Legend

c : Country

r: Subcontinent

 $\psi_{c,m,t,s}$: Latent variable used

infer the proportion $\phi_{c,t,m,s}$

 $\phi_{c,m,t,s}$: Proportion of modern contraceptive m, supplied by sector s, at time t in country c.

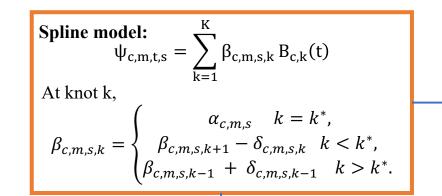
 $\alpha_{c,m,s}^{coun}$: Hierarchically estimated intercept term, informed by the most recently observed level (k*) supplied by sector s of method m in country c.

 $\beta_{c,m,s,k}$: Spline coefficient, informed by estimated crossmethod correlations.

 $B_{c,k}(t)$: Basis functions for country c at knot k.

 $\delta_{c.m.s.k}$: Difference between spline coefficients K and K+1 for sector s of method m in country c.

 $\sigma_{\alpha_s}^2$: Sector-specific variance for x = Country / Subcontinent $\widehat{\Sigma}_{\delta s}^{global}$: Variance-covariance matrix estimated using national-level data from all countries available for sector s.



Proportions:

$$\phi_{c,t,m,1} = logit^{-1}(\psi_{c,t,m,1})$$

$$\phi_{c,t,m,2} = (1 - \phi_{c,t,m,1}) logit^{-1} (\psi_{c,t,m,2})$$

$$\phi_{c,t,m,3} = 1 - (\phi_{c,t,m,1} + \phi_{c,t,m,2})$$

$$\phi_{c,t,m,3} = 1 - (\phi_{c,t,m,1} + \phi_{c,t,m,2})$$

Multi-country national estimation

 $\boldsymbol{\delta}_{c,1:M,s,k} | \Sigma_{\delta,s} \sim MVN(\mathbf{0}, \Sigma_{\delta,s})$

 $\alpha_{c,m,s}^{coun.} \mid \alpha_{r[c],m,s}^{subcont.}, \sigma_{\alpha_s^{coun.}}^2 \sim N(\alpha_{r[c],m,s}^{subcont.}, \sigma_{\alpha_s^{coun.}}^2)$

 $\alpha_{r,m,s}^{subcont.} | \alpha_{m,s}^{world}, \sigma_{\alpha_s^{subcont.}}^2 \sim N\left(\alpha_{m,s}^{world}, \sigma_{\alpha_s^{subcont.}}^2\right)$

 $\alpha_{m,s}^{world} \sim N(0, 10^2)$

Single-country national estimation

Multi-country national estimates inform single-country national estimates

$$\Sigma_{\delta,s} = \ \widehat{\Sigma}_{\delta,s}^{global}$$

The variance-covariance matrix of multicountry national model informs the Wishart prior of single-country national model.

$$\alpha_{r[c],m,s}^{subcont.} = \widehat{\alpha}_{r[c],m,s}^{subcont.}$$

$$\sigma_{\alpha_{s}^{coun.}}^{2} = \widehat{\sigma}_{\alpha_{s}^{coun.}}^{2}$$

Hierarchically estimated intercept of multicountry national model informs the prior of intercept in single-country national model.

$$\delta_{c,1:M,s,k} \mid \Sigma_{\delta,s} \sim \text{MVN}\left(0, \hat{\Sigma}_{\delta,s}^{\text{globa}l}\right)$$

 $\alpha_{c,m,s}^{coun.} \mid \hat{\alpha}_{r[c],m,s}^{subcont.}, \hat{\sigma}_{\alpha_{c,s}}^2 \sim N(\hat{\alpha}_{r[c],m,s}^{subcont.}, \hat{\sigma}_{\alpha_s^{coun.}}^2)$