$$
\begin{aligned}
R(\theta_1, \theta_2) &= \frac{g_1(\theta_1)}{g_2(\theta_2)} = \frac{\mu_1 - \mu_2}{\sigma} \\
\theta_1 &= \mu_1 - \mu_2 \\
\theta_2 &= \sigma^2 \\
g_1(x) &= x \quad \implies \quad g_1'(x) = 1 \\
g_2(x) &= \sqrt{x} \quad \implies \quad g_2'(x) = \frac{1}{2\sqrt{x}}
\end{aligned}
$$

$$
\mathbf{\Sigma} = \begin{bmatrix} 2\sigma^2 & \frac{1}{2}(\mu_{13} - \mu_{23}) \\ \frac{1}{2}(\mu_{13} - \mu_{23}) & \frac{1}{4}\left(\mu_{14} + \mu_{24} - 2\sigma^4\right) \end{bmatrix}
$$

and

$$
\mathbf{D}' = \left[\frac{g_1'(\theta_1)}{g_2(\theta_2)}, -\frac{g_1(\theta_1)g_2'(\theta_2)}{g_2^2(\theta_2)}\right] = \left[\frac{1}{\sigma}, -\frac{(\mu_1 - \mu_2)}{\sigma^2}\left(\frac{1}{2\sigma}\right)\right] = \left[\frac{1}{\sigma}, -\frac{(\mu_1 - \mu_2)}{2\sigma^3}\right].
$$

$$
\mathbf{x}'\mathbf{A}\mathbf{x} = \begin{bmatrix} x_1 & x_2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{12} & a_{22} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = a_{11}x_1^2 + 2a_{12}x_1x_2 + a_{22}x_2^2
$$

therefore

$$
\begin{aligned}
\mathbf{D}'\mathbf{\Sigma}\mathbf{D} &= \begin{bmatrix} \frac{1}{\sigma} & -\frac{(\mu_1-\mu_2)}{2\sigma^3} \end{bmatrix} \begin{bmatrix} 2\sigma^2 & \frac{1}{2}(\mu_{13} - \mu_{23}) \\ \frac{1}{2}(\mu_{13} - \mu_{23}) & \frac{1}{4}\left(\mu_{14} + \mu_{24} - 2\sigma^4\right) \end{bmatrix} \begin{bmatrix} \frac{1}{\sigma} \\ -\frac{(\mu_1-\mu_2)}{2\sigma^3} \end{bmatrix} \\
&= \left(2\sigma^2\right)\left(\frac{1}{\sigma}\right)^2 + 2\left[\frac{1}{2}(\mu_{13} - \mu_{23})\right]\left[\frac{1}{\sigma}\right]\left[-\frac{(\mu_1 - \mu_2)}{2\sigma^3}\right] + \left[\frac{1}{4}(\mu_{14} + \mu_{24}) - \frac{\sigma^4}{2}\right]\left[-\frac{(\mu_1 - \mu_2)}{2\sigma^3}\right]^2 \\
\xi^2 &= 2 - \underbrace{\frac{(\mu_1 - \mu_2)(\mu_{13} - \mu_{23})}{2\sigma^4}}_{t_1} + \underbrace{\frac{(\mu_1 - \mu_2)^2}{4\sigma^6}}_{t_2}\underbrace{\left(\frac{\mu_{14} + \mu_{24}}{4} - \frac{\sigma^4}{2}\right)}_{t_3}
\end{aligned}
$$