

How fast did developing countries grow in the 1990s?

Testing survey vs. national accounts-based growth estimates

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Abstract: The growing divergence between national accounts and survey-based estimates of developing country consumption per capita is fueling a controversy over how much poverty fell during the 1990s. This paper ranks rival per capita growth rates with respect to their ability to predict changes in a range of non-monetary welfare indicators including nutritional status, child mortality, school enrollment rates, etc. National accounts based growth estimates, particularly those of the Penn World Tables, generally out-perform survey based growth rates in these tests.

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Since income inequality changes slowly, changes in absolute poverty depend largely on per capita income growth. Surprisingly, just how fast per capita income and consumption grew in developing countries during the 1990s is the subject of some controversy. Measured using household expenditure surveys, mean consumption per capita grew about 1-2% annually. However, national accounts based estimates, including the Penn World Tables, suggest per capita consumption growth averaged 3-4% during the volatile 1990s.¹ Depending on which growth estimate one accepts, by 2000 developing country \$1/day poverty fell to about 10% or remained over 20%.²

Differences in poverty and growth estimates of this magnitude are hard to overlook, and even harder to explain. Debate over why survey and national accounts estimates diverge has focused on *a priori* arguments regarding data collection methods and survey coverage. Deaton (2003) and Ravallion (2003) conclude survey-means more accurately reflect living standards among the poor, while Bhalla (2002) and Sala-i-Martin (2002) argue changes in survey means are less reliable than standard national accounts estimates. This paper uses an *ex post* approach to evaluate alternate per capita growth and poverty estimates. Our working hypothesis is that, if inequality changes slowly, changes in per capita income and poverty should be correlated with other non-monetary measures of physical well-being. One way to test alternate per capita growth estimates, therefore, is to compare their performance in predicting changes in various non-monetary welfare indicators.³

Table 1 summarizes a set of non-monetary welfare indicators previously found to be correlated with changes in poverty and per capita income (see McLeod (2003)). To the extent that these

¹ See Deaton (2003) Table 3 and pages 4-5.

² 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) and UNCTAD (2002)).

³ McLeod (2003) uses a similar approach to test whether various Latin American poverty estimates out-perform per capita income in predicting non-monetary welfare indicators. Karshenas (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.

indicators are collected by agencies other than those conducting expenditure surveys or constructing national accounts, they can be viewed as independent samples drawn from the same population targeted by expenditure surveys.⁴ The first group of indicators reflect the negative consequences of low incomes, including malnutrition and high mortality rates, particularly among infants and children. A second group of indicators capture household decisions influenced by per capita income. These include birth rates, child labor force participation, primary school enrollments, etc. Note that, apart from literacy rates, these indicators are reported not reported annually. To create a sample of growth rates consistent with this lower reporting frequency, surveys less than two years apart were dropped resulting in the sample shown in Table A-1. Even after dropping these surveys, our sample includes about 70 three plus year intervals for each indicator (see Table 2 and Table A-1).

Rival growth estimates can be ranked using a sequence of non-nested hypothesis tests to choose the best “model” for predicting changes in a particular non-monetary welfare indicator w_i ,

$$M_1 : \Delta w_i = \Delta y_{1i} \mathbf{b}_1 + z_i \mathbf{b}_2 + \mathbf{e}_{i1}$$

$$M_2 : \Delta w_i = \Delta y_{2i} \mathbf{g}_1 + z_i \mathbf{g}_2 + \mathbf{e}_{i2}$$

where the sole difference in each model is the measure of per capita income, consumption 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 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 income growth. The z_i variables used 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 of the demographic and education related variables exhibit global time trends, increasing at a constant annual rate irrespective of changes in income or poverty. These trends were incorporated by either including the interval length, s , as a separate conditioning or z_i variable or by

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.

