male	Female	Total	
Armenia	2005	0.788	0.771	0.783	0.978
Egypt	2007	0.702	0.688	0.701	0.979
Peru	2005	0.685	0.687	0.686	1.003
Vietnam	2002	0.682	0.691	0.684	1.014
Indonesia	2003	0.679	0.637	0.676	0.938
Kyrgyz Republic	1997	0.671	0.690	0.675	1.028
India	2005	0.625	0.603	0.622	0.965
Nicaragua	2000	0.589	0.627	0.600	1.064
Bolivia	2003	0.589	0.610	0.592	1.036
Pakistan	2007	0.526	0.551	0.529	1.047
Zambia	2002	0.476	0.468	0.475	0.983
Nigeria	2003	0.455	0.537	0.466	1.181
Senegal	2005	0.447	0.517	0.463	1.157
Ethiopia	2005	0.364	0.415	0.373	1.138
Burkina Faso	2003	0.360	0.434	0.366	1.206

Source: Demographic and Health Surveys; own calculations.

Inequality in Human Development between countries and subgroups

Country	HDI	Gini index				GDP index (without log transform.)	Gini (PovcalNet) (%)
		Educ. index	Life index	GDP index	Income (uncapped)		
Armenia (2005)	0.059	0.053	0.119	0.090	0.334	0.340	33.8
Kyrgyz Republic (1997)	0.080	0.058	0.165	0.112	0.320	0.336	35.98
Vietnam (2002)	0.091	0.132	0.125	0.118	0.330	0.346	37.55
Indonesia (2003)	0.092	0.119	0.159	0.085	0.280	0.289	30.23
Egypt (2007)	0.095	0.158	0.128	0.083	0.310	0.316	32.14
India (2005)	0.106	0.221	0.140	0.085	0.295	0.306	33.32
Peru (2005)	0.112	0.110	0.169	0.151	0.496	0.505	53.01
Pakistan (2007)	0.144	0.266	0.207	0.101	0.305	0.317	31.18
Nicaragua (2000)	0.149	0.230	0.154	0.189	0.499	0.518	50.3
Bolivia (2003)	0.152	0.178	0.191	0.219	0.555	0.577	60.24
Zambia (2002)	0.167	0.173	0.253	0.232	0.416	0.465	42.08
Ethiopia (2005)	0.178	0.317	0.287	0.107	0.233	0.262	29.76
Senegal (2005)	0.181	0.354	0.223	0.148	0.382	0.402	39.19
Burkina Faso (2003)	0.202	0.419	0.256	0.179	0.385	0.422	39.6
Nigeria (2003)	0.214	0.281	0.304	0.219	0.424	0.467	42.93

Source: Demographic and Health Surveys; own calculations.

Note: HDI is based on the regression based approach for literacy and enrolment., The Gini for the global HDI is based on the Gray-Purser dataset.

Within and between inequality in human development by country and sub-group

	By income deciles			By urban and rural areas			By Education of household head		
	Total	Theil Index of life HDI		Total	Theil Index of life HDI		Total	Theil Index of life HDI	
		Within group	Between group		Within group	Between group		Within group	Between group
Armenia (2005)	0.006	0.005	0.001	0.006	0.006	0.000	0.006	0.006	0.000
Burkina Faso	0.073	0.042	0.031	0.073	0.053	0.020	0.073	0.059	0.014
Bolivia	0.044	0.021	0.023	0.044	0.030	0.014	0.044	0.035	0.009
Egypt (2007)	0.016	0.009	0.007	0.016	0.014	0.002	0.016	0.011	0.006
Ethiopia (2005)	0.054	0.037	0.016	0.174	0.122	0.052	0.053	0.046	0.008
India (2005)	0.016	0.011	0.005	0.016	0.014	0.002	0.016	0.013	0.003
Indonesia (2003)	0.021	0.015	0.006	0.021	0.018	0.002	0.021	0.015	0.005
Kyrgyz Republic (1997)	0.011	0.008	0.003	0.011	0.010	0.001	0.011	0.010	0.001
Nicaragua (2000)	0.042	0.019	0.024	0.042	0.029	0.013	0.042	0.030	0.012
Nigeria (2003)	0.095	0.057	0.039	0.095	0.086	0.009	0.096	0.068	0.028
Pakistan (2007)	0.037	0.021	0.016	0.037	0.031	0.006	0.037	0.028	0.008
Peru (2005)	0.023	0.012	0.011	0.023	0.015	0.008	0.023	0.018	0.006
Senegal (2005)	0.059	0.031	0.028	0.059	0.039	0.020	0.057	0.045	0.012
Vietnam (2002)	0.015	0.010	0.005	0.015	0.014	0.001	0.015	0.012	0.003
Zambia (2002)	0.050	0.026	0.024	0.050	0.036	0.013	0.050	0.038	0.012

