3.2.2

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$E[X]$:

$$E[X] = E[M] * E[B] = r * \frac{1-q}{q}\frac{\alpha}{\beta} = 2 \times 10^5$$

$Var(X)$:

$$Var(X) = Var(B) * E[M] + E[B]^2 * Var(M) = 1.1 \times 10^{10}$$

$P(X \leq 500\,000)$:

$$\begin{aligned} P(X \leq 500\,000) &= P(M=0) + \sum_{k=1}^{\infty} P(M=k) * F_{\sum_1^k B}(500\,000) \\ &= q^r + \sum_{k=1}^{\infty} P(M=k) * H(500\,000, \alpha * k\,, \beta) \\ &= 0.9882276 \end{aligned}$$

$\Pi_{0.99}(X)$:

```
VaR <- function(k) uniroot(function(x) Fx(x)-k,c(0,700000))$root
```

```
TVaR <- function(k){
    v <- VaR(k)
    sum(sapply(seq(1000),function(i) dnbinom(i,r,q)*a*i/b*(1-pgamma(v,a*i+1,b))))/(1-k)
}
```

$$\begin{aligned} \Pi_{0.99}(X) &= TVaR_{0.99}(X) \\ &= \frac{E[X * 1_{\{X > VaR_{0.99}\}}]}{1-0.99} \\ &= \sum_{k=1}^{\infty} P(M=i) * \frac{\alpha * k}{\beta} * \overline{H}(VaR_{0.99}, \alpha * k + 1, \beta) \\ &= 5.7726189 \times 10^5 \end{aligned}$$

$\Pi^{(1)}, \Pi_{\kappa}^{(2)}$ & $\Pi_{\kappa}^{(3)}$:

$$\Pi^{(1)} = 2 \times 10^5$$

Pour le reste, il est tard jsuis tanné.