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How fast did developing country poverty fall during the 1990s? Capabilities-based tests of rival estimates

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Abstract

Non-nested hypothesis tests are used to rank eight widely used international per capita income and poverty measures with respect to how well they predict changes in capabilities: lower child mortality, higher enrollment rates, better nutrition, etc. National accounts based generally out-perform survey-based growth and poverty estimates in these tests.

Keywords: Economic growth; Poverty; Household surveys; Developing countries

JEL classification: I32; O15

Exactly how fast household consumption rose and poverty fell during the 1990s is the subject of some controversy.[1] World Bank household surveys suggest developing country consumption per capita grew about 1–2% annually during the volatile 1990s. However, national accounts based estimates have per

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[1] If inequality changes slowly, changes in per capita income and poverty should be correlated with other non-monetary measures of physical well-being. To test World Bank poverty rates, Kashenas (2001) regresses the UNDP's HDI index and the FAO's proportion malnourished on alternate poverty rates, but does not report formal hypothesis tests nor does he pit changes in poverty against standard per capita income and consumption growth rates. McLeod (2003) use a similar approach to test whether various Latin American poverty estimates out-perform per capita income in predicting non-monetary welfare indicators.

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capita consumption growing at almost twice as fast.[2] Depending on which of these growth estimates one accepts, developing country $1/day poverty ended the century at about 21% or fell to about 10%.[3]

Differences in poverty estimates of this magnitude are hard to overlook, and even harder to explain. Debate over why survey and national accounts estimates diverge so much focuses on data collection methods and survey coverage. Deaton (2003) and Ravallion (in press) contend surveys more accurately capture living standards among poor households, while Bhalla (2002) and Sala-i-Martin (2002) argue national accounts-based consumption estimates are more reliable and consistent than survey means. This paper provides an alternative ex-post method for evaluating rival poverty and growth estimates.

Our working hypothesis is that falling poverty and rising consumption per capita should be reflected in a better quality of life for the poor. Consumption of commodities is generally a means to a fairly universal set of ends, what Sen (1999) terms "capabilities" or achievements: greater literacy, lower mortality rates, etc. Hence one way to evaluate alternative various income-based measures of well-being is to test how well they predict changes in capabilities.

This paper uses standard non-nested hypothesis tests to compare eight alternative growth and poverty measures. Specifically, we regress capabilities or achievements w_i such as school enrollment or longevity on the value of commodities consumed by household i, $w_i = f_i(c(x_i))$ where $c(x_i)$ represents the relevant characteristics of commodities, such as the nutrient value of food, etc. Table 1 summarizes a set of capabilities or achievements previously found to be correlated with changes in poverty and per capita income (see McLeod, 2003). Most of these indicators are reported by agencies and organizations other than those that do expenditure surveys or construct national accounts. It this sense, these indicators reflect independent sampling of the same population targeted by household surveys and national accounts estimates.[4]

The first group indicators listed in Table 1 capture the negative outcomes associated with deprivation, including malnutrition and high mortality rates especially among infants and children. A second group of capabilities or achievements reflect rising household incomes: lower birth rates, lower child labor force participation, higher primary school enrollments, etc. Note that, apart from literacy rates, these indicators are not reported annually. To create a sample of growth rates consistent with this lower reporting frequency, household surveys less than two years apart were dropped resulting in the sample listed in footnote 6 of Table 1. After dropping surveys less than three years apart, our sample includes about 70 intervals three years or longer for each capability indicator listed in Table 2.

Rival growth and poverty estimates can be ranked using a sequence of non-nested hypothesis tests to choose the best "model" for predicting changes in capabilities measure w_i,

$$M_1: \Delta w_i = \Delta y_{1i}\beta_1 + z_i\beta_2 + \varepsilon_{i1} \qquad M_2: \Delta w_i = \Delta y_{2i}\gamma_1 + z_i\gamma_2 + \varepsilon_{i2}$$

where the sole difference in each model is the measure of per capita consumption, income or poverty Δy_{1i} vs. Δy_{2i} (Δc_{1i} vs. Δc_{2i}) all in log changes. The rival models may share a one or more conditioning

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[2] See Table 3 and pages 4–5 in Deaton (2003).

