

# Estimation of Under-5 Mortality by Wealth Quintile

Fengqing Chao<sup>1</sup>, Danzhen You<sup>2</sup>, Jon Pedersen<sup>3</sup>, Lucia Hug<sup>2</sup>, Leontine Alkema<sup>4</sup>

<sup>1</sup>(Email: ephchf@nus.edu.sg), Saw Swee Hock School of Public Health, **National University of Singapore**. <sup>2</sup>Division of Data, Research and Policy, **UNICEF**. <sup>3</sup>Fafo Institute of Applied International Studies, **Fafo**. <sup>4</sup>Department of Biostatistics and Epidemiology, **University of Massachusetts, Amherst**.

## Introduction

### Objective

- ▶ Estimate the levels and trends of under-5 mortality rate (U5MR; probability of dying before age 5) by wealth quintile across countries from 1990 to 2015;
- ▶ Estimate the relation between ratios of quintile-specific U5MR and the national-level U5MR (all quintiles combined);
- ▶ Implement a reproducible statistical model;

### Wealth Quintiles

- ▶ Refer to 5 equal-size birth groups with different levels of socioeconomic status according to the wealth index assigned to each household;
- ▶ 1st wealth quintile = the poorest group; 5th wealth quintile = the richest group.

### Wealth Index

- ▶ Computed based on selected questions asked in the Demographic Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS);
- ▶ Indicator variables: any item that will reflect economic status:
  - ▶ Type of flooring (dirt/cement/parquet)? Type of toilet (bush/flush)? Has electricity? Number of members per sleeping room? etc.
- ▶ Use principal component analysis (PCA) to assign the indicator weights, and get the weighted sum as the wealth index.

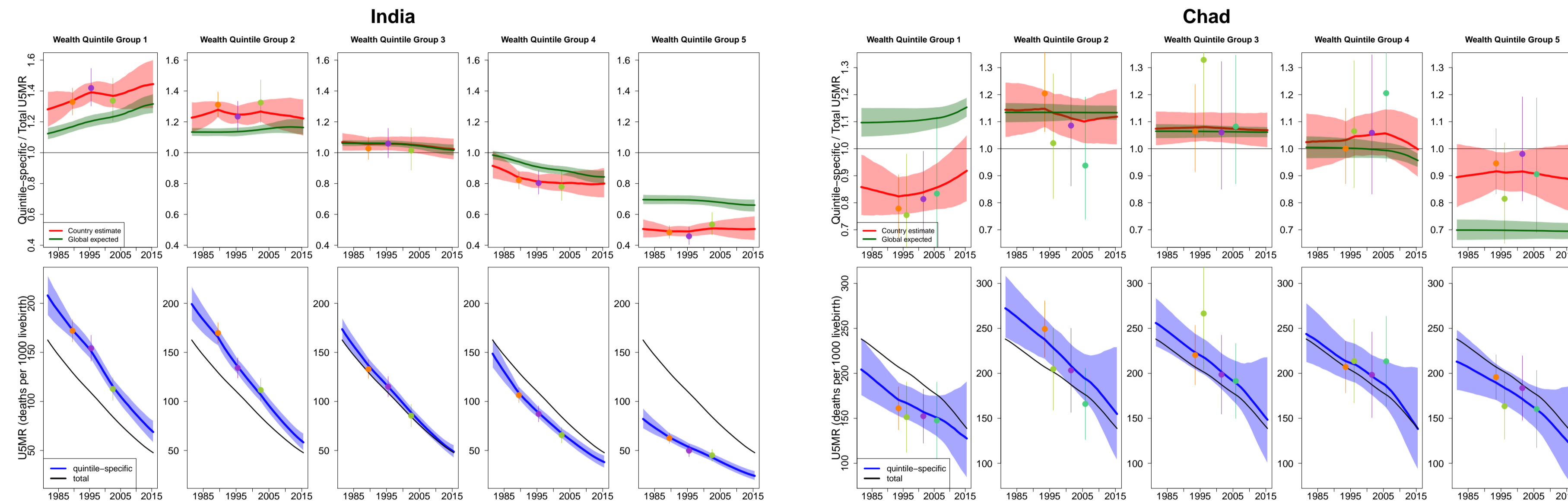
## Data

Data Types	# surveys
DHS direct	208
MICS direct	17
MICS indirect	66
<b>total</b>	<b>291</b>

