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Testing the Kuznets Curve for Countries and Households Using the Body Mass Index

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This paper was prepared for the WIDER Conference on Advancing Health Equity, Helsinki, Finland, September 29-30, 2006

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1. INTRODUCTION

The idea that there is a relationship between the level of economic well-being and inequality has a long history in development economics. Based on historical data from the United States, England, and Germany, Kuznets' (1955) seminal paper argued that there is an inverted-U-shaped relationship between inequality and economic development: poor countries have relatively little inequality; inequality at first worsens as incomes increase; but at some higher level, inequality begins to decline with further growth. Many authors have tested and confirmed this hypothesis with cross-country data (see for example, Saith 1983; Paukert 1973, Ahluwalia, Carter and Chenery 1979; Anand and Kanbur 1993); although, a closer examination of the relationship between growth and inequality that relies on time series data tends to find far less support for the inverted-U (Ravallion and Chen 1997; Fields 2001; Ravallion 2005; Bruno, Ravallion and Squire 1998). At the household level, Kanbur and Haddad (1992) and Haddad, Kanbur and Bouis (1995) use data on individual caloric intake in the Philippines to explore the possibility of an intra-household Kuznets curve: an inverse-U relationship between a household's living standards and inequality within the household.

This paper tests for relationships between level of well-being and inequality at both inter-country and intra-household levels, but using a different indicator of well-being, the body mass index (BMI). BMI is defined as one's weight in kilograms divided by height in centimeters squared. People with low body mass suffer from inadequate caloric intake and/or health problems. As such, BMI reflects both consumption (of calories, sanitation, and health care) and health status, two important dimensions of well-being.[1] Section 2.1 discusses the advantages and disadvantages of using BMI as a measure of well-being. Here, we highlight two of the important advantages. First, BMI is measured for individuals, an aspect that is critical for the study of intra-household inequality, but which also matters for inter-country data. Studies of income inequality use income per capita or per adult equivalent, implicitly assuming that household incomes (or expenditures) are pooled and divided "equally" among household members according to their needs. Haddad and Kanbur (1990) note that this biases our measure of inequality downward. To the extent that intra-household inequality varies with the level of well-being, this bias will also affect estimates of an intra-household Kuznets curve. This provides one motivation for an exploration of inequality based on non-income measures of well-being as it allows us to examine the extent to which intrahousehold inequality contributes to overall country inequality.

Even though there are few papers that examine the intra-household Kuznets curve in the existing literature, [2] the argument that intra-household inequality exists has

[1] Elsewhere, we have argued that it is both important and feasible to take Sen's notion of multidimensional well-being seriously in empirical work. See Duclos, Sahn, and Younger (forthcoming); Pradhan, Sahn, and Younger (2003); and Sahn and Younger (2005, forthcoming).
[2] But see these three closely related publications: Haddad and Kanbur (1990), Kanbur and Haddad (1992), Haddad, Kanbur and Bouis (1995).

theoretical and empirical support. A variety of cooperative and non-cooperative bargaining models provide the basis for the argument that the equal sharing implication of Becker's (1974) unitary model of the household is unlikely to be realistic (Browning and Chiappori 1988; McElroy 1990; McElroy and Horney 1981; Chen and Woolley 2001; Lundberg and Pollack 1993). Empirical papers support this view (Alderman, Haddad, and Hoddinott 1997; Pitt, Rosenzweig and Hassan 1990; Rosenzweig and Schultz 1982; Thomas 1990; Sahn and Stifel 2002).

A second reason to use BMI in our intra-household inequality analysis is that, unlike caloric intake, BMI captures individual's consumption relative to their needs. The amount of calories that one needs to consume varies considerably by height, age, health status, climate, and physical work effort. While Haddad, Kanbur, and Bouis (1995) do adjust their calorie intake data by broad classes of activities, this is only a rough approximation of each person’s actual needs. Using BMI is a much more effective way to get a summary measure of caloric consumption net of needs.

In the remainder of the paper, Section 2 provides a discussion of the empirical approach employed in the paper. Following a discussion of the results in Section 3, we conclude in Section 4 with a discussion of the implications of the findings.

2. EMPIRICAL APPROACH

2.1 Measuring Inequality

2.1.1 Indicators of Well-being

Reliance on income, expenditures, or wages is the norm for measuring inequality, although there are some efforts to exploring non-income indicators of inequality along dimensions such as assets, education, health or even time use – for example, engaged in leisure (Deininger and Olinto 1999; Thomas, Wang and Fan 2000; Pradhan, Sahn and Younger 2003; Sahn and Younger 2005, forthcoming; Bittman and Wajcman 2004.) In this paper we add to the small body of literature that examines non-income dimensions of inequality by using BMI as a measure of well-being.

Since the distribution of BMI differs by age and gender, we standardize each person’s BMI to the reference standard of a fixed age/sex reference group, which in our case is a 20-year-old female:

$$BMI = F_{\bar{a},\bar{g}}^{-1}(F_{a,g}(bmi)) \qquad (1)$$

where F is the distribution function of BMI in the WHO reference population for an age/sex group defined by age (a) and gender (g); *bmi* is the actual body mass index; $\bar{a}$ = 20 years; $\bar{g}$ = female; and *BMI* is standardized BMI. The standardized BMI measure is constructed such that an individual’s position in the distribution, in terms of percentiles, is the same for actual BMI in the actual age/sex group and the transformed BMI in the distribution of 20-year-old females. Our choice of 20-year-old females for the standardization is arbitrary. We could have selected, for example, 10-month-old boys. Our results, however, are not sensitive to this standardization.

Standardized BMI is an attractive measure of well-being for many reasons. As noted in the introduction, it is related to consumption and health, and, critically, it is a measure of individual rather than household well-being. This is a clear advantage over income measures that are not feasible for intra-household inequality measurement, and that must assume an arbitrary sharing rule for national inequality measurement. Consumption is an alternative to income, but much of a household's consumption has a public good component. Any assignment of a household’s expenditure on shelter or public services to individuals in the household is necessarily arbitrary. Further, consumption, especially at the individual level, is measured with considerable error, [3] and comparisons across space and time face difficult issues of price deflation.[4]

There are consumption measures that reflect individual consumption, most notably caloric intake as used by Kanbur and Haddad (1992) and Haddad, Kanbur, and Bouis (1995). But this, too, is a difficult measurement. The only accurate option for measuring individual food consumption is to engage in an intrusive exercise of on-sight weighing of plates and the commodities consumed, so as to take account of sharing and plate waste, something notoriously difficult to do, especially for period beyond a day or two (del Ninno et al. 2001; Johnson, Soultanakis and Matthews 1998; Bouis 1994). In some contexts, recording food consumption away from home is an important problem. Finally, as noted in the introduction, food consumption does not account for differences in needs of individuals, largely a reflection of energy expenditures, climate, and underlying health status.

