$$E(\max(r_1 + p_M, r_2)) = \int_{-\infty}^{\infty} x f(x) dx)$$

where $f(x) = F'(x)$
F being the cumulative distribution function

$$\begin{aligned}
F(x) &= \int_0^x f(x) dx & (1)\\
&= prob\{\max\{r_1 + p_M, r_2\} < x\} & (2)\\
&= prob\{r_1 + p_M < x\} * prob\{r_2 < x\} & (3)\\
&= \begin{cases} (x^2 - p_M x), & p_M < x < 1 \\ (x - p_M), & 1 < x < p_M \\ 1, & x > 1 + p_M \\ 0, & otherwise \end{cases} & (4)
\end{aligned}$$

Thus,

$$f(x) = \begin{cases} 2x - p_M, & p_M < x < 1 \\ 1, & 1 < x < 1 + p_M \\ 0, & otherwise \end{cases} \qquad (5)$$

And so,

$$\begin{aligned}
&\int_{-\infty}^{\infty} x f(x) dx & (6)\\
&= \int_{p_M}^{1+p_M} 2x^2 - p_M x dx + \int_1^{1+p_M} x dx & (7)\\
&= \frac{2}{3} + \frac{1}{2} p_M + \frac{1}{2} p_M^2 - \frac{1}{6} p_M^3 & (8)
\end{aligned}$$