[3] Survey-based World Bank estimates have developing country $1/day poverty rates falling from about 28% in 1990 to about 22% in 2000. But national accounts based estimates for same countries and poverty lines suggest $1/day poverty fell to about 6–13% (see Bhalla, 2002; Sala-i-Martin, 2002; UNCTAD, 2003).

[4] Demographic and school enrollment statistics, for example, are drawn from census data and/or official records or surveys conducted independently of periodic household surveys.

Table 1
Alternative capabilities indicators with best predictor[a] and per capita income/consumption growth rates

Low-income/poverty deprivation indicators		Reporting[b] frequency	Source agency[c]	Per capita growth best[a] [alternate[d]] log change in	
w_1	Wasting: low weight for age, % children under 5	3.6 years	WHO	y_8	$[P_{11}, P_{21}, y_2]$
w_2	Stunting: low height for age, % children under 5	3.9 years	WHO	y_3, y_8	$[P_{11}, P_{21}, y_S]$
w_3	Proportion of population undernourished	8 years	FAO	c_1	$[c_5, y_2, c_3]$
w_4	Female death rate per 1000	4.5 years	World Bank	c_3	$[y_8, y_3]$
w_5	Infant mortality rate	2.1 years	UNICEF	c_3	$[c_5]$
w_6	Under 5 mortality rate	4.2 years	UNICEF	c_3	$[y_3, y_8]$
w_7	Life expectancy at birth, total (years)	2.8 years	World Bank	c_1, c_3	$[y_3]$
Household capabilities					
w_8	Total fertility rate (births per woman)	1.8 years	UN Stats. Div.	c_3	$[y_8]$
w_9	Child labor participation age 10–14 (% of cohort)	2.8 years	ILO	c_4, y_4	$[y_2, y_3]$
w_{10}	School enrollment, primary (% gross)	1.3 years	UNESCO	c_1	$[c_3, c_5]$
w_{11}	Illiteracy rate, % of males age 15–24	Annual	UNESCO	y_3, y_2	$[y_8, y_4]$
w_{12}	Pupils reaching grade 5 (% of cohort), total	4 years	OECD and WEI	y_2, y_3	$[H_1]$
w_{13}	Population growth log % change	1.4 years	UNESCO	y_2	$[y_3, y_8]$

Alternate per capita income measures		Alternate per capita consumption measures	
y_2	Real GDP per capita (constant 1995 US$)	y_S	Mean survey income (World Bank GPM)
y_3	Real GDP per capita ($PPP PWT 6.1 Laspeyres)	c_1	Household final cons. exp. per capita ($1995)
y_4	Real GNI per capita[e] (WB $PPP international)	c_3	y_3 times PTW 6.1 Consumption Share (kc)
y_5	Real GDP per capita (PWT 6.1-chain index)	c_4	y_4 times WB WDI consumption share
y_8	Real GDP per adult equiv. (PWT 6.1 RGDPAE)	c_5	y_5 times PTW 6.1 Consumption Share (kc)
Poverty rates $1/day[f]		**Poverty rates $2/day[f]**	
H_1	$1/day poverty rate or headcount $p(0)$	H_2	$2/day poverty rate or headcount $p(0)$
P_{11}	$1/day poverty gap $p(1)$	P_{12}	$2/day poverty gap $p(1)$
P_{21}	$1/day FGT or gap squared $p(2)$	P_{22}	$2/day FGT or gap squared $p(2)$

[a] "Best indicators" are both correlated with changes in the welfare or capabilities indicator over time, as indicated by significant t-statistic, and are not encompassed any other income, consumption of poverty measure tested using Cox tests at the 5% significance level for the rival non-nested models described in the text and reported in Table 2 below.

[b] Average reporting frequency 1990–2001. Data between reporting years were filled in assuming a constant growth rate.

[c] All poverty rates and survey mean income or consumption came for the World Bank's Global Poverty Monitoring web page as of August 2003. Capabilities indicators are from World Bank's World Development Indicators 2002 CD-ROM. The "proportion of undernourished" is from Nations (2002). UNICEF's low birth weight measure was dropped due to infrequent and uneven reporting. The complete data set for this paper is available at www.fordham.edu/economics/mcleod.

