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Extra Opgave Inleiding Financiele Wiskunde 2010

Consider a 3-period Binomial model with $S_0 = 10$, $u = 4/3$, $d = 1/3$ and $r = 1/9$. Suppose that the real probability P satisfies $P(H) = p$, $P(T) = q$, and let $\tilde{P}$ denote the risk neutral probability.

1. Determine the values of $\tilde{E}_1(S_3)(H)$, $\tilde{E}_1(S_3)(T)$.
2. Determine the distribution of $\tilde{E}_2(S_3)$.
3. Find $\tilde{E}_1(\frac{S_3}{S_1})$.
4. Show that $E_1(S_3) = \frac{(3p+1)^2}{9} S_1$.
5. Find $E(E_1(S_3))$.