Source: Human Development Reports, PovcalNet, World Development Indicators.

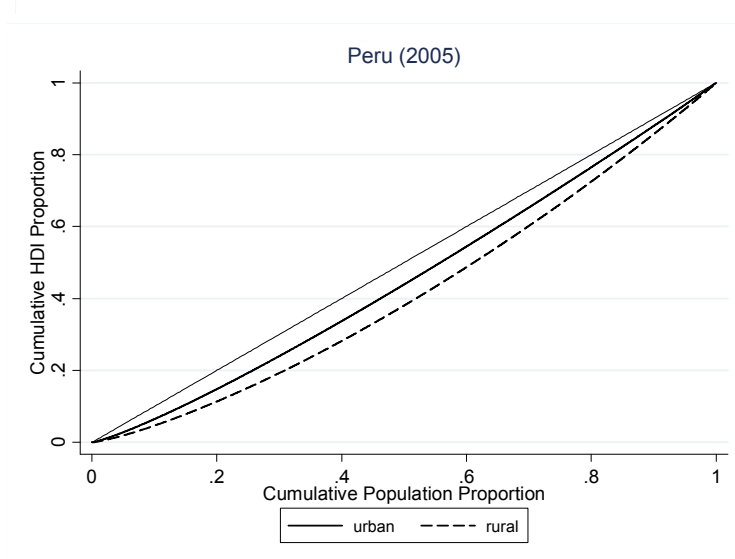
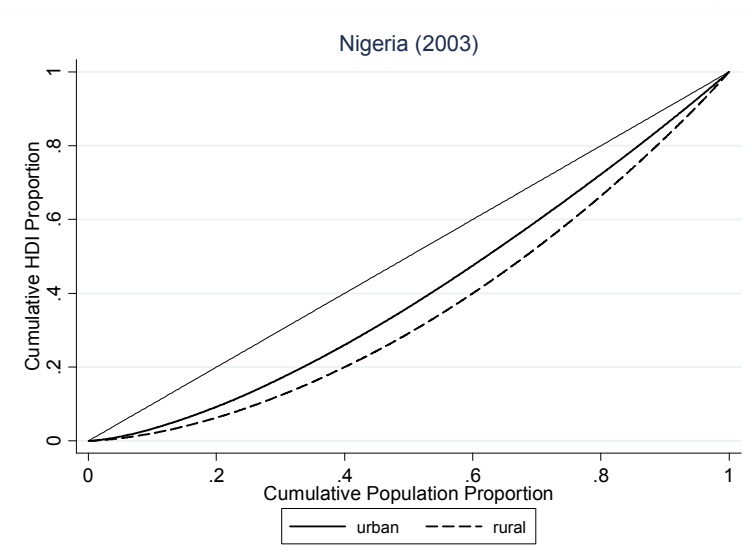
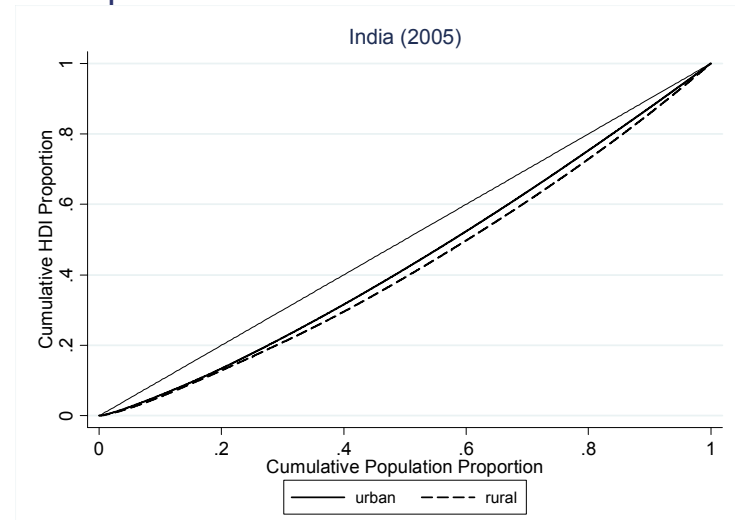
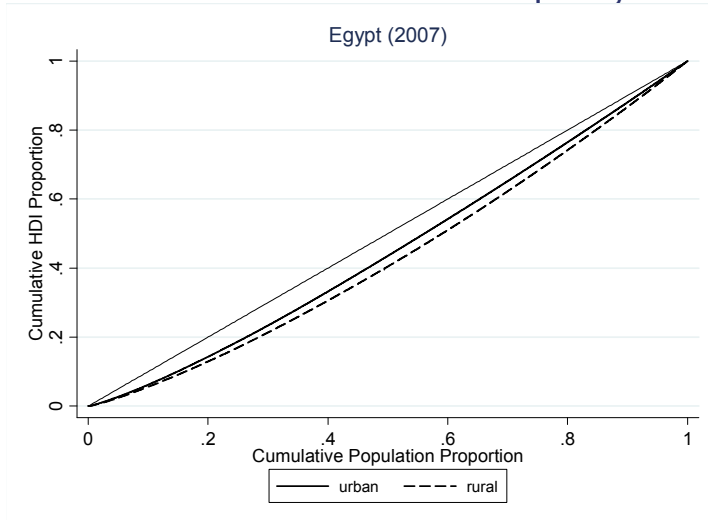
Summary

