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## Pricing and Hedging GMWBs in a Binomial Model

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We consider the Guaranteed Minimum Withdrawal Benefits (GMWB) variable annuity rider under a static withdrawal strategy but allowing for early surrenders. We briefly present and extend results from the literature for a continuous-time model where the underlying asset is log-normally distributed. Particular attention is paid to the unique perspectives of both the insured and the insurer. We construct a binomial model in several steps. The price processes are first stated assuming no surrenders and it is proven that the fair fee rate enables a dynamic delta hedging strategy. Similar results hold when optimal surrenders are assumed. Finally we introduce mortality and demonstrate through simulations that delta hedging results in a perfect hedge only in the limit as mortality risk diversification is attained. We conclude by applying approximation methods which significantly improve the computational efficiency of the binomial asset pricing model for the GMWB product.