While incomes and consumption dominate inequality analysis, the recent literature on inequality and poverty has begun to consider other possible indicators of well-being, many of which are observable for individuals. In our own work, we have used the heights of young children as a measure of well-being for both poverty and inequality analysis (Pradhan, Sahn, and Younger, 2003; Duclos, Sahn, and Younger, forthcoming). While growth of children is widely acknowledged as an excellent and objective indicator of children’s general health and nutritional status (Cole and Parkin 1977; Mata 1978; Tanner 1981; Mosley and Chen 1984; WHO 1995; Martorell et al. 1975; Beaton et al. 1990; Strauss and Thomas 1995; Behrman and Deololikar 1988), adults’ heights were determined in their childhood, long before they were members of their current household. Thus, intra-household height inequality would not provide useful information on the distribution of consumption within that household today.

[3] Differences in questionnaire design, recall periods, and even the nature of interviewer training have been shown to have important impacts on now household consumption is measured (Bhalla and Glewwe 1986; Pradhan 2000; Scott and Amenuvegbe 1990; Demery and Mehra 1996; Deaton and Grosh 2000).
[4] There are also difficulties associated with measuring the range of food and non-food goods and services that an individual consumes. For example, if a parent purchases a musical instrument for their child and pays for their lessons, to whom do we assign the consumption value of these expenditures?

Other health measures found in the literature include life expectancy, mortality, and morbidity. Unfortunately, all of these have serious measurement problems. Life expectancy is not directly observable, so it must be predicted based on observable indicators (age, gender, weight, behaviors such as smoking, and medical data) and life tables that are based on past experience but do not correspond to the future experiences of those presently alive (Deaton 1999). That prediction necessarily reduces the variance of measured variable, a problem that can be severe if the prediction is not accurate. Mortality is a discrete variable and so not amenable to inequality analysis.[5] Self-reported morbidity data are notoriously inaccurate (Kroeger 1985; Hill and Mamdani 1989; Over et al. 1992; Schultz and Tansel 1997; Bound 1991). Activities of daily living (ADLs) provide more objective measures of morbidity (Strauss et al. 1993; Dow et al.1997; Newhouse et al.1993), but they are not yet standardized across age and gender groups, something that is required to explore intra-household inequality. Further, many of these variables are ordinal rather than cardinal measures, e.g., “Can you climb a flight of stairs?” not “How many stairs can you climb?” There is also the practical matter that such data are not widely available, particularly from developing countries.

Other possible indicators that are amendable to individual measurement, such as educational attainment, cognitive achievement (e.g., test scores) and happiness, have a series of associated problems that preclude them from being appropriate for examining the relationship between well-being and inequality within the household. These indicators can not be employed for certain age persons and are difficult to standardize across age and gender groups.

None of these problems apply to BMI. It is a positive, cardinal measure that applies to individuals. It reflects command over food, and also non-food resources that affect medical care, the probability of infection (e.g., sanitary conditions), and labor saving technologies). It accounts for caloric consumption relative to needs. And BMI is easily and accurately measured. Likewise, BMI is easily measured, only requiring a scale, measuring tape and board, and a few days of training for enumerators which reducing the likelihood of measurement problems. Measurement error is likely to be random, unlike most other indicators we considered above where errors are correlated with other unobservables and measures of well-being such as incomes.

There are, however, two potential problems with BMI as a measure of well-being. First, most poverty and inequality analysis require that utility be non-decreasing in the measure of well-being. This may not be the case for BMI: there is a threshold above which too much body mass is unhealthy. However, despite the negative health effects of obesity, BMI still measures, at least in one dimension, the allocation of resources within the household relative to need. A second problem is that BMI captures only a part of household consumption, that related to food and health status.

Practically, for the African and Asian countries included in our analysis, these problems are not too severe. Food consumption is a large part of overall household consumption, and obesity remains very low, afflicting less than a few percent of each

[5] Most inequality measures require data that are continuous and positive.

sample. In fact, our calculations using the available household survey data indicate that the country with the highest share of obese individuals is Brazil, 9.1 percent, while the lowest rate is Vietnam where less than one percent of the population is obese. Further, unlike a skewed income distribution in which the richest observations have considerable leverage over inequality estimates, BMI distributions do not have a long right tails, so that even a non-trivial percentage of obese people will not have such a large effect on the inequality measures.

2.1.2 Inequality Measures

We use the Theil's mean log deviation, which is the generalized entropy measure with α=0, as our measure of inequality. Unlike the Gini, this measure is sub-group decomposable, which is useful as we will discuss further below. In the case of country level inequality, for a given country *k*, the index is defined by

$$T(k) = \frac{1}{N_k} \sum \ln\left(\frac{\mu_k}{BMI_{i,k}} \right) \tag{2}$$

where N_k is the sample size in country k, μ_k is the mean height in the sample, and $BMI_{i,k}$ is the standardized BMI of the ith person in the sample. The same measure is applicable to intra-household inequality, where the calculation uses household size N_h, mean household body mass μ_h, and the BMI of each household member, $BMI_{i,h}$.[6]

2.2 Standard of Living Indicator

The Kuznets curve graphs average income levels against income inequality. By strict analogy, our BMI-based Kuznets curves should graph average BMI against BMI inequality. Yet much of the existing inequality literature that uses non-income measures of well-being compares inequality in a given measure (e.g., BMI, child heights) to average income (or consumption) (Wagstaff, Paci, and van Doorslaer, 1991; van Doorslaer et al.1997).

