CROSS-POPULATION COMPARABILITY AND PPPs:
ISSUES RELATING TO HEALTH PRICES

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1 Introduction

Cross-population comparability of data is a major issue, especially in areas of research pertaining to international comparisons. The problems of intertemporal and interspatial comparability of income and price data are well-known, the latter being one primary focus of the International Comparison Program (ICP). In the public health arena, this issue of cross-population comparability has recently been highlighted in the context of measurement of non-fatal population health, as well as in the measurement of the responsiveness of health systems to the legitimate expectations of the population.[1] The measurement of population health, for instance, often relies on self-report survey data on different domains of health (e.g., mobility, vision, etc.). These self-report survey data are typically categorical in nature. One example of self-report health data comes from the WHO Multi-Country Household Survey Study on Health and Responsiveness.[2] The main self-report question on the domain of mobility is: "Overall in the past 30 days, how much difficulty did you have with moving around?" Respondents are asked to classify themselves using one of five response categories: "1=Extreme/Cannot do; 2=Severe difficulty; 3=Moderate difficulty; 4=Mild difficulty; 5=No difficulty."

One key analytical issue is that these self-report ordinal responses are not comparable across populations primarily because of response category cut-point shifts.[3] Conceptualizing the observed responses as resulting from a mapping between an underlying unobserved

[1] Murray, CJL, A Tandon, JA Salomon, CD Mathers, and R Sadana (2001), "Cross-Population Comparability of Evidence for Health Policy," *Global Progamme on Evidence for Health Policy Discussion Paper No. 35*, Geneva: World Health Organization.

[2] Ustun, TB, S Chatterji, M Villanueva *et al.* (2001), "WHO Multi-Country Household Survey Study on Health and Responsiveness 2000-2001," *Global Programme on Evidence for Health Policy Discussion Paper No. 37*, Geneva: World Health Organization.

[3] Tandon, A, CJL Murray, JA Salomon, and G King (2001), "Statistical Methods for Enhancing Cross-Population Comparability," *Global Programme on Evidence for Health Policy Discussion Paper No. 42*, Geneva: World Health Organization.

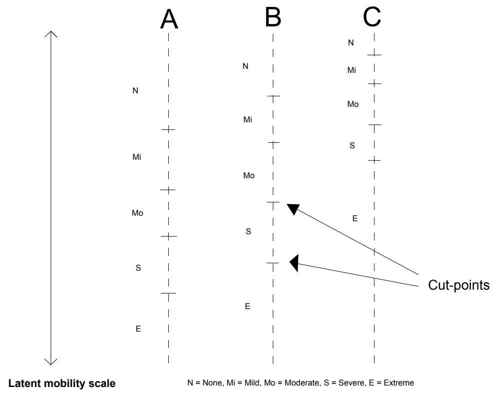

Figure 1: Mapping from latent variable to observed categorical responses.

latent variable (e.g., ability on the domain of mobility) and categorical response categories, cut-points are threshold levels on the latent variable that characterize the transition from one observed categorical response to the next. If cut-points differ systematically across populations, or even across sociodemographic groups within a population, then the observed ordinal responses are not cross-population comparable since they will not imply the same level on the underlying latent variable that we are trying to measure (Figure 1). Another way of characterizing this problem is that, for the same level of the latent variable on any given domain, the probability of an individual responding in any given response category is different across populations.

As mentioned earlier, this issue of cross-population comparability is not limited to health surveys: it is of equal relevance to self-report surveys on responsiveness of health systems, as well as in the measurement of other variables. Another interesting example is the construction of an asset index using a series of asset and other indicator variables from household surveys.[4] For a given level of (unobserved) permanent income or wealth, the probability of asset ownership is likely to be different in different countries. So, for example, having access to running water may be a useful indicator of the relative economic status of a household in a low-income country. The same indicator variable, though, may not be of much use in measuring economic status in a high-income country. Needless to say, this has important implications for the construction of – and analysis of data from – cross-country surveys.

