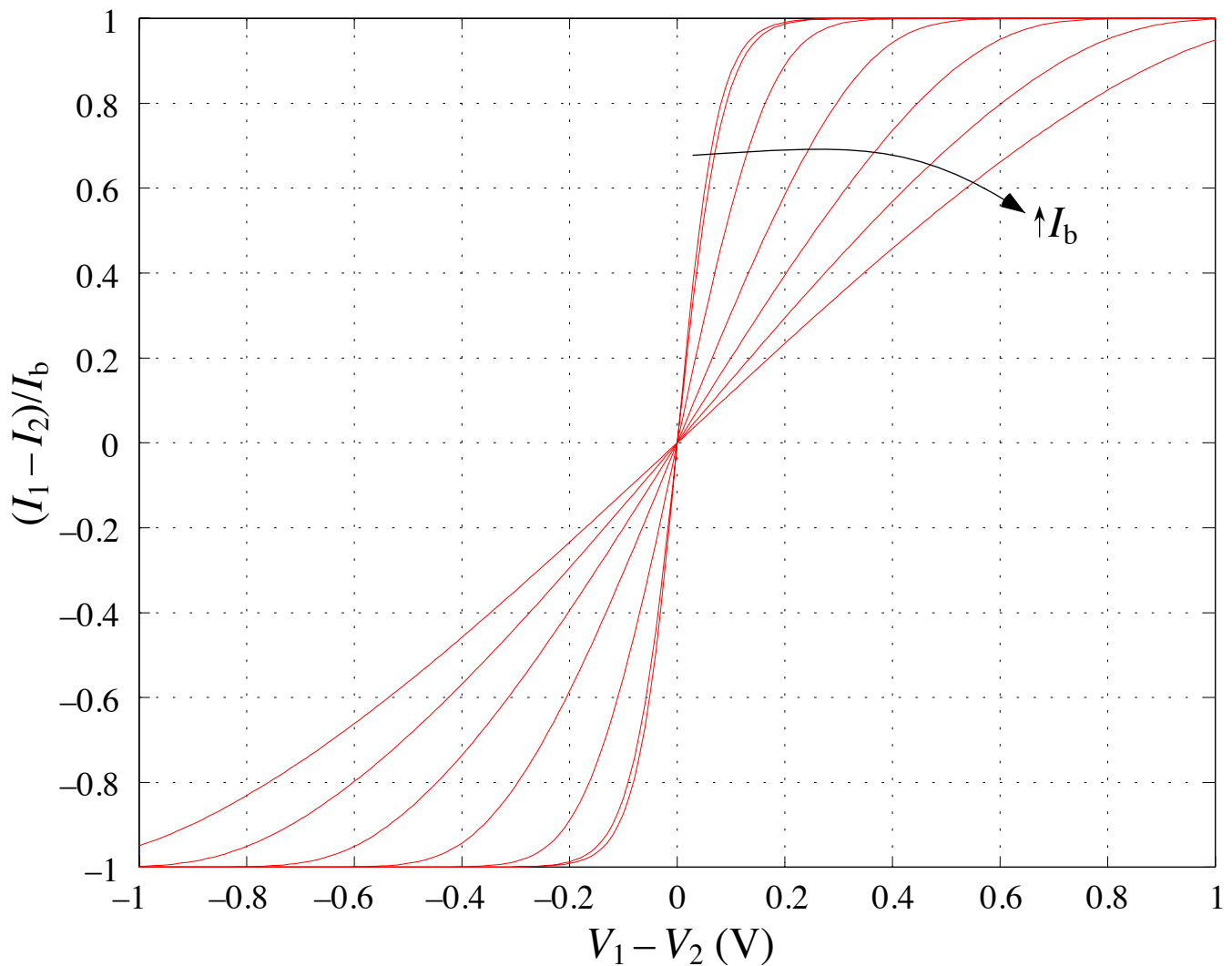