We prefer ordering households from "poorest to richest" using the mean standardized BMI of the household or country. If our case for using BMI as a reasonable measure of well-being for inequality analysis is valid, then the same case applies for using BMI to measure the level of well-being. Conceptually, examining the correlation between inequality in BMI and some normalized expenditure value informs us about the relationship between these two distinct measures of well-being. In this approach, the problem of inequality within the household is conceived of as a consequence of income (expenditure) inequality, or an underlying process that contributes to inequality among

[6] We exclude one person households from our analysis.

socioeconomic groups in the population.[7] This approach gives primacy to the notion that well-being should be measured in income terms, and that inequality in other welfare outcomes is to be examined as a consequence.

We feel, however, that BMI should be taken seriously as a measure of well-being in its own right. Consider an example of two populations, A and B, with equal levels of average health and equal levels of health inequality. However, assume that in population A, there is a strong correlation between health and income, while in B there is not. We would not want to adopt the view that health inequality in population A is a more serious public policy problem, owing to the stronger correlation with income (or some other measure of social stratification). To the extent that we can identify a cardinal measure of health inequality, which we do in this paper, comparisons of distributions of health are meaningful, regardless of whether health is correlated with welfare measured along other dimensions (Deaton 2001).

Nevertheless, to be consistent with the literature that uses mean incomes to measure well-being, we repeat our analysis ordering households (countries) from poorest to richest using expenditures (GDP) per capita. In doing so, however, we acknowledge the challenges of dealing with issues of price deflators and exchange rates. Likewise, while we adopt the norm of using per capita consumption, the reality is that the choice of an equivalence scale that takes into account both the household size and composition is highly subjective and will also affect the results.

2.3 Kuznets Curve Estimation

Most of the research on the relationship between poverty and inequality, whether it be at the country level or intra-household level relies on a combination of visual identification of whether there is a U-shaped relationship, or the utilization of parametric estimators, though Haddad, Kanbur and Bouis (1995) use a more flexible spline function with endogenous knots. However, it is now straightforward to estimate the bivariate relation between average BMI and BMI inequality non-parametrically, allowing a completely flexible functional form. We use this approach, although, we also present more traditional parametric results for a quadratic function as a point of comparison. In each regression, we use the Nadaraya-Watson estimator with a Gaussian kernel and Silverman's (1986) optimal bandwidth. Estimates are calculated for 100 evenly spaced values of the regressor, either mean BMI or expenditures per capita.

At each estimation point the linearized standard error was derived using Rao's (1973) linearization approach, as adapted by the Distributive analysis/Analyse Distributive (DAD) package (Duclos and Abdelkrim 2006).

[7] Murray, Gakidou, and Frenk (1999) point out that the magnitude of health inequality measured in this way is conditioned by the critical choice of what variable is used to disaggregate the population into social groups.

One important concern in terms of examining and interpreting the non-parametric models is that there are standard errors around these estimates. Drawing any inference requires knowledge of their magnitude. We therefore make a simple calculation of whether, and what direction To judge whether a non-parametric regression has Kuznets' inverted-U shape, we test for statistically significant differences in the levels of inequality at three ranges of the BMI or consumption/GDP distribution: the 5th to 15th percentile range, the 45 to 55th percentile range and the 85-95th percentile range. If the middle range has signficantly greater inequality than the extremes, we reject the null of no Kuznets relation.

2.4 Decompositions

In addition to estimating the Kuznets curve, it is useful to decompose overall country inequality into between-household and within-household inequality. Unlike the Gini index, the mean log deviation is sub-group decomposable. Let a national sample consist of *K* households. Total inequality within the country can be decomposed according to:

$$I(total) = \sum_{k=1}^{K} \frac{N_k}{N} \left[I(k) \right] + \frac{1}{N} \sum_{k=1}^{K} N_k \ln(\frac{\mu}{\mu_k}) \tag{3}$$

where *I()* is the mean log deviation (inequality), μ is the average BMI for the entire sample, μ_k is average BMI for household k, N is the entire sample size, and N_k is the sample size in household k. The latter term defines between-household inequality as the inequality at household means, while the first term sums all within-household inequality. Households with no health inequality have *I(k)* equal to zero and thus do not contribute to within-household health inequality – the first term – but they do affect between-household inequality insofar as their mean BMI differs from the mean BMI for the country.

3. DATA

For our work on intra-household analysis, we use the Living Standards Measurement Study (LSMS) surveys shown in Table 1. The purpose of these surveys is to collect individual, household, and community level data to measure levels and changes in living standards of the populations sampled. As discussed by Glewwe and Grosch (1998), Grosch and Glewwe (2000) and the World Bank Living Standards Measurement Survey web site,[8] the national statistical offices of each of the countries conducted the surveys with technical support from the World Bank. Multi-stage sampling techniques were used in selecting the samples of households, and sampling was done in a way to ensure self-weighting (i.e., each household has equal probability of being in the sample). The household surveys collect detailed information on expenditures, income,

[8] http://www.worldbank.org/lsms/

employment, assets, basic needs and socio-economic characteristics of the households. All were designed to be nationally representative, with the exception of the Tanzanian Kagera study. Our choice of LSMS surveys, include Brazil,[9] Cote d'Ivoire,[10] Ghana,[11]Guatemala,[12] Nicaragua,[13] Tanzania[14] and Vietnam.[15] They were selected because they include anthropometric data on all household members. This was not done in most LSMS surveys (or in the Demographic Health Surveys discussed below). In several of the countries, more than one survey was conducted, and in these instances we use the data from all years, both individually and in combination. We only report the latter in this paper given the space constraints. However, individual survey results for each country were qualitatively consistent with the aggregated country-specific findings.

In calculating the household mean BMIs and the mean log deviation, we excluded household members who were pregnant or lactating, or who had BMIs outside four standard deviations from the survey's overall mean. Households with mean BMI less than 15 and greater than 35 were deleted. Finally, we identified and eliminated outliers in the Kuznets regressions using the method of Hadi (1992, 1994) to identify multivariate outliers. For an explanation of the algorithm, see Robinson, Cox, and Odom (2005).[16] In general, elimination of these observations has little effect on the nonparametric estimates, but they do sometimes affect the curvature of parametric curves, though never their first derivative.

Our expenditure per capita variables were taken from the data sets prepared by the World Bank. In addition to market purchases for food, non-foods and services, they include the imputed value of home consumed goods as well as housing and durable goods.