- Significant differences between two alternatives to calculate education index
- Large differences in human development across income groups
- Human development in urban areas higher than in rural areas; substantial differences in Africa
- Age and education of household head matters
- No clear picture for headship and household size (i.e. small differentials)
- Gini lower for HDI than for income
- Inequality within population subgroups always higher than between groups

- We provide a method and illustration for calculating the HDI at the household level
- Despite the assumptions that have to be made, we think that the calculation of a household specific HDI has a significant value added for the HDR.
- Allows a large range of previously unavailable analyses
- Transparent and intuitive measure of the level and inequality of deprivation in multiple dimensions within and across population subgroups and over time
- The results can provide new insights with respect to differences in the levels human development by population subgroups (e.g. inequality in HDI for different subgroups is driven by different sub-components)
- The main problem of calculating a household-based HDI is data limitation
- However – strong assumptions can be justified by applying reasonable approaches to overcome data problems
- Due to regression-based predictions: Not HDI for particular households in survey, but HDI for households with certain characteristics (those that are used in regression); but this is what should be of interest to policy-makers.
- Despite its shortcomings, this approach hopefully enhances the discussion of measurement issues concerning the HDI

- Possible to Implement in rich countries such as Germany?
- Problems:
 - Also not a single survey that cover health, education, and incomes well (possibly based on Mikrozensus?);
 - Difficult to impute differentials in life expectancy based on infant mortality rates
 - Need to study socio-economic determinants of health directly (own research project);
 - Possibly better to adjust HDI rather than calculate household-based version based on strong assumptions.
 - E.g. use subjective questions on health rather than life expectancy.