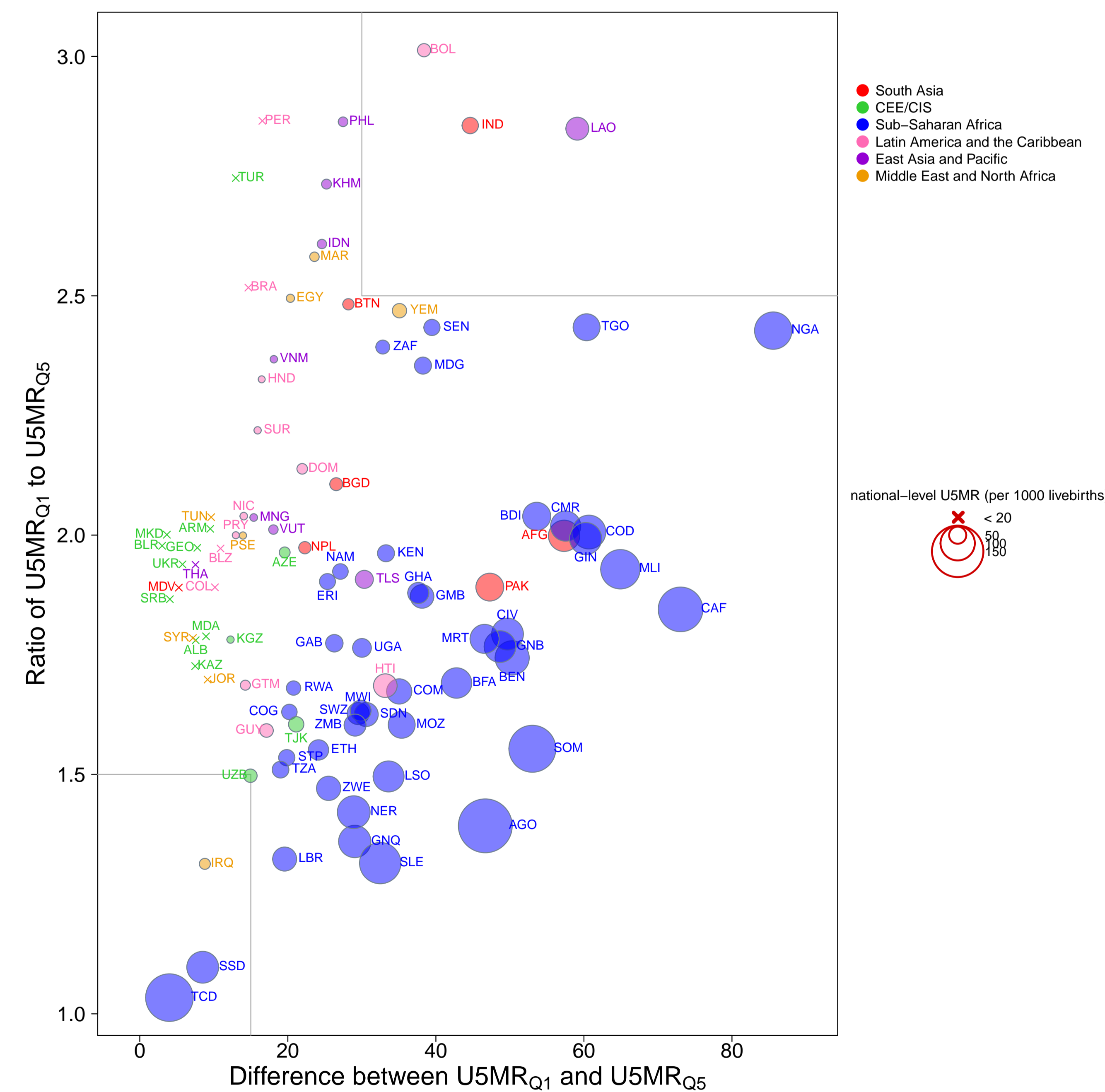
Table: **Database for modeling**. ‘Direct’: full birth history data. ‘Indirect’: summary birth history data.

- ▶ 95 countries with DHS and/or MICS survey data;
- ▶ Each survey has 1 data point for each quintile;
- ▶ Range of reference year: 1987 – 2011.

## Results



**Model estimates and 90% CI for India and Chad.** Row 1: ratio of wealth quintile-specific to national-level U5MR. Row 2: wealth quintile-specific and national-level U5MR.



**Figure: The ratio of the poorest to the richest U5MR against the difference between the poorest and the richest U5MR, in 2015, for all countries with data.** Dots are colored by the region. Size of the dots are proportion to the national-level U5MR in that country-year.

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## Method

**Model Constraint** For country  $c$  in year  $t$ , the quintile-specific U5MRs are related to the national-level U5MR as follows:

$$\sum_{w=1}^5 Q_{w,c,t} = 5 \cdot Q_{total,c,t}.$$

- ▶  $Q_{total,c,t}$ : the national-level U5MR (all wealth quintile combined);
- ▶  $Q_{w,c,t}$ : the U5MR from the  $w$ -th wealth quintile group.