In our cross-country analysis of the relationship between inequality and levels of well-being, we rely on the Demographic and Health Survey (DHS) surveys (Table 1). The DHS surveys are conducted in single rounds and include a household schedule, including a list of members and basic household demographic information, as well as an individual questionnaire for women of reproductive age (15-49), as well as data on their children who are still alive. The individual survey includes anthropometric measures of

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[9] http://www.worldbank.org/html/prdph/lsms/country/brazil/docs/introducao.pdf
[10] See Grootaert (1986) and Ainsworth and Munoz (1986) for a more detailed discussion of these data sets.
[11] Glewwe (1991), http://www.worldbank.org/html/prdph/lsms/country/gh/GH88BIF.pdf
[12] http://www.worldbank.org/lsms/country/guat/gt00docs.html; Marini and Gragnolati 2003
[13] http://www.worldbank.org/lsms/country/ni2001/ni01docs.html
[14] http://www.worldbank.org/html/prdph/lsms/country/kagera/kagdocs.html#top
[15] http://www.worldbank.org/html/prdph/lsms/country/vn98/vn98bif.pdf, Dollar and Glewwe (1998).
[16] Hadi's algorithm first identifies a core cluster that contains 'good' data and calculates the robust estimators for its mean and covariance matrix. A distance measure is then computed from each observation to the center of the core. Based on the chi-squared distribution, the closest point outside the core is tested for consistency. When it is consistent, the point is added to the core. We repeat the process until all the data points are added, or a point is identified as an outlier. When there is a point identified, all other points with distances greater than this point is considered as an outlie.

women and their young children, but not other family members, precluding their use for analyzing intrahousehold inequality. The designs of the surveys are quite similar across time and across countries. The DHS are far more numerous than the LSMS surveys. Specifically, we utilize survey from 29 countries in our analysis. We also tested the sensitivity of the results to the inclusion of multiple surveys from each country, and found little effect. We therefore just report the results using the most recent survey for each country.

4. FINDINGS

4.1 Intra-household Inequality

We find a pattern of increasing intra-household inequality as well-being in the household increases, not the inverted-U shape of the Kuznets curve. Figure 1 depicts the non-parametric regression for a pooled sample of all the households from the 7 countries for which we are able to construct a mean log deviation for BMI. Standard errors around this regression are shown by the dotted lines. The graph also includes the prediction from a least squares regression of inequality on BMI and its square.

The results suggest a clear pattern of increasing inequality across the entire range of observations when we order households by their mean BMI (Figure 1a). Statistical comparisons of the differences between the non-parametric estimate at three test points along the BMI distribution -- the 10^{th}, 50^{th}, and 90^{th} percentiles-- confirm what is easily inferred from visually examining the figure: inequality is increasing (see Table 2). We superimpose on the non-parametric results the predicted parametric relationship between mean household BMI and intrahousehold inequality. While there is a clear positive slope that appears quite linear, in fact the quadratic term is negative and statistically significant. However, the coefficient is so small that the function always has a positive slope at any reasonable BMI (Table 3).

A similar set of non-parametric and parametric regression results are plotted in Figure 1b where we order households by expenditures per capita. Note that because of the long right hand tale in the expenditure distribution we scale the x-axis in percentiles, rather than monetary values. This does not affect the ordering but does define the interval on the x-axis to be the same between each household in the distribution. The curve tends to be flatter at the lower end, although, the parametric results still indicate an increasing level of inequality as expenditures increase (Table 3). Likewise, the statistical comparison of the test points at the 50^{th} and 90^{th} percentile of the non-parametric regression reinforces that finding of increasing inequality as well-being improves (Table 2).

It is also noteworthy that in both non-parametric regressions, the curve does turn downward at high values of BMI or expenditures per capita. However, the data are very sparse in this region, so the standard errors are quite large and we cannot reject the null that these values are not lower than those found near the median. This raises the question of whether, if we had enough observations from rich or higher BMI households, would we find the hypothesized Kuznets curve. We can get some insight into that question when we next examine the results for each country, and more specifically focus on the better off countries from Latin America in our sample.

Figure 2 presents comparable results for individual countries, where the ordering of household well-being is based on average BMI. For all seven countries we find the same story of increasing inequality across the range of household average BMI. The statistical tests of the 10^{th}, 50^{th} and 90th percentiles confirm this is the case; for each country the differences are positive, and usually significant (Table 2). Likewise, the parametric model results in Table 3 all indicate increasing inequality, but often this relationship is convex, as seen by the positive and often significant quadratic term in the models (Table 3). For countries like Brazil and Guatemala we see a hint of a down-turn in inequality at very high levels of mean BMI. But these are far above the 90 percentile of the distribution, even for these countries that have high average BMIs. Thus, given the paucity of observations and the large standard errors, we must treat these observations with great caution and can not rely on them to reject the null of increasing inequality across the entire range of BMI.

The country specific results based on the expenditure ordering are found in Figure 3. The kernel estimates from Guatemala, Nicaragua, Tanzania and Vietnam suggest an upward trend in inequality, with the opposite being the case for Brazil. The statistical test results in Table 2 show that in 5 of the 7 countries there is a statistically significant increase in the level of BMI inequality from the 50th to 90^{th} percentile of the expenditure distribution, while the other two countries indicate no statistical difference in levels of inequality. The results for the difference between the 10^{th} and 50^{th} percentile are decidedly more mixed. We also note, however, that in Brazil and Guatemala we do find some evidence in the parametric regressions of a concave function with a maximum in the relevant range of the expenditure distribution. This is the only hint of an intra-household Kuznets curve, but again, it is quite weak and not supported either by the non-parametric regressions, or when we order well-being by the preferred metric of average BMI.

Overall, the results for the BMI ordering provide strong support the notion that inequality increases across the entire range of average household BMI, although, this is less clear in the case of the expenditure ordering where the changes across the bottom end of the distribution in particular are not as consistent. In terms of the specific question of whether there is an inverted Kuznet's relationship, there is little support for this hypothesis. The qualification is that at the highest level of the BMI distribution there are some indication from the non-parametric results that the level of inequality is declining. However, the number of observations at these tails is so small, and the standard errors so large, as to provide little validation for this hypothesis.