dividing Dy_i , Dx_i and Dz_i by s to get average annual growth rates.⁵ Apart from time trends, the conditioning variables generally do not affect the ranking of the various growth rates. However, they often increase the power of the non-nested tests, breaking “ties” for example where 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. First they must have a statistically significant impact on Dw_i with the expected sign. This generally means a significant t-statistic as well as a partial R^2 greater than 5%. The second property of “best predictors” is that they cannot be rejected by any alternative growth measure with a Cox test at 5% significance level. That is, “best” growth rates encompass the information provided by all rivals, at least for predicting this particular Dw_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” (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, however neither of these measures adds any predictive power to a model including PPP income per adult equivalent (y_8). World Bank national accounts per capita GDP growth (Dy_2) occupies a middle ground. They outperform the SMC derived measures in predicting Dw_1 using normal goodness of fit measures, but can be rejected at the

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 Cox-statistics are significant at the 5% level implying both models have some predictive power or ii) one model can be rejected at the 5% level but other cannot—evidence favoring the model that cannot be rejected or iii) neither model can be rejected at the 5% level. Our “best predictor” variables marked with a * meet a weak version of outcome (ii) they can reject a model based on survey income at 5% level, but they themselves cannot be rejected at the 5% by any other poverty, income or consumption growth measure.

5% level using Cox tests for an alternative model including survey mean income or survey-based poverty rates DP_{11} and DP_{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, Dy_3 , and per adult equivalent, Dy_8 , dominate the SMC growth, Dy_5 , as neither can be rejected at the 5% level by any of other income growth rate tested creating a tie for “best predictor” (so both Dy_8 and Dy_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 non-monetary welfare indicators across countries. In contrast, the PWT 6.1 and World Bank national accounts based growth rates are generally correlated with changes in malnutrition, under five mortality rates, child labor force participation and primary school enrollment rates.⁷

There are two possible interpretations of these results. The interpretation most favorable to the household surveys is to argue that only the two anthropometric child malnutrition measures reflect the status of the poorest groups: those targeted by household expenditure surveys. This explains why changes in survey based measures are most correlated with these indicators. The other demographic and mortality indicators, one might argue, reflect decisions by a broader household income strata, a population whose status is reflected national accounts-based consumption and income measures. However, even for the two UNICEF malnutrition 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 much better predictors of the FAO malnutrition measure, w_3 .

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 some time trend, for example, changes in income or consumption did not explain much if any variance in many 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 babies (LBWB), was dropped due to poor data quality. Bangladesh, for example, has only one estimate for LBWB: 50% in 1986. We did not omit any indicators that were significantly correlated with changes in survey mean income.

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.

A second interpretation is that in predicting a range of welfare indicators, the national accounts based measures clearly outperform survey-based growth rates. Growth rates based on 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 household 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 track non-monetary welfare indicators while survey-based growth estimates typically do not.

These results provide some comfort to producers and us users of national accounts based growth rates, but they do not explain why survey and national accounts mean income are diverging. Certainly further tests are warranted using other indicators of well being, conditioned on other state variables, and using direct comparisons of alternate poverty estimates. Overall these results and those of McLeod (2003) tend to support, and certainly do not undermine, use of per capita growth and poverty rates benchmarked to national accounting aggregates.

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Table 1: Alternative Welfare Indicators with best predictor^{1/} and alternate per capita income or consumption growth rates

