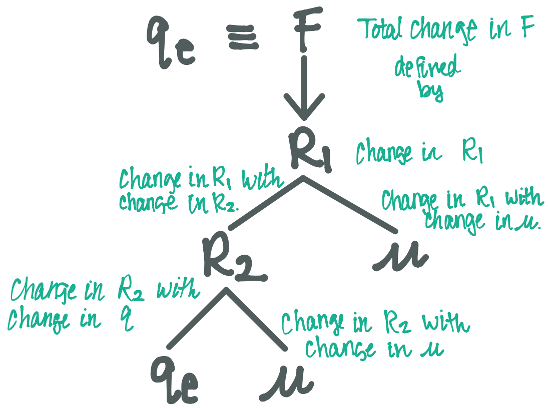
$$q_1 = R_1(q_2, u) \qquad q_2 = R_2(q_1, u)$$

$$q_e \equiv F(q_e, u) \equiv R_1(R_2(q_e, u)) \quad \text{Find} \quad \frac{dq_e}{dq_u}$$



TOTAL DIFFERENTIAL

$$dq_e = \frac{\partial R_1}{\partial R_2} \cdot \left\{ \frac{\partial R_2}{\partial q_e} \cdot dq_e + \frac{\partial R_2}{\partial u} \cdot du \right\} + \frac{\partial R_1}{\partial u} \cdot du$$

Total differential with chain rule.

$$= \frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial q_e} \cdot dq_e + \frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial u} \cdot du + \frac{\partial R_1}{\partial u} \cdot du$$

Distribute effects

$$dq_e - \frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial q_e} \cdot dq_e = \frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial u} \cdot du + \frac{\partial R_1}{\partial u} \cdot du$$

collect dq_e to 1 side and du to the other.

$$dq_e \left[1 - \frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial q_e} \right] = \left[\frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial u} + \frac{\partial R_1}{\partial u} \right] \cdot du$$

Factor out dq_e and du.

$$\frac{dq_e}{du} = \frac{\left[\frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial u} + \frac{\partial R_1}{\partial u} \right]}{\left[1 - \frac{\partial R_1}{\partial R_2} \cdot \frac{\partial R_2}{\partial q_e} \right]}$$

divide across the required terms to isolate dq_e / du