4.2 Cross-country Results

We next present the BMI analog to the original Kuznets curve: a relation between BMI inequality measured at the country level and mean country BMI. We calculate country inequality using the mean log deviation of womens' BMIs, using data from 67 DHS surveys. Our results in Figure 4, as well as the accompanying models in Table 4 show clearly that like the intra-household story, inequality increases across the entire relevant range; there is not Kuznets curve but instead, as overall household well-being improves based on mean BMI or expenditures per capita, the level of inequality also rises.

4.2 Decompositions

We next turn to the results of the decomposition of total country inequality into the within and between household shares for all 7 countries for which we are able to measure both (Table 5). We do so for GE (-1), GE(0), GE(1) and GE(2). We find, remarkably, that a smaller share of the total country inequality is between household than within household inequality, as result not sensitive to the choice of the general entropy index. Focusing on GE(0) that we use elsewhere in the paper, in Cote d'Ivoire nearly two-thirds of the total inequality is within household. The within-household shares in Brazil and Nicaragua of 55 percent are the lowest of any of the cases observed.

We are particularly intrigued by these results as they seem to provide some rather startling empirical evidence in response the question posed by Haddad and Kanbur (1990) regarding the importance of the omission of intra-household inequality. If we did not take into account the "between" household component of total inequality in the seven countries examined, country inequality would have been reduced by more than half, and as much as two-thirds in the case of Cote d'Ivoire.

5. CONCLUSIONS

This paper explores the Kuznets curve and the intra-household Kuznets curve using inequality of the body mass index. BMI is a good measure of well-being for inequality analysis. It is positive, cardinal, and it applies to individuals. It reflects command over food, and also non-food resources that affect medical care, the probability of infection (e.g. sanitary conditions), and labor saving technologies. It accounts for caloric consumption relative to needs. And BMI is easily and accurately measured, making it widely available in household survey data.

We do not find any evidence to support either the Kuznets curve or the intra-household Kuznets curve. Instead, we find consistent evidence for an increase in BMI inequality as average living standards (of countries or households) improve. These results are distinct from the literature on the Kuznets curve and the intra-household Kuznets curve. While controversy surrounds the former, our sense of the literature is that there is no relation -- either inverse U-shaped or monotonic -- between average incomes and inequality of income across countries. Haddad and Kanbur (1990) and Haddad, Kanbur, and Bouis (1995) also find little or no relationship between household expenditures per capita and intra-household inequality of calorie consumption. We, on the other hand, usually find a statistically significant increasing relationship.

One qualification to our findings is that the survey data we employ are all from poor countries. As we note earlier, there is a hint that at the highest level of average household BMI that inequality fall. This may be the case, but is not something we can empirically verify from our data.

A distinct and surprising result is that between one half and two-thirds of BMI inequality is accounted for by within-household BMI. This finding clearly suggests that a large share of the inequality that is measured using household surveys, assume that the well-being of all household members is the same, is likely grossly under-estimating overall inequality in a given country. It also implies that policies and programs that target households, not individuals, will be largely ineffective.

To what extent are our results relevant for policy makers? The study of income distributions is often closely linked to the public policy question of *re*distribution of income. Yet it is not possible to redistribute the body mass of an existing household or population among its members in the same way that we can redistribute income. Nevertheless, differences in inequality in the distribution of standardized weights in the household can presumably be related to public policy choices. For example, policies could target the most underweight members of households or countries for better nutrition or health care. While not a direct redistribution, such a policy, if effective, could help to equalize BMI.

There are several examples of research that provide insight into the intra-household allocation of resources and how policy may affect that allocation. For example, the work by Sahn and Gerstle's paper on Romania (2004), Kooreman's on Netherlands (2000), as well as the work of Lundberg, Pollack and Wales for the UK (1997) show how transfer payments accruing to women affect expenditure patterns within the household. But we are not aware of any research that examines explicitly the role of policy in reducing intra-household inequality. The need for such research seems great, particularly in light of our decomposition analysis which suggests that most BMI inequality is actually intra-household. Policies that ignore this fact could address at most only about a third of total BMI inequality.

Finally, our results are entirely descriptive, and efforts to explain the patterns that we observe constitute an important research agenda. This ranges from gaining more insight into whether there are regular patterns in terms of which household members gain disproportionately as mean BMIs increase, as well as the possible role of policy in altering allocative decisions within the household.

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Table 1: Surveys and sample sizes

	Survey Period				
LSMS Surveys	1	2	3	4	Total
Country	Number of Households				
Cote d'Ivoire (85,86,87,88)	583	1,456	1,379	1,384	4,802
Ghana (87,88)	2,383	2,462			4,845
Tanzania Kagera (91,92,93,94)	777	771	775	750	3,073
Vietnam (93,98)	4,610	5,730			10,340
Brazil (97)	4,141				4,141
Guatemala (00)	6,332				6,332
Nicaragua (98)	3,020				3,020
All Countries					36,553
DHS Surveys					
Country	Number of Women				
Bangladesh (96,00,04)	4,063	4,697	10,603		19,363
Benin (96,01)	2,330	5,449			7,779
Bolivia (94,98,03)	2,347	4,202	16,348		22,897
Burkina Faso (92,99,03)	3,467	3,351	10,996		17,814
Cameroon (98,04)	1,661	4,646			6,307
Chad (97,04)	3,709	2,952			6,661
Cote d'Ivoire (94,98)	3,146	2,740			5,886
Colombia (95,00,05)	3,319	3,245	36,836		43,400
Dominican Republic (91,96)	2,163	7,434			9,597
Egypt (92,00)	4,858	14,013			18,871
Ghana (93,98,03)	1,781	2,076	4,933		8,790
Guatemala (95,99)	5,015	2,398			7,413
Haiti (94,00)	1,902	9,159			11,061
Kazakhstan (95,99)	3,538	2,222			5,760
Kenya (93,98,03)	3,363	3,294	7,184		13,841
Madagascar (97,03)	2,627	7,150			9,777
Malawi (92,00)	2,342	11,479			13,821
Mali (95,01)	4,306	10,522			14,828
Morocco (92,04)	2,890	15,941			18,831
Mozambique (97,03)	2,842	10,533			13,375
Nepal (96,01)	3,420	7,959			11,379
Nicaragua (97,01)	12,258	11,936			24,194
Nigeria (99,03)	2,204	6,606			8,810
Peru (92,96,00)	5,200	10,843	25,506		41,549
Tanzania (91,96,04)	4,513	3,820	9,159		17,492
Turkey (93,98)	2,417	2,327			4,744
Uganda (95,00)	3,234	5,829			9,063
Zambia (92,96,01)	3,290	3,904	6,732		13,926
Zimbabwe (94,99)	1,983	5,169			7,152
Total					414,381

