L_1

$$\hat{p}_{(j)} = \begin{cases} \dfrac{n_{(j)}}{\gamma}, & j=1 \\ \dfrac{n_{(j)}}{2\lambda\ d+\gamma}, & j=2 \\ \dfrac{n_{(j)}}{2\lambda\ (d+e)\ +\gamma}, & j=3,4 \end{cases} . \tag{14}$$

Note that $d + e = 1$ and thus, γ satisfies the following equation

$$\sum_{j=1}^{4} p_{(j)} = \frac{n_{(1)}}{\gamma} + \frac{n_{(2)}}{2\lambda\ d+\gamma} + \frac{n_{(3)}+n_{(4)}}{2\lambda\ +\gamma} = 1. \tag{15}$$

We can solve for γ by taking the real roots of the cubic equation

$$\gamma^3 + A\ \gamma^2 + B\ \gamma + C = 0, \tag{16}$$

where $A = 2\lambda\,(1+d) - N$, $B = 2\lambda \times [-n_{(1)} - n_{(2)} - d\ (N - n_{(2)}) + 2\lambda\ d]$ and $C = -4\lambda^2\ n_{(1)}\ d$.

L_2

$$\hat{p}_{(j)} = \begin{cases} \dfrac{((1+d)\ \lambda-\gamma) \pm \sqrt{((1+d)\ \lambda-\gamma)^2 + 8\lambda n_{(j)}}}{4\lambda}, & j=1 \\ \dfrac{(\lambda\ e-\gamma) \pm \sqrt{(\lambda\ e-\gamma)^2 + 8\lambda n_{(j)}}}{4\lambda}, & j=2 \\ \dfrac{-\gamma \pm \sqrt{\gamma^2 + 8\lambda n_{(j)}}}{4\lambda} & j=3,4 \end{cases} . \tag{17}$$

To solve for γ, take the sum of the positive roots for each $\hat{p}_{(j)}$.