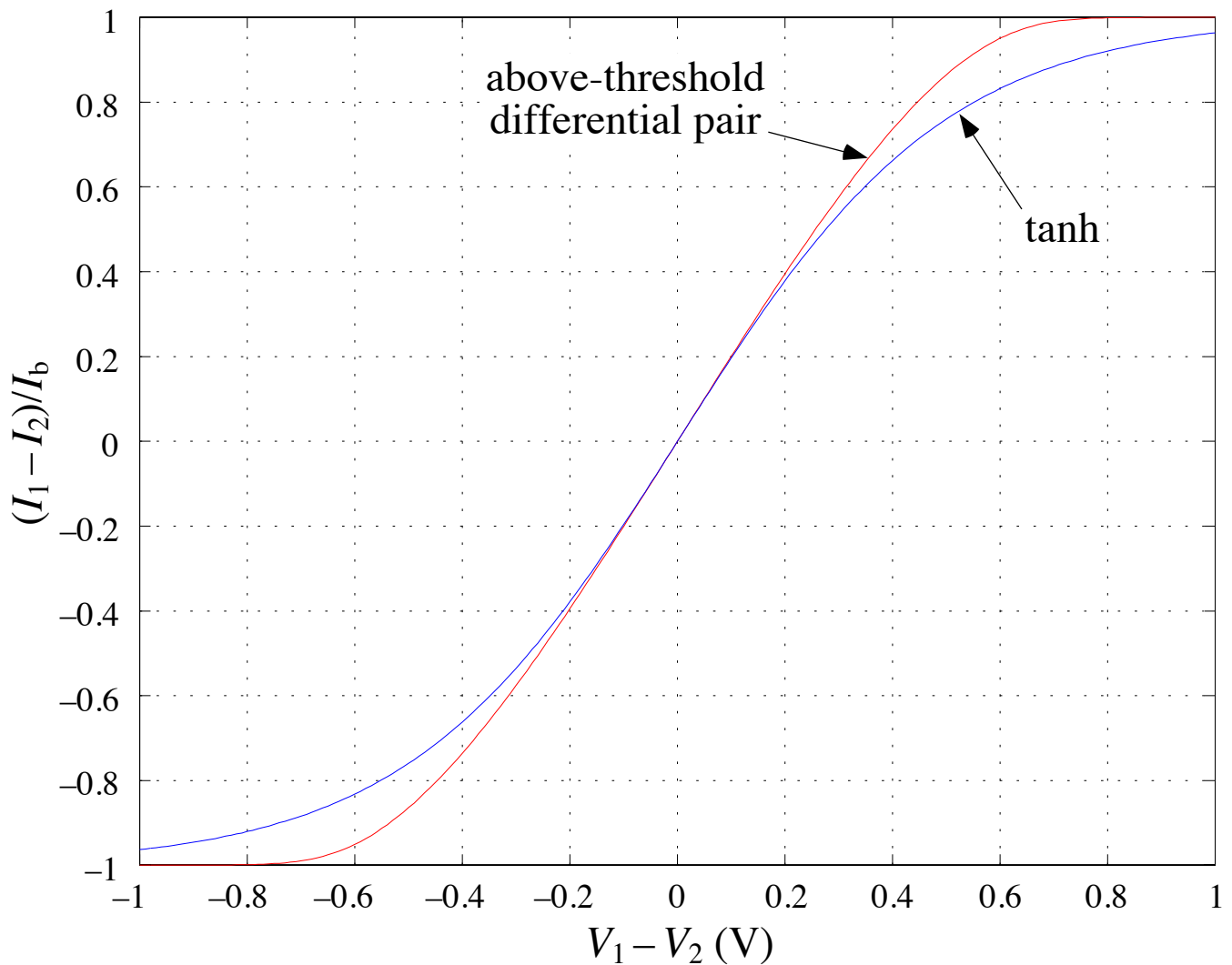