[d] Alternate indicators are among the most correlated with welfare indicator but which are often dominated by the "best" income or consumption measure at the 5% confidence level. The Penn World Tables 6.1 income indicators c_3, c_5, y_3, y_5 and y_8 from Heston et al. (2002) are highly correlated but sometimes rank differently in the Cox tests so all were used.

[e] Deflated using the U.S. GDP deflator.

[f] Sample countries and poverty rate survey years: Algeria: 88, 95; Bangladesh: 84, 88, 92, 96; Brazil: 85, 88, 89, 93, 97; Chile: 87, 90, 92, 94; China: 85, 90, 93, 94, 98; Cote d'Ivoire: 85, 87, 88, 93, 95; Colombia: 88,91,96; Costa Rica: 86,90,93,96; Dominican Rep: 89, 96; Ecuador: 92, 95; Ghana: 87, 92, 99; Guatemala: 87,89; Honduras: 89,92,96; Indonesia: 88,93,98; India: 83, 86, 89, 90, 94, 95,97; Jamaica: 93,96; Jordan: 88, 90, 93, 96; Kenya: 91, 94; Sri Lanka: 85, 90, 95; Lesotho: 86, 93; Morocco: 85, 90; Madagascar: 90,93; Mexico: 84,89,92,95; Mali: 89,94; Mauritania: 93,95; Nepal: 85,95; Niger: 85,92,95,97; Pakistan: 87, 90, 93, 96; Panama: 89,91,95,97; Paraguay: 87,96; Peru: 85,94,96; Philippines: 85,88,91,94,97; El Salvador: 89,96; Thailand: 81, 88, 92, 96, 98; Tunisia: 95, 90; Turkey: 88,94; Venezuela: 81, 87, 89, 93, 96; Zambia: 91, 93, 96.

Table 2

Capability/deprivation changes predicted by Rival Income and Poverty Measures Non-nested Cox tests: Model 1 benchmark uses World Bank-GPM survey average income or consumption[a]

Wasting: children under 5

M_1: $\Delta w_1/s = f(\Delta y_S/s, w_0, \text{lat})$[b], $n=67$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δy_8	−1.5	−12.1	0.34	−4.9
Δy_2	−3.6	−10.9	0.24	−4.8
ΔP_{11}	−2.2	−4.1	0.17	4.0
ΔP_{21}	−2.3	−4.4	0.18	3.9
Δy_S			0.13	−3.0

Stunting: children under 5

M_1: $\Delta w_2 = f(\Delta y_S, w_0, \text{lat})$, $n=69$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δy_3	−1.6	−6.2	0.23	−2.7
*Δy_8	−1.8	−11.8	0.24	−3.7
Δy_S			0.15	−3.7
ΔP_{11}	−3.0	−2.4	0.14	3.3
ΔP_{21}	−3.3	−1.7	0.12	3.4

Undernourished population share

M_1: $\Delta w_3 = f(\Delta y_S, w_0, \text{lat})$, $n=75$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δc_1	0.18	−397	0.28	−3.8
Δy_2	0.12	−344	0.24	−3.3
Δc_5	−0.32	−1335	0.23	−3.2
Δc_3	−0.28	−1202	0.23	−3.2
Δy_S			0.05	0.2

Female death rate

M_1: $\Delta w_4 = f(\Delta y_S, w_0)$[b], $n=76$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δc_3	−1.2	−1538	0.24	−2.7
Δy_3	0.3	−72	0.22	−2.5
Δy_8	0.2	−73	0.22	−2.4
Δy_S			0.05	0.3

Under 5 mortality rate

M_1: $\Delta w_6 = f(\Delta y_S, t, y_0)$[b], $n=76$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δc_3	0.1	−3710	0.56	−3.4
Δy_3	0.3	−207	0.54	−2.3
Δy_8	0.3	−517	0.54	−2.3
Δy_S			0.47	−0.5

Life expectancy at birth

M_1: $\Delta w_8 = f(\Delta y_S, t)$, $n=76$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δc_1	−0.7	−68	0.37	3.4
Δy_3	−0.1	−24	0.34	2.9
*Δc_3	−3.2	−141	0.34	2.8
Δy_S			0.27	0.70

