$$p\left(\mathbf{y},\boldsymbol{\gamma},\sigma^2,\Sigma;\Theta\right)=p\left(\sigma^2\right)p\left(\Sigma;\Theta\right)\prod_{i=1}^{n_s}p\left(\mathbf{y}_i\mid\boldsymbol{\gamma}_i,\sigma^2\right)p\left(\boldsymbol{\gamma}_i\mid\Sigma\right)$$

$$p\left(\boldsymbol{\gamma}_i\mid\mathbf{y}_i,\sigma^2,\Sigma;\Theta\right)\propto p\left(\mathbf{y}_i\mid\boldsymbol{\gamma}_i,\sigma^2\right)p\left(\boldsymbol{\gamma}_i\mid\Sigma\right)$$

$$=\exp\left(-\frac{1}{2\sigma^2}\sum_{t=1}^{n_i}\left(y_{it}-z_{it}^{\top}\boldsymbol{\gamma}_i\right)^{\top}\left(y_{it}-z_{it}^{\top}\boldsymbol{\gamma}_i\right)\right)\exp\left(-\frac{1}{2}\boldsymbol{\gamma}_i^{\top}\Sigma^{-1}\boldsymbol{\gamma}_i\right)$$

$$=\exp\left(-\frac{1}{2\sigma^2}\left(\mathbf{y}_i-Z_i\boldsymbol{\gamma}_i\right)^{\top}\left(\mathbf{y}_i-Z_i\boldsymbol{\gamma}_i\right)\right)\exp\left(-\frac{1}{2}\boldsymbol{\gamma}_i^{\top}\Sigma^{-1}\boldsymbol{\gamma}_i\right)$$

$$=\exp\left(-\frac{1}{2}\left(\left(\mathbf{y}_i-Z_i\boldsymbol{\gamma}_i\right)^{\top}\left(\sigma^2 I\right)^{-1}\left(\mathbf{y}_i-Z_i\boldsymbol{\gamma}_i\right)+\boldsymbol{\gamma}_i^{\top}\Sigma^{-1}\boldsymbol{\gamma}_i\right)\right)$$

$$\propto\exp\left(-\frac{1}{2}\left(-2\sigma^{-2}\mathbf{y}_i^{\top}Z_i\boldsymbol{\gamma}_i+\sigma^{-2}\boldsymbol{\gamma}_i^{\top}Z_i^{\top}Z_i\boldsymbol{\gamma}_i+\boldsymbol{\gamma}_i^{\top}\Sigma^{-1}\boldsymbol{\gamma}_i\right)\right)$$

$$=\exp\left(-\frac{1}{2}\left(\boldsymbol{\gamma}_i^{\top}\left(\sigma^{-2}Z_i^{\top}Z_i+\Sigma^{-1}\right)\boldsymbol{\gamma}_i-2\sigma^{-2}\mathbf{y}_i^{\top}Z_i\boldsymbol{\gamma}_i\right)\right)$$

$$\sim\mathcal{N}\left(\left(\sigma^{-2}Z_i^{\top}Z_i+\Sigma^{-1}\right)^{-1}\sigma^{-2}\mathbf{y}_i^{\top}Z_i,\left(\sigma^{-2}Z_i^{\top}Z_i+\Sigma^{-1}\right)^{-1}\right)$$

$$p\left(\sigma^2\mid\mathbf{y},\boldsymbol{\gamma},\Sigma;\Theta\right)\propto p\left(\mathbf{y}\mid\boldsymbol{\gamma},\sigma^2\right)p\left(\sigma^2\right)=p\left(\sigma^2\right)\prod_{i=1}^{n_s}p\left(\mathbf{y}_i\mid\boldsymbol{\gamma}_i,\sigma^2\right)$$

$$\propto\sigma^{-2\frac{(n+1)}{2}}\exp\left(-\frac{1}{2\sigma^2}\sum_{i=1}^{n_s}\sum_{t=1}^{n_t}\left(y_{it}-z_{it}^{\top}\boldsymbol{\gamma}_i\right)^{\top}\left(y_{it}-z_{it}^{\top}\boldsymbol{\gamma}_i\right)\right)$$

$$\sim\mathrm{I}\Gamma\left(\frac{n}{2},\frac{1}{2}\sum_{i=1}^{n_s}\sum_{t=1}^{n_t}\left(y_{it}-z_{it}^{\top}\boldsymbol{\gamma}_i\right)^{\top}\left(y_{it}-z_{it}^{\top}\boldsymbol{\gamma}_i\right)\right)$$

$$p\left(\Sigma\mid\mathbf{y},\boldsymbol{\gamma},\sigma^2;\Theta\right)\propto\mathcal{IW}\left(d_0+n_s,C_0+\sum_{i=1}^{n_s}\boldsymbol{\gamma}_i\boldsymbol{\gamma}_i^{\top}\right)$$