Table 2. Statistical comparisons of test points of intra-household inequality

Country	Expenditure per capita		Mean BMI	
	10 vs 50th percentile	50th vs 90 percentile	10 vs 50th percentile	50th vs 90 percentile
Brazil	D	I	I ***	I **
Cote D'Ivoire	D *	I *	I	I ***
Ghana	D **	I ***	I ***	I ***
Guatemala	I ***	D	I **	I ***
Nicaragua	I	I ***	I ***	I *
Tanzania	I	I ***	I *	I ***
Vietnam	D	I ***	I ***	I ***
All Countries	D	I ***	I ***	I *

Notes: I is an increase, D is a decrease; ***significant at 1%, **significant at 5%, and *significant at 10%.

Table 3. Parametric models of the relationship between intra-household inequality and well-being

Variable	Brazil	Cote d'Ivoire	Ghana	Guatemala	Nicaragua	Kagera	Vietnam	All Countries
Mean BMI	0.073	-0.563	-0.301	0.017	0.359	-0.513	-0.168	0.103
	[0.79]	[4.84]**	[3.10]**	[0.17]	[4.40]**	[4.92]**	[2.22]*	[2.49]*
Mean BMI squared	0.085	1.587	1.066	0.222	-0.497	1.506	0.642	-0.017
	[0.44]	[5.62]**	[4.34]**	[1.06]	[2.87]**	[5.76]**	[3.26]**	[0.18]
Constant	-0.012	0.055	0.023	-0.007	-0.048	0.048	0.013	-0.014
	[1.11]	[4.59]**	[2.44]*	[0.61]	[5.03]**	[4.61]**	[1.80]+	[3.20]**
Observations	4247	4546	4685	6438	2991	2982	5666	23572
R-squared	0.1	0.09	0.14	0.14	0.16	0.11	0.09	0.15

Notes: Robust t statistics in brackets

+ significant at 10%; * significant at 5%; ** significant at 1%
Coefficients multiplied by 100

Variable	Brazil	Cote d'Ivoire	Ghana	Guatemala	Nicaragua	Kagera	Vietnam	All Countries
PC Exp percentile	0.352	-0.153	-0.508	1.135	-0.26	0.102	-0.364	0.468
	[1.37]	[1.01]	[3.86]**	[4.55]**	[1.02]	[0.73]	[4.57]**	[2.78]**
PC Exp percentile	-37.732	14.829	52.95	-76.761	53.348	5.457	55.03	-20.164
	[1.49]	[1.01]	[4.19]**	[3.11]**	[2.05]*	[0.40]	[7.09]**	[1.31]
Constant	0.009	0.008	0.007	0.006	0.007	0.006	0.004	0.006
	[17.04]**	[23.09]**	[24.40]**	[15.27]**	[14.98]**	[17.81]**	[25.26]**	[13.78]**
Observations	4135	4696	4702	6339	2926	1973	5558	23067
R-squared	0	0	0	0.02	0.01	0.01	0.03	0.01

Notes: Robust t statistics in brackets

+ significant at 10%; * significant at 5%; ** significant at 1%
Coefficient multiplied by 10^4

Table 4. Cross country regression results

Dependent Variable: Mean Log Deviation				
Mean BMI			0.119	0.508
			[5.75]**	[1.49]
Mean BMI squared				-0.831
				[1.14]
ln GDP	0.262	0.392		
	[4.43]**	[0.28]		
ln GDP squared		-0.865		
		[0.09]		
Constant	-0.006	-0.011	-0.014	-0.059
	[1.37]	[0.21]	[2.88]**	[1.47]
Observations	67	67	67	67
R-squared	0.23	0.23	0.34	0.35

Notes: Absolute value of t statistics in brackets
+ significant at 10%; * significant at 5%; ** significant at 1%
All coefficients multiplied by 100

Table 5. Decomposition of total inequality into within versus between household inequality

Country	% shares							
	Within	Between	Within	Between	Within	Between	Within	Between
	GE(-1)		GE(0)		GE(1)		GE(2)	
Cote d'Ivoire (85,86,87,88)	69.1316527	30.8683473	65.6174334	34.3825666	67.0562048	32.9437952	71.1131555	28.8868445
Ghana (87,88)	55.2083333	44.7916667	56.1415684	43.8584316	58.7454765	41.2545235	65.8278146	34.1721854
Kagera (91,92,93,94)	60.5331599	39.4668401	61.5194565	38.4805435	63.6874649	36.3125351	67.294686	32.705314
Vietnam (98)	59.4117647	40.5882353	59.7949886	40.2050114	60.8974359	39.1025641	63.9019793	36.0980207
Brazil (97)	54.517134	45.482866	55.1608859	44.8391141	57.037037	42.962963	60.761736	39.238264
Guatemala (00)	57.0237599	42.9762401	57.4703557	42.5296443	61.0855263	38.9144737	68.8888889	31.1111111
Nicaragua (98)	59.1739476	40.8260524	55.3816047	44.6183953	57.840697	42.159303	65.0358897	34.9641103

Figure 1a: Intrahousehold BMI inequality and household well-being, all countries pooled, order by mean household BMI