Child labor force participation

M_1: $\Delta w_9 = f(\Delta y_S, s, w_0)$, $n=68$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
Δy_3	0.0	−30.3	0.48	−2.6
*Δc_4	−1.1	−145	0.48	−2.5
Δy_2	−0.7	−108	0.49	−2.5
*Δy_4	−0.4	−68	0.48	−2.4
Δy_S			0.42	−0.5

Gross primary enrollment

M_1: $\Delta w_{10} = f(\Delta y_S, w_0)$[b], $n=74$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δc_1	−1.2	−69	0.29	2.6
*Δc_3	−6.3	−278	0.28	2.4
Δc_5	−7.2	−315	0.28	2.4
Δy_S			0.20	−0.7

Males age 15–24 illiteracy rate

M_1: $\Delta w_{11}/s = f(\Delta y_S/s, w_0)$, $n=67$

M_2:[d]	Cox statistic[c] M_1 v M_2	Cox statistic[c] M_2 v M_1	R^2	Δc or Δy t-statistic
*Δy_3	−1.3	−11.2	0.72	−3.1
*Δy_2	−4.2	−42	0.73	−3.0
Δy_4	−3.2	−18.3	0.72	−2.7
Δy_8	−1.8	−9.4	0.72	−2.6
Δy_S			0.70	1.6

*This measure cannot be rejected at the 5% level by a model including a rival growth or poverty rate, for all conditioning variables discussed in footnote 1.

[a] For the intervals in our sample, World Bank survey income averaged 2.2% annually; while other national accounts-based income measures grew 3–4.4%.

[b] As defined in Table 1 Δy_S is the log change in survey mean income Δw_i, Δc_i and Δy_i are log changes in physical well being, per capita consumption and per capita income measures over the survey intervals. Global time trends are captured by s, the number of years between each survey while w_0 and y_0 are log levels of that welfare indicator or income or consumption at the beginning of each interval. Latitude was the only other conditioning variable used.

[c] Both the simpler J-test and the Cox-test yielded similar results, but only the normally distributed Cox statistic is reported here. Davidson and McKinnon (1993) show that these two tests are asymptotically equivalent, but in our finite sample the Cox test was often more powerful. See also footnote 6 in the text.

[d] Model 2 uses the income variable listed below instead of Δy_S. That is the only difference between M_1 and M_2.

variables z_i. These "state variables" play a role analogous to that of fixed effects in panel estimation-picking up the influence of country specific or time dependent effects apart from consumption or poverty changes in each country. The z_i variables include a time trend (the survey interval, s), initial levels of y_i, c_i or w_i, and in a few cases, latitude. Many demographic and education related variables exhibit global time trends which were generally picked up by adding the interval length, s, as a separate conditioning or z_i variable rather than by dividing by s to get average annual growth rates.[5] Apart from time trends, the conditioning or z variables typically generally do not affect test rankings. However, they often increase the power of the non-nested tests, breaking "ties" for example when neither model is rejected by the Cox test.[6]

The main results of these tests are summarized in the last column of Table 1. A "best predictor" income or poverty measure must meet two criteria: one is to have a statistically significant impact on capability Δw_i with the expected sign. This generally means a significant t-statistic as well as a partial R^2 greater than 5%. Second, "best predictors" cannot be rejected by any alternative growth measure with a Cox test at 5% significance level. That is, "best" growth rates encompass all rivals, rendering their information statistically redundant for predicting Δw_i.

Table 2 illustrates how these two criteria were applied to rank rival income and consumption measures. For the malnutrition indicator "low weight for height in children under 5 years old" (wasting), w_1, the default model M_1, driven by changes in survey mean consumption (SMC) can be rejected by an identical model with growth in PPP income per adult equivalent from the PWT 6.1 serving as the growth measure (conditioning on latitude and the initial level of w_1). SMC and \$1/day poverty gaps derived from expenditure surveys are significant predictors of both anthropometric malnutrition indicators, with significant t-statistics of the correct sign. However, neither of these measures adds any predictive power to a model including PPP income per adult equivalent (y_8). World Bank national accounts-based per capita GDP growth (Δy_2) occupies a middle ground, outperforming the household survey based measures in predicting Δw_1 using normal goodness of fit measures, only to be rejected at the 5% level using Cox tests for an alternative model including survey mean income or survey-based poverty rates ΔP_{11} and ΔP_{21}. Another testing scenario emerges for w_2: the proportion of children under 5 exhibiting low weight for age (stunting). In this case both PWT GDP per capita and adult equivalent (Δy_3 and Δy_8, respectively) dominate the survey mean income growth, Δy_S, as neither can be rejected at the 5% level by any of other income growth rate tested creating a tie for "best predictor" (note that Δy_8 and Δy_3 are starred).