		Reporting ^{3/} Frequency	Source Agency ^{4/}	Per Capita Growth Best ^{1/} [alternate ^{2/}] Log Change in:	
Low income/poverty outcomes:					
w ₁	Wasting: low weight for age, % children under 5	3.6 yrs	WHO	y ₈	[P ₁₁ , P ₂₁ ,y ₂]
w ₂	Stunting: low height for age, % children under 5	3.9 yrs	WHO	y ₃ ,y ₈	[P ₁₁ , P ₂₁ ,y ₅]
w ₃	Proportion of population undernourished	8 yrs	FAO	c ₁	[c ₅ ,y ₂ ,c ₃]
w ₄	Female Death rate per 1,000	4.5 yrs	World Bank	c ₃	[y ₈ ,y ₃]
w ₅	Infant Mortality Rate	2.1 yrs	UNICEF	c ₃	[c ₅]
w ₆	Under 5 Mortality Rate	4.2 yrs	UNICEF	c ₃	[y ₃ ,y ₈]
w ₇	Life expectancy at birth, total (years)	2.8 yrs	World Bank	c ₁ ,c ₃	[y ₃]
Household decisions affected by income:					
w ₈	Total Fertility rate (births per woman)	1.8 yrs	UN Stats. Div.	c ₃	[y ₈]
w ₉	Child Labor participation age 10-14 (% of cohort)	2.8 yrs	ILO	c ₄ ,y ₄	[y ₂ ,y ₃]
w ₁₀	School enrollment, primary (% gross)	1.3 yrs	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 yrs	OECD & WEI	y ₂ ,y ₃	[H ₁]
w ₁₃	Population Growth log % change	1.4yrs	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 ₅	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 ^{5/} (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) ^{5/}	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			Poverty Rates \$2/day		
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)		

1/ Best indicators are both correlated with changes in the welfare indicator over time, as indicated by significant t-statistic, and are not encompassed any other income, consumption or 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.

2/ 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. Among the growth measures, the three PWT 6.1 indicators c₃, c₅, y₃, y₅ and y₈ are highly correlated, yet at times can be distinguished in the Cox tests so all are reported here.

3/ Average reporting frequency 1990-2001, based in listings in the World Bank WDI online.

4/ Source: World Bank, World Development Indicators 2002 CD-Rom and WDI Online. All of the poverty rates and the survey mean income or consumption came for the World Bank’s Global Poverty Monitoring web pages as of August 2003.

5/ Deflated using the U.S. GDP deflator. There was almost no difference in the PWT chain index and Laspeyres real per capita income estimates, so Table 2 results are generally reported for one or the other.

Table 2: Models of non-monetary welfare indicators based on rival growth rates

(Model 1 is based on survey mean income/consumption)