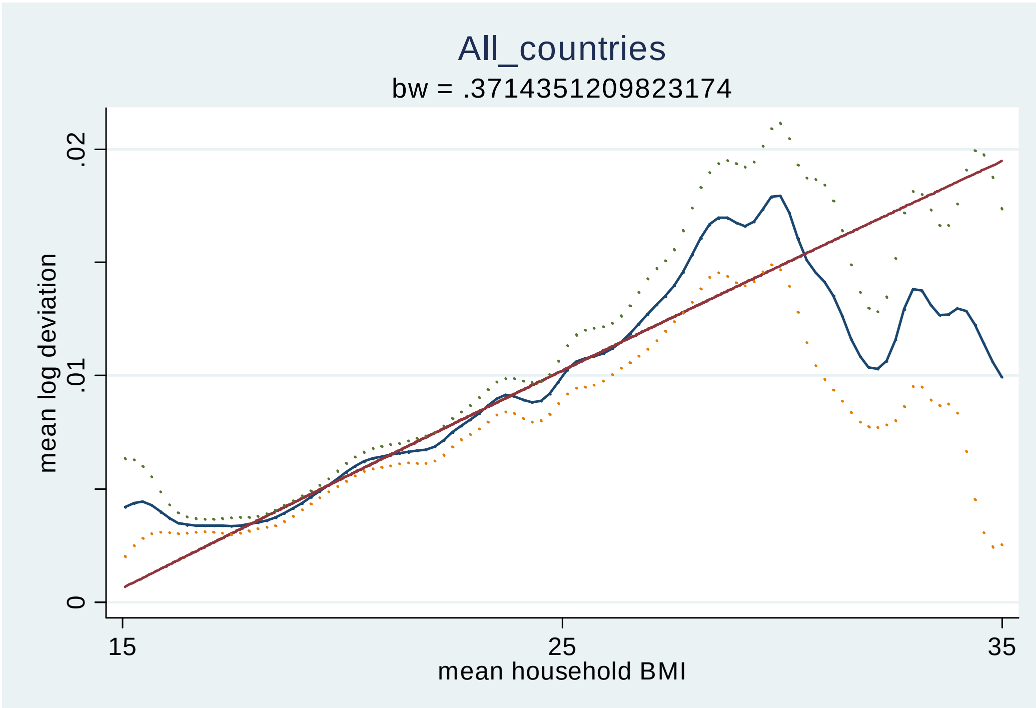

Figure 1b: Intrahousehold BMI inequality and household well-being, all countries pooled, order by per capita expenditures