One striking overall result of these tests is that, apart from two of three malnutrition indicators, log changes in survey mean income is rarely correlated with changes in achievements or capabilities across countries or over time. In contrast, the PWT 6.1 and World Bank national accounts based growth rates

[5] This second approach gives equal weight to both long and short survey intervals, not a desirable weighting scheme given that non-monetary indicators are collected less frequently than income statistics. Ideally more weight would be given to longer intervals. This is, in effect, what adding a separate trend variable does.

[6] Non-nested hypothesis tests have three possible outcomes: (i) both test statistics are significant implying both models have some predictive power or (ii) one model can be rejected at the 5% level but others cannot — evidence favoring the model that cannot be rejected or (iii) neither model can be rejected at the 5% level. Variables with a * meet condition (2) — all alternative models are rejected at the 5% level, but the reverse is never true.

are generally correlated with changes in malnutrition, under five mortality rates, child labor force participation and primary school enrollment rates.[7]

These results can be interpreted in several ways. The interpretation most favorable to the household survey estimates is to argue that only the two anthropometric child malnutrition measures reflect the status of the poorest groups: the households mainly targeted by household expenditure surveys. This is why survey based income measures are most correlated with these indicators. Other demographic and mortality indicators, one could argue, reflect decisions by a broader household income strata, a population whose status is better captured by national accounts-based consumption and income measures. However, even for the two UNICEF malnutrition achievement indicators, at least one national accounts-based growth measure clearly encompasses all the survey-based measures, including all poverty rates.[8] Also, national accounts measures are better predictors of the FAO malnutrition measure w_3.

A second interpretation is that for a wide range of capabilities indicators, national accounts based consumption measures clearly outperform their survey-based counterparts. Growth rates derived from the Penn World Tables and standard national accounting aggregates are correlated with broad range of demographic statistics, including death rates, enrollment rates, as well as all of the anthropometric malnutrition indicators tested here. Hence claims that only household surveys capture the "true distribution of income" may be overstated. Though household surveys remain virtually the only source of high frequency income distribution data, they may not be reliable indicators of overall trends in average income and consumption levels. Sampling bias and particularly inconsistencies in survey methods over time may undermine the reliability of income growth estimates based on survey means, as Sala-i-Martin (2002) and others argue. This would explain why national accounts based growth estimates predict enhanced capabilities across countries and over time while survey-based growth estimates typical do not.

The tests reported here suggest widely used World Bank survey based poverty rates may understate progress in developing countries during the 1990s. Certainly further tests are warranted using other indicators of well being and a wider range of state variables. Direct comparison of alternate poverty estimates would also be helpful. Overall, however, these results support use of per capita growth and poverty rates benchmarked to national accounting aggregates as is current practice at UNCTAD and CEPAL for example.

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[7] These indicators often represent a class of variables: birth and death rates for example are effectively represented by child mortality rates and longevity. Some indicators are simply not affected by short term changes in income or consumption. Given a time trend, for example, changes in income or consumption did not explain much of the variance in education and enrollment variables. Perhaps controlling for public investment in education or other demographic changes would make the effect of income more evident. One indicator, UNICEF's prevalence of low birth weight (LBW) babies, was dropped due lack of data. Bangladesh, for example, has only one estimate for LBW babies: 50% in 1986.

[8] In this context, the survey based measures have an advantage, as only poverty rates derived from expenditure surveys are tested (national accounts based measures were not available to this author). McLeod (2003) finds national accounts based Latin poverty rates generally out-perform survey based estimates using a similar testing strategy to that employed here.

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