Inequality in Human Development



Appendix: calculating education component

- Illustration of the means of socioeconomic characteristics for households *with* and *without* children in school going age (Zambia 2002)

Means for household with children in school-going age			
Variable	N	Mean	Std. Dev.
Age (head)	6035	42.486	14.938
Female headed household	6035	0.221	0.415
Urban	6035	1.721	0.449
Household size	6035	5.851	2.664
Asset index	6035	-0.108	0.929
Sex (1=male)	6035	0.780	0.414
Head has no education	6006	0.464	0.499
Means for household without children in school-going age			
Age (head)	960	47.995	18.523
Female headed household	960	0.296	0.457
Urban	960	1.751	0.433
Household size	960	2.117	1.200
Asset index	960	-0.335	0.713
Sex (1=male)	960	0.704	0.457
Head has no education	958	0.608	0.489

Source: Demographic and Health Surveys; own calculations.

Appendix: calculating education component

■ Illustration of the regression results for enrolment (Zambia 2002)

Enrolment Rate	Coefficient	Std. Err.	P> z
Age (head)	0.073	0.003	0.000
Age ² (head)	-0.126	0.006	0.000
Age ³ (head)	0.007	0.000	0.000
Urban	-0.010	0.007	0.156
Female headed household (=1)	0.040	0.004	0.000
Household Size	-0.020	0.001	0.000
Number of children at home	0.039	0.002	0.000
Asset index	0.115	0.004	0.000
Sex (female=1)	0.000	0.013	0.994
Head has no education (=1)	-0.072	0.004	0.000
<i>Interactions</i>			
Sex X urban	0.000	0.000	0.608
Sex X age	0.005	0.007	0.444
Urban X age	0.000	0.000	0.000
<i>Cluster means</i>			
Mean literacy per cluster	-0.072	0.020	0.000
Mean enrolment rate per cluster	0.920	0.016	0.000
Mean Asset index value per cluster	-0.124	0.007	0.000
Mean years of education per cluster	0.012	0.003	0.001
Constant	-1.295	0.046	0.000
<i>N</i>	35121		
<i>R</i> ²	0.3001		

Note: Controlled for region dummies.

Source: Demographic and Health Survey; own calculations.

Methodology: calculating GDP component

- **Second step: Estimate household income per capita distribution**
- The national income distributions will be modeled by a log-normal distribution: $LN(\mu, \sigma)$
- The density of the log-normal distribution is given by:

$$f(x; \mu, \sigma) = \frac{1}{x\sigma\sqrt{2\pi}} \cdot e^{-(\log(x)-\mu)^2/2\sigma^2}, \quad x > 0$$

- The mean and variance are given by:

$$E(Y) = e^{\mu+\sigma^2/2} \quad \text{Var}(Y) = (e^{\sigma^2} - 1)e^{2\mu+\sigma^2}$$

- The Gini coefficient G of $LN(\mu, \sigma)$ is given by:

$$G = 2\Phi(\sigma/\sqrt{2}) - 1$$

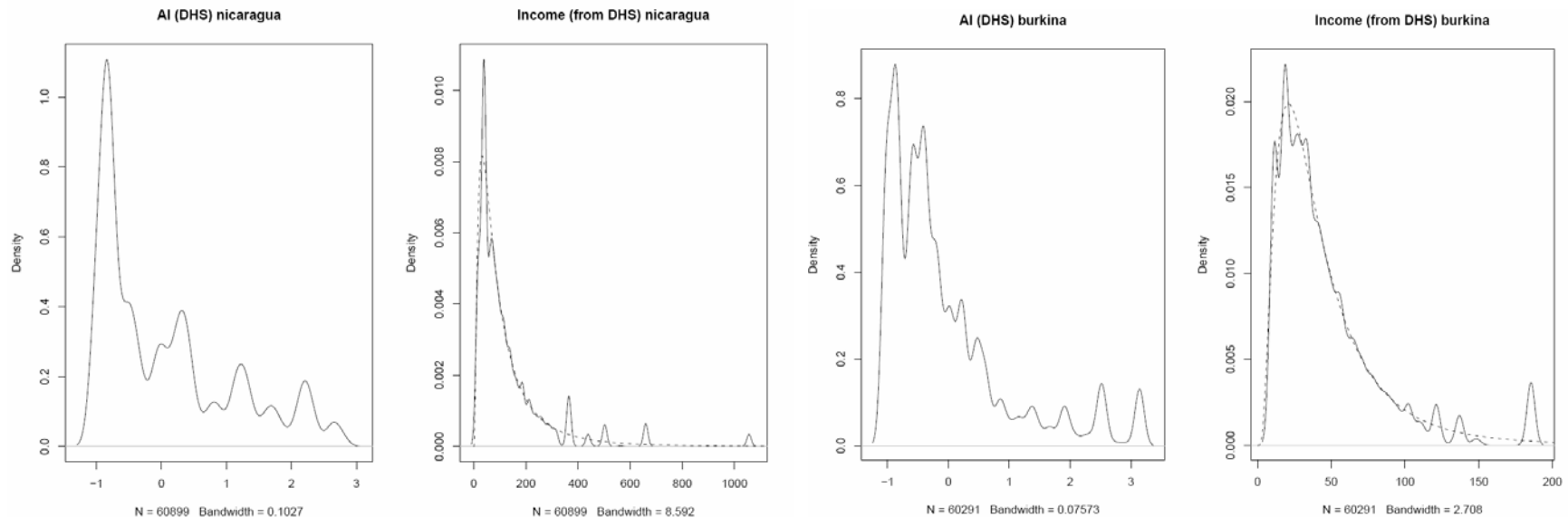
- The parameters μ and σ of $LN(\mu, \sigma)$ can be determined from the average income $E(Y)$ and the Gini coefficient G :

$$\sigma = \sqrt{2}\Phi^{-1}\left(\frac{G+1}{2}\right) \quad \mu = \log(E(Y)) - \sigma^2/2$$

- Data on the Gini and on the mean income are taken from PovcalNet.

Methodology: calculating GDP component

- **Third step: Simulate household income per capita based on the asset index**
 1. Estimate $LN_A(\mu, \sigma)$ based on the asset index – μ and σ are estimated using ML
 2. Estimate $LN_I(\mu, \sigma)$ of the income distribution – μ and σ are estimated based on the Gini and the mean income
 3. Attach to each quantum of the asset index LN_A the respective income value from the LN_I



- Approach is validated with LSMS data where both income and assets are available (Harttgen and Vollmer 2010)
- Promising first results

Incorporating inequality in dimensions and across people

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Table 3: Household based HDI, FLS and Seth measure

Country	HDI		FLS measure									
	Rank	(alpha=1)	Rank	(alpha=0)	Rank	(alpha=-1)	Rank	(alpha=-2)	Rank	(alpha=-2)	Rank	(beta=-1)
Armenia (2005)	0.783	1	0.783	1	0.759	1	0.697	1	0.318	2	0.463	1
Egypt (2007)	0.693	2	0.693	2	0.667	2	0.589	2	0.193	4	0.302	4
Indonesia (2003)	0.680	3	0.680	3	0.653	3	0.585	4	0.057	11	0.097	12
Peru (2005)	0.682	4	0.682	4	0.651	4	0.536	6	0.159	5	0.253	5
Vietnam (2002)	0.679	5	0.679	5	0.640	5	0.580	3	0.321	1	0.437	2
Kyrgyz R. (1997)	0.669	6	0.669	6	0.636	6	0.561	5	0.213	3	0.325	3
India (2005)	0.623	7	0.623	7	0.574	7	0.525	7	0.139	6	0.225	6
Nicaragua (2000)	0.587	8	0.587	8	0.537	8	0.420	8	0.137	7	0.214	7
Bolivia (2003)	0.583	9	0.583	9	0.533	9	0.411	9	0.074	10	0.124	10
Pakistan (2007)	0.530	10	0.530	10	0.485	10	0.378	10	0.099	9	0.159	9
Zambia (2002)	0.490	11	0.490	11	0.435	11	0.303	11	0.049	14	0.082	14
Senegal (2005)	0.462	12	0.462	12	0.403	12	0.292	12	0.107	8	0.162	8
Nigeria (2003)	0.462	13	0.462	13	0.400	13	0.254	13	0.042	15	0.071	15
Ethiopia (2005)	0.380	14	0.380	14	0.332	14	0.242	14	0.054	13	0.088	13
Burkina Faso (2003)	0.370	15	0.370	15	0.298	15	0.204	15	0.055	12	0.122	11