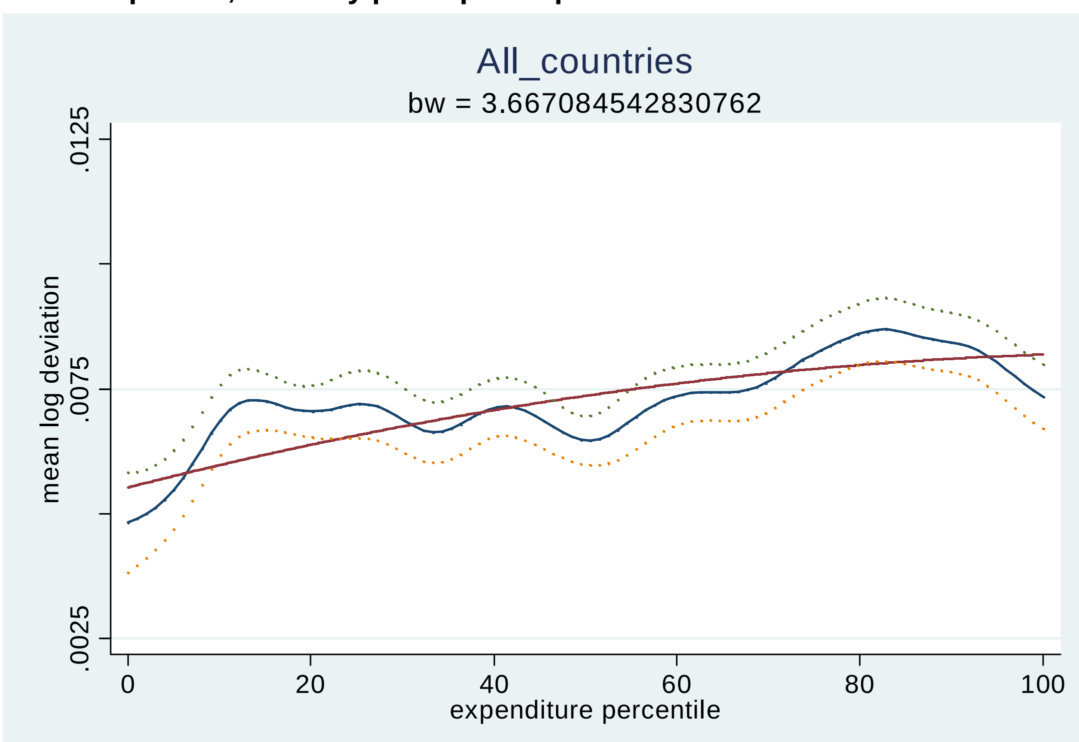

Figure 2: Intra-household BMI inequality by mean household standardized BMI

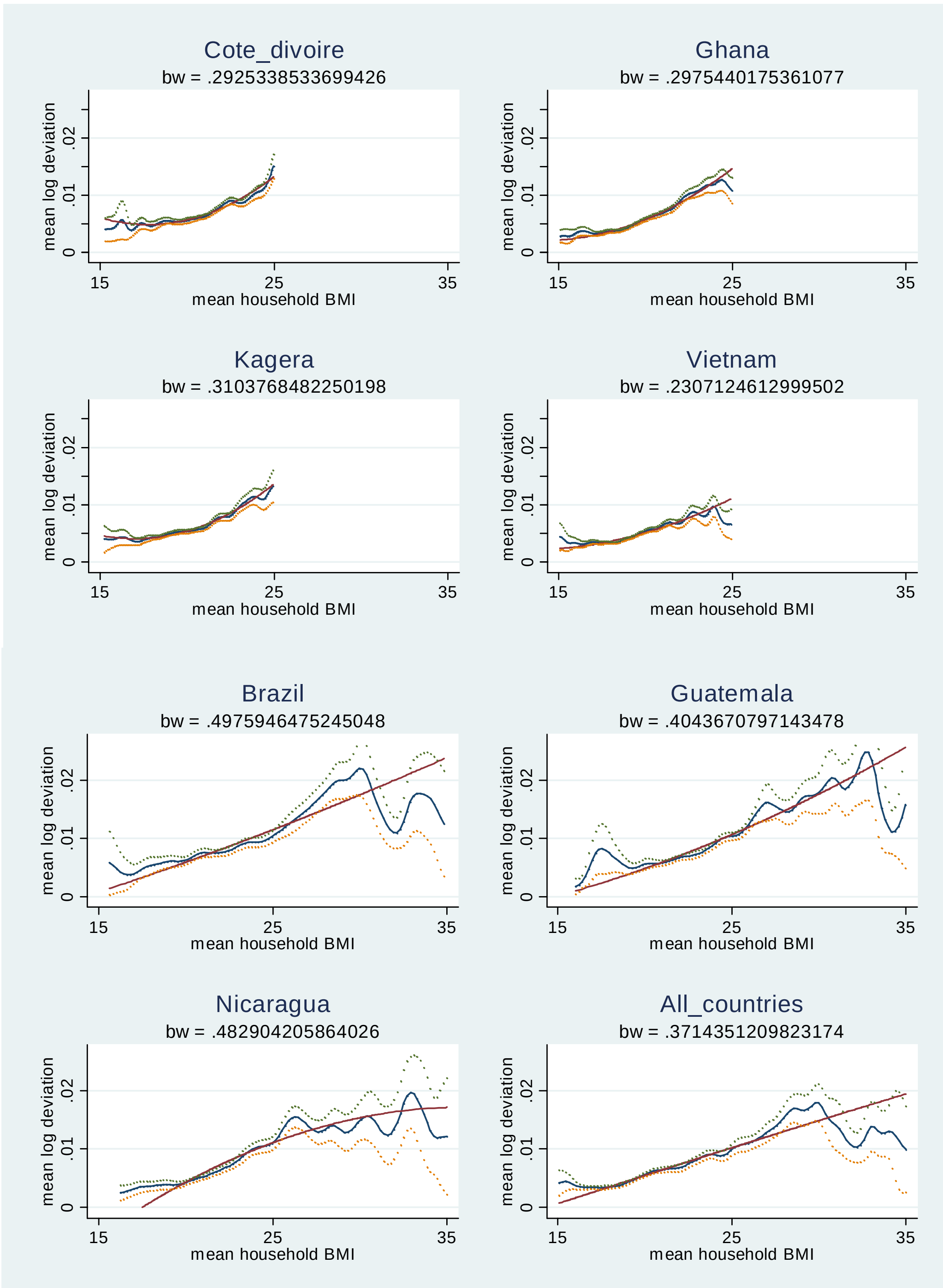

Figure 3: Intra-household BMI inequality by mean per capita expenditure

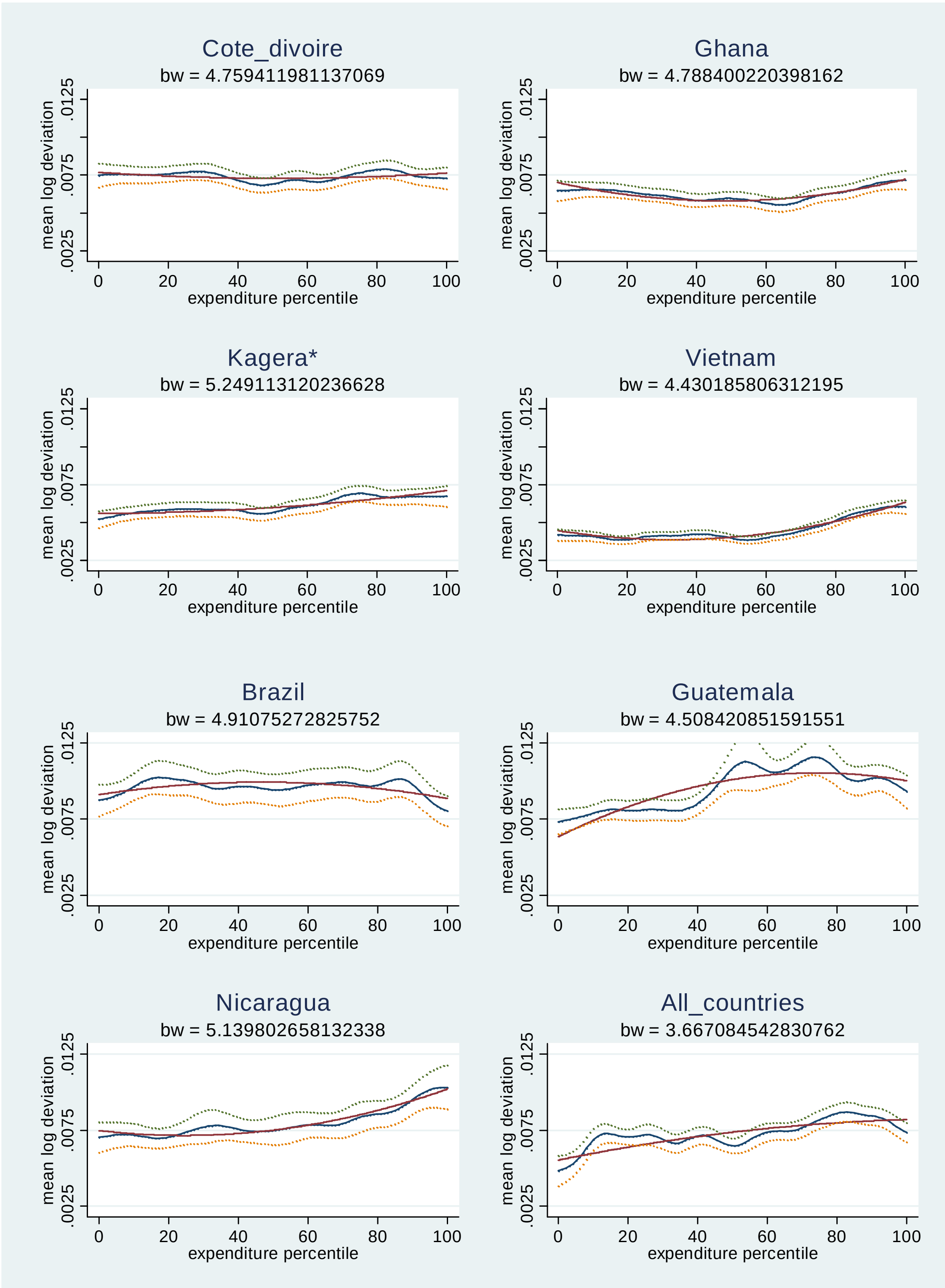

Figure 4. Cross-country relationship between BMI inequality and well-being