Observe that the term $\mathbb{E}(D_i(t+1) - D_i(t) \,|\, \mathcal{F}_t)$ is expectation of an indicator, and hence the probability

$$\begin{aligned}
P_i(t) &= P(\text{new vertex at time } t+1 \to i\text{-th vertex} \,|\, \mathcal{F}_t) \\
&= \sum_{\substack{k_1, k_2, \ldots, \\ k_{\lfloor (t+1)p \rfloor} \in [t+1] \setminus \{i\}}} \Bigg[\frac{D_{k_1}(t) \ldots D_{k_{\lfloor (t+1)p \rfloor}}(t)}{\sum_{\substack{j_1, j_2, \ldots, \\ j_{\lfloor (t+1)p \rfloor} \in [t+1]}} D_{j_1}(t) \ldots D_{j_{\lfloor (t+1)p \rfloor}}(t)} \\
&\qquad \times \frac{D_i(t)}{\sum_{j=1}^{t+1} D_j(t) - \{ D_{k_1}(t) \ldots D_{k_{\lfloor (t+1)p \rfloor}}(t) \}} \Bigg] \\
&= D_i(t) P_i'(t).
\end{aligned}$$