Note: HDI is based on the regression based approach for literacy and enrolment.

Household specific Education Index – by HDI deciles

Country	Year	Edu index										Total	Ratio	Ratio	
		1	2	3	4	5	6	7	8	9	10		10:1	10:median:	
Armenia	2005	0.782	0.770	0.807	0.822	0.827	0.846	0.850	0.865	0.877	0.900	0.835	1.151	1.069	1.077
Kyrgyz Republic	1997	0.729	0.764	0.774	0.793	0.800	0.808	0.812	0.841	0.852	0.888	0.805	1.218	1.091	1.117
Peru	2005	0.493	0.582	0.626	0.664	0.714	0.745	0.770	0.800	0.821	0.863	0.724	1.752	1.141	1.536
Vietnam	2002	0.458	0.533	0.608	0.654	0.702	0.730	0.766	0.803	0.830	0.860	0.695	1.877	1.178	1.593
Indonesia	2003	0.505	0.574	0.614	0.650	0.680	0.710	0.744	0.775	0.806	0.845	0.690	1.675	1.185	1.414
Egypt	2007	0.388	0.456	0.495	0.558	0.606	0.660	0.715	0.751	0.797	0.858	0.639	2.211	1.278	1.729
Bolivia	2003	0.373	0.451	0.492	0.553	0.595	0.655	0.701	0.751	0.793	0.847	0.624	2.269	1.313	1.728
Zambia	2002	0.344	0.455	0.481	0.524	0.558	0.599	0.639	0.685	0.746	0.820	0.598	2.382	1.331	1.790
Nicaragua	2000	0.236	0.301	0.350	0.410	0.467	0.528	0.593	0.674	0.731	0.820	0.540	3.476	1.495	2.325
Nigeria	2003	0.178	0.286	0.375	0.452	0.513	0.599	0.665	0.735	0.806	0.856	0.538	4.809	1.511	3.183
India	2005	0.325	0.335	0.373	0.429	0.502	0.554	0.610	0.665	0.715	0.789	0.496	2.425	1.571	1.543
Pakistan	2007	0.208	0.264	0.298	0.331	0.384	0.437	0.499	0.559	0.638	0.722	0.435	3.466	1.678	2.065
Senegal	2005	0.144	0.188	0.193	0.218	0.237	0.273	0.315	0.410	0.526	0.707	0.339	4.898	2.517	1.946
Ethiopia	2005	0.150	0.197	0.210	0.219	0.253	0.273	0.277	0.334	0.472	0.710	0.281	4.734	2.944	1.608
Burkina Faso	2003	0.095	0.110	0.123	0.129	0.135	0.157	0.180	0.218	0.352	0.591	0.204	6.231	4.381	1.422

Source: Demographic and Health Surveys; own calculations.