# Above-Threshold Differential Pair



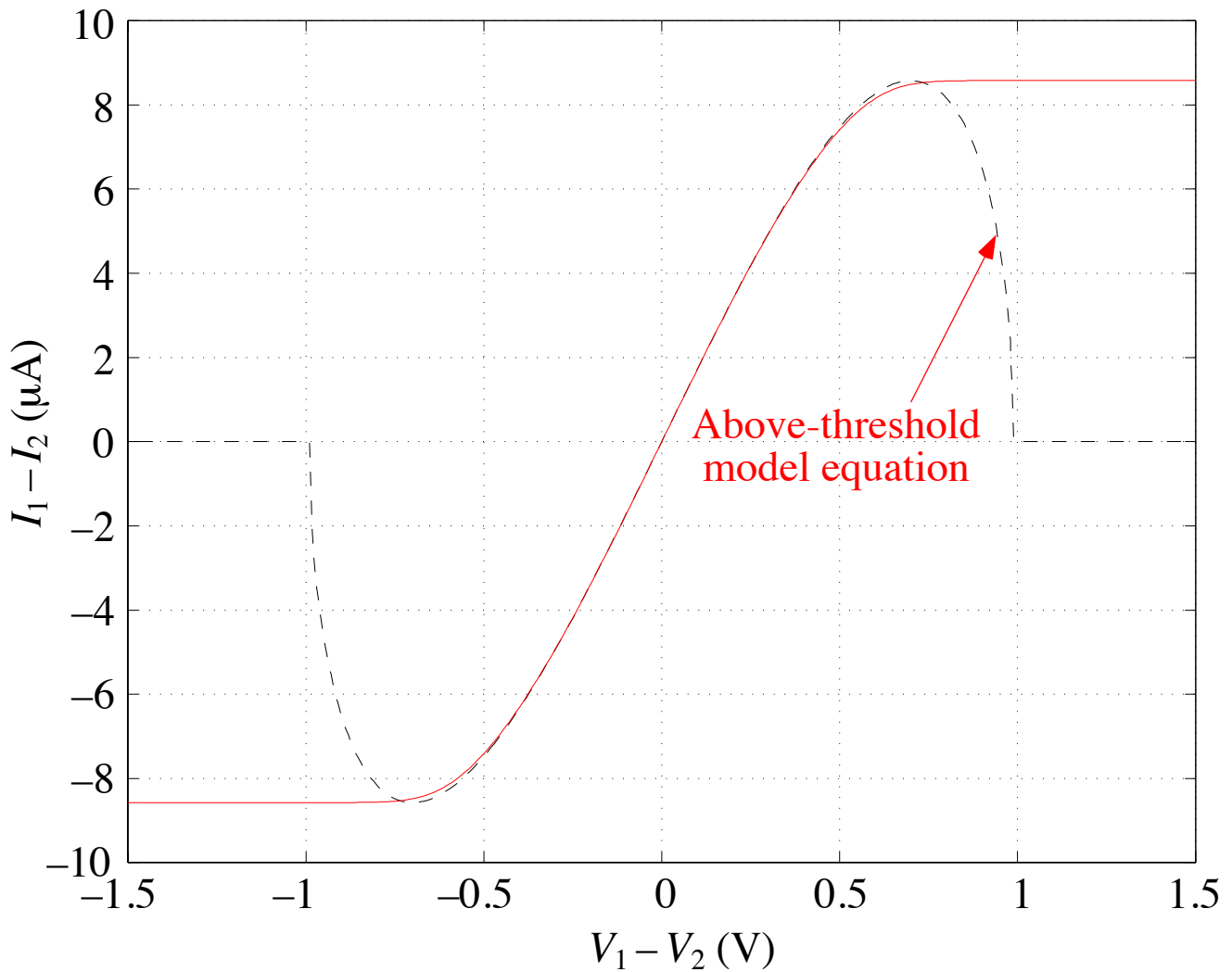
- ▶ No difference in *qualitative* behavior.
- ▶ Softer nonlinearity.
- ▶ Wider linear range  $\Leftrightarrow$  Lower  $g_m/I_b$

# Above-Threshold Differential Pair



► Less nonlinearity than  $\tanh(x)$  with same slope.

# Above-Threshold Differential Pair



► Why does the above-threshold model break?

$$I_1 - I_2 = I_b \sqrt{\frac{\beta_b}{\beta} \left( \frac{V_1 - V_2}{V_b - V_{T0}} \right)} \sqrt{2 - \frac{\beta_b}{\beta} \left( \frac{V_1 - V_2}{V_b - V_{T0}} \right)^2}$$

$$|V_1 - V_2| < \sqrt{\frac{\beta_b}{\beta}} (V_b - V_{T0})$$