How does this apply in the context of health-related PPP data?A similar issue of cross-population comparability would come up in data relating to the prices of health goods and services. Any meaningful international comparisons of health sector outlays – either as measures of resource available to the health system or for assessing cost-effectiveness of health interventions or for other reasons – must be PPP based. This implies that health price levels would need to be measured across different countries and then compared in order to estimate some form of a PPP conversion factor. In this paper, we show how latent

[4]Ferguson, B, CJL Murray, A Tandon, and E Gakidou (2001), "Estimating Permanent Income Using Asset and Indicator Variables," *Global Programme on Evidence for Health Policy Discussion Paper No. 44*, Geneva: World Health Organization.

variable models such as the ones mentioned above may prove useful in the construction of price levels using international survey data on prices of health goods and services (and is generalizable to the entire spectrum of goods and services prices in the ICP).

We start with a simple measurement model of health PPPs.[5] Assume we have j countries in the sample. Abstracting from the issue of weights, we assume there is a single unobserved latent variable which is the international health price level (P^*) that we are interested in estimating. What we do observe are multiple *indicators* of this international health price level in the form of price data [in local currency units (LCUs)] for different health goods and services in the two different countries. Each of these observed item-specific prices is related to the international health price level P^* (albeit in a different manner). Statistically speaking, this can be characterized as follows. Suppose we have $i = 1, ..., N$ items. We observe measurements (P_{ij}^o) of the price level of item i in country j. This implies:

$$P_{ij}^o = e_j P^* + \varepsilon_j, \qquad i = 1, ..., N. \tag{1}$$

Here, ε_j is the country-specific stochastic error term (with country-specific variance $\sigma_{\varepsilon j}^2$, which implies that the model allows for some observed price indicators to be "noisier" than in other countries in terms of their relationship with the underlying latent variable). As can be seen, equation (1) relates the international price level P^* to the price level in each country, with the relation coefficient being the PPP exchange rate e.

In addition, we allow the international price level to be predicted by each of the items in the health basket:

$$P^* = \boldsymbol{\beta}'\mathbf{D} + u, \tag{2}$$

where $\mathbf{D}$ is a vector of dummy variables for the items in the health basket, and u is the stochastic error term in the relation between the items in the health basket and the international price level P^*. Equations (1) and (2) represent the structural equations model. These equations cannot be estimated as is since they involve an unobserved latent variable P^*. The reduced form for this system of equations can be derived by substituting (2) into:

$$P_{ij}^o = e_j(\boldsymbol{\beta}'\mathbf{D} + u) + \varepsilon_j, \qquad i = 1, ..., N. \tag{3}$$

Equation (3) can be estimated using full-information maximum likelihood methods. For identification purposes, additional restrictions on the parameters are required (one such restriction would be to set $\sigma_u^2 = 1$).[6,7]

[5] A related model can be found in Robins, P.K. and R.W. West (1977), "Measurement Errors in the Estimation of Home Value," *Journal of the American Statistical Association*, 72(358):290-294.

[6] Goldberger, AS (1972), "Maximum-Likelihood Estimation of Regressions Containing Unobservable Independent Variables," *International Economic Review*, 13(1):1-15.

[7] Joreskog, KG and AS Goldberger (1975), "Estimation of a Model with Multiple Indicators and Multiple Causes of a Single Latent Variable," *Journal of the American Statistical Association*, 70(351):631-639.

The advantage of such latent variable models is that they explicitly acknowledge that any given measure of the price level in the survey is but one indicator of the underlying price level, and should be treated as such. Furthermore, each of these indicators may have a different relationship with the underlying latent variable in different countries. The model is easily generalizable to situations where the basket does not consist only of health but is a conglomeration of typical goods and services consumed by a household in a given time period.

