$$\Pr(\mathbf{s}, \mathbf{D} \mid \mathbf{r}) = \prod_{c=1}^{C} \Pr(\mathbf{s}_c, \mathbf{D}_c \mid r_c)$$

$$= \prod_{c=1}^{C} \left[\pi_{s_{c1}} \prod_{b \in \mathcal{I}} P^{(r_c)}_{s_{c\psi(b)} s_{c\phi(b)}}(t_b) \right.$$

$$\left. \times \prod_{b \in \mathcal{E}} P^{(r_c)}_{s_{c\psi(b)} D_{c\phi(b)}}(t_b) \right]$$