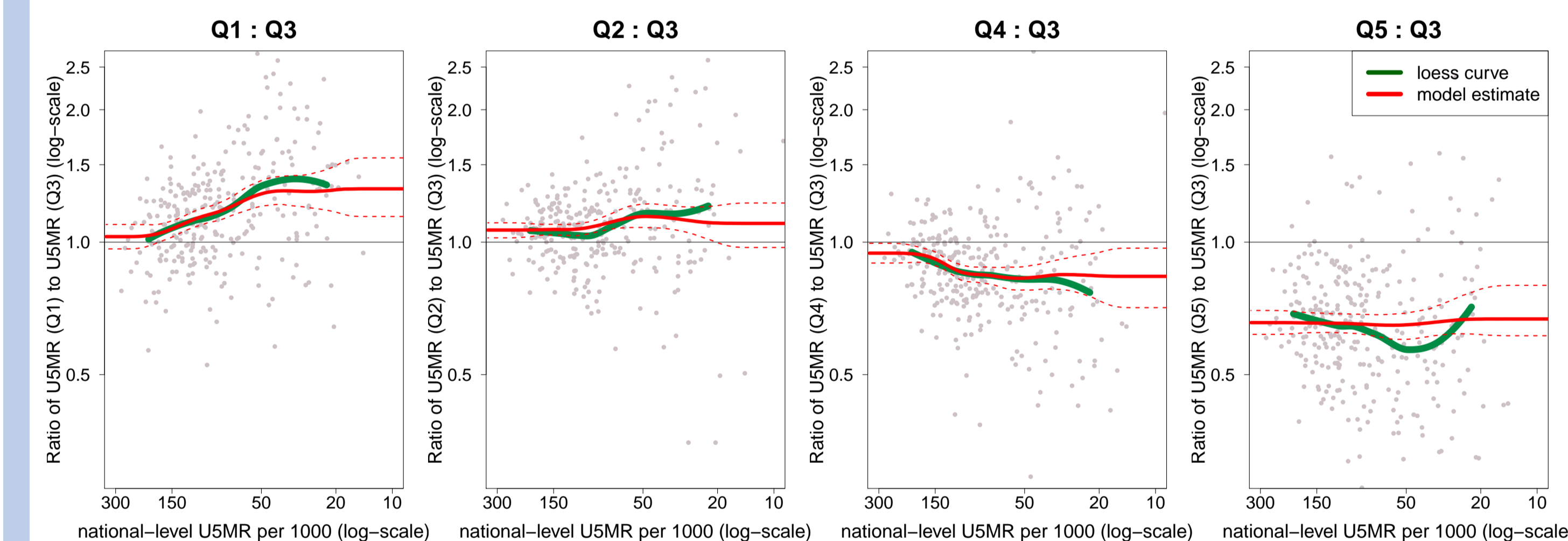
To incorporate the constraint, we estimated the Q3-disparity ratios  $S_{w,c,t}$  for  $w = 1, 2, 4, 5$ , defined as:  $S_{w,c,t} = Q_{w,c,t}/Q_{3,c,t}$ .

The quintile-specific U5MRs are expressed as:

$$Q_{w,c,t} = S_{w,c,t} \cdot Q_{w,c,t}, \text{ for } w = 1, 2, 4, 5,$$

$$Q_{3,c,t} = \frac{5 \cdot Q_{total,c,t}}{(S_{1,c,t} + S_{2,c,t} + S_{4,c,t} + S_{5,c,t} + 1)}.$$

### Modelling Motivation



**Figure: Q3-disparity ratios against national-level U5MR.** The grey dots: data. Green curves: loess curves. Red solid curves: median estimates for the expected Q3-disparity ratios. Red dashed lines: 95% CI.

$S_{w,c,t}$  is modeled as:  $S_{w,c,t} = U_{w,c,t} \cdot P_{w,c,t}$ .

- ▶  $U_{w,c,t}$ : the expected Q3-disparity ratio modelled by a 1st order penalized splines function  $\log(U_{w,c,t}) = f_w(Q_{total,c,t})$ .
- ▶  $P_{w,c,t}$ : relative difference between  $S$  and  $U$ .

$$\log(P_{w,c,t}) \sim N(\rho_w \cdot \log(P_{w,c,t-1}), \sigma_e^2).$$

**Data Model** For each wealth quintile  $w = 1, \dots, 5$ :

$$\log(r_{w,i}) \sim N(\log(R_{w,c[t],t[i]}), \gamma_{w,i}^2).$$

- ▶  $r_{w,i} = q_{w,i}/q_{total,i}$ , the  $i$ -th observed ratio of the  $w$ -th wealth quintile-specific U5MR to the national-level U5MR;
- ▶  $R_{w,c,t} = Q_{w,c,t}/Q_{total,c,t}$ ;
- ▶  $\gamma_{w,i}^2$  is the sampling variance for the  $i$ -th observation.