Household specific Life expectancy Index – by HDI deciles

Country	Year	Life index										Total	Ratio	Ratio	
		1	2	3	4	5	6	7	8	9	10		10:1	10:median:	
Armenia	2005	0.486	0.762	0.826	0.880	0.907	0.942	0.970	0.999	1.031	1.102	0.891	2.266	1.179	1.923
Vietnam	2002	0.520	0.723	0.792	0.831	0.868	0.915	0.934	0.949	0.987	1.085	0.861	2.086	1.184	1.761
India	2005	0.435	0.769	0.860	0.895	0.905	0.932	0.950	0.967	0.990	1.037	0.848	2.386	1.122	2.126
Egypt	2007	0.444	0.660	0.744	0.781	0.811	0.833	0.855	0.885	0.922	0.987	0.802	2.221	1.189	1.869
Indonesia	2003	0.353	0.602	0.700	0.763	0.815	0.844	0.873	0.911	0.955	1.019	0.784	2.889	1.173	2.464
Nicaragua	2000	0.328	0.579	0.681	0.728	0.753	0.772	0.803	0.807	0.854	0.919	0.742	2.804	1.156	2.425
Peru	2005	0.284	0.482	0.606	0.684	0.733	0.766	0.802	0.841	0.882	0.928	0.726	3.272	1.149	2.848
Kyrgyz Republic	1997	0.311	0.490	0.598	0.680	0.746	0.808	0.866	0.877	0.909	0.958	0.724	3.077	1.251	2.460
Bolivia	2003	0.242	0.495	0.628	0.676	0.727	0.749	0.774	0.795	0.823	0.886	0.678	3.659	1.204	3.039
Pakistan	2007	0.221	0.437	0.547	0.624	0.669	0.694	0.726	0.753	0.787	0.876	0.634	3.956	1.324	2.989
Senegal	2005	0.146	0.348	0.489	0.570	0.625	0.663	0.707	0.702	0.727	0.792	0.586	5.410	1.248	4.334
Zambia	2002	0.171	0.305	0.415	0.480	0.525	0.580	0.620	0.664	0.722	0.814	0.545	4.753	1.414	3.362
Burkina Faso	2003	0.116	0.303	0.423	0.523	0.606	0.646	0.687	0.721	0.711	0.772	0.539	6.657	1.323	5.032
Nigeria	2003	0.110	0.263	0.396	0.483	0.554	0.573	0.620	0.658	0.695	0.800	0.507	7.289	1.452	5.019
Ethiopia	2005	0.110	0.245	0.364	0.454	0.511	0.590	0.682	0.728	0.744	0.827	0.502	7.546	1.620	4.657

Source: Demographic and Health Surveys; own calculations.

Household specific Human Development Index – by age of household head

Country	Year	HDI					Total	Ratio oldest/ youngest
		20-29	30-39	40-59	60+			
Armenia	2005	0.749	0.810	0.776	0.785	0.783	1.049	
Egypt	2007	0.629	0.698	0.711	0.624	0.693	0.993	
Peru	2005	0.608	0.685	0.698	0.665	0.682	1.094	
Indonesia	2003	0.609	0.695	0.690	0.634	0.680	1.042	
Vietnam	2002	0.586	0.697	0.692	0.640	0.679	1.091	
Kyrgyz Republic	1997	0.582	0.688	0.696	0.611	0.669	1.051	
India	2005	0.559	0.624	0.632	0.616	0.623	1.103	
Nicaragua	2000	0.529	0.601	0.596	0.573	0.587	1.084	
Bolivia	2003	0.550	0.586	0.594	0.566	0.583	1.028	
Pakistan	2007	0.441	0.515	0.556	0.510	0.530	1.156	
Zambia	2002	0.414	0.501	0.521	0.437	0.490	1.056	
Nigeria	2003	0.426	0.458	0.476	0.436	0.463	1.026	
Senegal	2005	0.415	0.446	0.473	0.457	0.462	1.101	
Ethiopia	2005	0.308	0.365	0.407	0.378	0.380	1.227	
Burkina Faso	2003	0.312	0.362	0.380	0.370	0.370	1.186	

Source: Demographic and Health Surveys; own calculations.