In this paper, we propose to demonstrate the use of such models in the construction of health sector price indices. The basic features of the model will be demonstrated using African price data. In particular, for purposes of discussion, we focus attention on a small basket of health goods and services for 11 African countries.

2 A Simple Example

We highlight the model elaborated in the previous section using a sub-set of African price data for 11 countries and for 11 items in the health basket. The names of the countries and the items considered in the health basket are listed in Tables 1 and 2.

Table 1: Sample

List of countries
Benin
Cameroon
Congo
Cote d'Ivoire
Guinea
Malawi
Mali
Senegal
Tanzania
Zambia
Zimbabwe

For now, we estimate a simpler version of the model elaborated in the previous section (one where there is no error term u). Table 3 lists the estimates of the PPP exchange rates (i.e., the e's)and table 4 lists the estimates of the coefficient on the item indicators (i.e., the β's).[8]

[8] Double-starred coefficients denote significance at 0.05 level. Single-starred at the 0.10 level. Estimates of the country-specific standard deviations are not reported.

Table 2: List of items in health basket

Items in Health Basket
NIVAQUINE, MALARAQUINE, CHLOROQUINE
COUGH SYRUP
IODIZED SPIRIT
ASPIRIN
ANTIBIOTIC TABLETS
COTTON WOOL
MEDICAL THERMOMETER
ADHESIVE PLASTER
CONSULTATION, GENERAL MEDICAL PRACTITIONER
X-RAY PHOTOGRAPHY
HOSPITAL CHARGES
ANTI-COUGH MEDICATION
LASILIX
ALDOMET
LABORATORY
ANTIBIOTIC CREAM
DENTAL CONSULTATION
VITAMIN B
SPECTACLES

Table 3: Estimates of multiple indicator coefficients

Dependent variable: P^*	**Coefficient**	**Standard Error**
NIVAQUINE	0.850**	0.095
COUGH SYRUP	0.954**	0.097
IODIZED SPIRIT	0.774**	0.095
ASPIRIN	0.790**	0.094
ANTIBIOTIC TABLETS	0.996**	0.099
COTTON WOOL	0.883**	0.096
MEDICAL THERMOMETER	0.977**	0.098
ADHESIVE PLASTER	0	
CONSULTATION	1.006**	0.099
X-RAY PHOTOGRAPHY	1.140**	0.103
HOSPITAL CHARGES	1.237**	0.106
ANTI-COUGH MEDICATION	0.934**	0.097
LASILIX	0.947**	0.098
ALDOMET	1.087**	0.101
LABORATORY	0.934**	0.097
ANTIBIOTIC CREAM	1.035**	0.100
DENTAL CONSULTATION	1.081**	0.101
VITAMIN B	0.892**	0.098
SPECTACLES	1.286**	0.108

Table 4: Estimates of PPP exchange rate factors

Dependent variable: $\ln(\mathbf{P}^{o}_{\mathbf{ij}})$	**Coefficient**	**Standard Error**
Benin	7.422	
Cameroon dummy	0.098	0.633
Congo dummy	0.263	0.644
Cote d'Ivoire dummy	0.415	0.629
Guinea dummy	0.391	0.678
Malawi dummy	-4.917**	0.300
Mali dummy	-0.308	0.606
Senegal dummy	0.174	0.640
Tanzania dummy	-0.941*	0.536
Zambia dummy	-0.323	0.614
Zimbabwe dummy	-4.441**	0.336

3 Conclusions

This paper has introduced a new latent-variable method of estimating health PPPs. The model is motivated by the problem of cross-population comparability that occurs in estimating health status using self-report indicators of health. The key attraction of latent variable models is the acknowledgement of the fact that any given price measure of a health good or service is imperfectly (and differently) related to the latent variable which we assume is the international price level for health. Key features of the model are highlighted using a sub-set of health price data from 11 African countries. This paper represents the beginning of a research work plan on the application of latent-variable statistical models in the analysis of cross-national survey data on prices.