Indicator: wasting children under 5					Indicator: stunting, children under 5					Indicator: % of pop. Undernourished				
$M_1 : Dw_1/s = f(Dy_s/s, w_0, lat)^{1/}$, n = 67					$M_1 : Dw_2 = f(Dy_s, w_0, lat)$, n = 69					$M_1 : Dw_3 = f(Dy_s, w_0, lat)$, n = 75				
Cox Statistic			Dc or Dy		Cox Statistic			Dc or Dy		Cox Statistic			Dc or Dy	
M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic	M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic	M_2 : ^{3/}	M_1 v M_2	M_2 v M_1	R ²	t-statistic
*Dy ₈	-1.5	-12.1	0.34	-4.9	*Dy ₃	-1.6	-6.2	0.23	-2.7	*Dc ₁	0.18	-397	0.28	-3.8
Dy ₂	-3.6	-10.9	0.24	-4.8	*Dy ₈	-1.8	-11.8	0.24	-3.7	Dy ₂	0.12	-344	0.24	-3.3
DP ₁₁	-2.2	-4.1	0.17	4.0	Dy _s			0.15	-3.7	Dc ₅	-0.32	-1335	0.23	-3.2
DP ₂₁	-2.3	-4.4	0.18	3.9	DP ₁₁	-3.0	-2.4	0.14	3.3	Dc ₃	-0.28	-1202	0.23	-3.2
Dy _s			0.13	-3.0	DP ₂₁	-3.3	-1.7	0.12	3.4	Dy _s			0.05	0.2
Indicator: female death rate					Indicator: under 5 mortality rate					Indicator: life expectancy at birth				
$M_1 : Dw_4 = f(Dy_s, w_0)^{1/}$, n = 76					$M_1 : Dw_6 = f(Dy_s, t, y_0)^{1/}$, n = 76					$M_1 : Dw_8 = f(Dy_s, t)$, n = 76				
Cox Statistic			Dc or Dy		Cox Statistic			Dc or Dy		Cox Statistic			Dc or Dy	
M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic	M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic	M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic
*Dc ₃	-1.2	-1538	0.24	-2.7	*Dc ₃	0.1	-3710	0.56	-3.4	*Dc ₁	-0.7	-68	0.37	3.4
Dy ₃	0.3	-72	0.22	-2.5	Dy ₃	0.3	-207	0.54	-2.3	Dy ₃	-0.1	-24	0.34	2.9
Dy ₈	0.2	-73	0.22	-2.4	Dy ₈	0.3	-517	0.54	-2.3	*Dc ₃	-3.2	-141	0.34	2.8
Dy _s			0.05	0.3	Dy _s			0.47	-0.5	Dy _s			0.27	0.70
Indicator: child labor participation					Indicator: gross primary enrollment					Indicator: male age 15-24 illiteracy				
$M_1 : Dw_9 = f(Dy_s, s, w_0)$, n = 68					$M_1 : Dw_{10} = f(Dy_s, w_0)^{1/}$, n = 74					$M_1 : Dw_{11}/s = f(Dy_s/s, w_0)$, n = 67				
Cox Statistic ²			Dc or Dy		Cox Statistic			Dc or Dy		Cox Statistic			Dc or Dy	
M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic	M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic	M_2 : ³	M_1 v M_2	M_2 v M_1	R ²	t-statistic
Dy ₃	0.0	-30.3	0.48	-2.6	*Dc ₁	-1.2	-69	0.29	2.6	*Dy ₃	-1.3	-11.2	72%	-3.1
*Dc ₄	-1.1	-145	0.48	-2.5	*Dc ₃	-6.3	-278	0.28	2.4	*Dy ₂	-4.2	-42	73%	-3.0
Dy ₂	-0.7	-108	0.49	-2.5	Dc ₅	-7.2	-315	0.28	2.4	Dy ₄	-3.2	-18.3	72%	-2.7
*Dy ₄	-0.4	-68	0.48	-2.4	Dy _s			0.20	-0.7	Dy ₈	-1.8	-9.4	72%	-2.6
Dy _s			0.42	-0.5						Dy _s			70%	1.6

1/ Where Dy_s is the log change in survey mean income Dw_i , Dc_i and Dy_i are log changes in physical well being, per capita consumption and per capita income measures over the interval s (see Table 1). Global time trends are captured by s , the interval in 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 z variable used.

2/ Both the simpler J-test and the Cox-test were computed but only the Cox statistic is reported. Davidson and McKinnon (1993) show these two tests are asymptotically equivalent, but in our finite sample the Cox test was often more powerful.

3/ Model 2 uses the income variable listed below instead of Dy_s . That is only difference between M_1 and M_2 .

*This measure cannot be rejected at the 5% level by a model including a rival growth or poverty rate, given this set of conditioning variables.

Data Appendix:

The data came from three basic sources. The survey means and poverty measures are from the World Bank's Global Poverty Monitoring database, (average monthly income, \$1993 PPP see www.worldbank.org/research/povmonitor/). The Penn World Tables version 6.1 is that made available at pwt.econ.upenn.edu. Most all of non-monetary welfare indicators are from World Bank's World Development Indicators 2002 CD-Rom. The FAO's 2002 "Proportion of Undernourished in the total Population" which was take directly from Table 1 of U.N. FAO (2002) SOFI report. Missing data for some indicators was filled in by interpolating with constant growth rates between reporting years. Frequency of reporting ranged from about every ten years for FAO undernourished population, to annually for illiteracy rates. The UNICEF series on prevalence of low birth weight babies had to be dropped because of infrequent and uneven reporting, particularly with respect to changes over time. The complete set of welfare indicators, with interpolated values of welfare indicators clearly marked, is available in spreadsheet format at www.fordham.edu/economics/mcleod.

