In the relevant probability space $(\Omega, \mathcal{F}, \mathbb{P})$, define the filtration

$$\begin{aligned}\mathcal{F}_0 &= \sigma\left(\{D_i(0) \,:\, i = 1, 2\}\right), \\ \text{and, } \mathcal{F}_t &= \sigma\left(\{D_i(s) \,:\, 0 \le s \le t, 1 \le i \le s+2\}\right) \quad \forall t \ge 1.\end{aligned}$$

We now find the conditional expectation $\mathbb{E}(D_i(t+1) \,|\, \mathcal{F}_t)$.

$$\begin{aligned}\mathbb{E}(D_i(t+1) \,\big|\, \mathcal{F}_t) &= \mathbb{E}(D_i(t) + D_i(t+1) - D_i(t) \,\big|\, \mathcal{F}_t) \\ &= D_i(t) + \mathbb{E}(D_i(t+1) - D_i(t) \,\big|\, \mathcal{F}_t) \\ &= D_i(t) + P_i(t) \\ &= D_i(t)\{1 + P_i'(t)\},\end{aligned}$$

where $P_i(t)$ is the conditional probability that the newly arriving vertex at time $t+1$ attaches to the vertex i, given $\mathcal{F}_t$.