$$\left(\frac{\partial x}{\partial T}\right)_v = \frac{-\left(\frac{\mathrm{d}v'}{\mathrm{d}T}\right)(v'' - v') - (v - v')\left(\left(\frac{\mathrm{d}v''}{\mathrm{d}T}\right) - \left(\frac{\mathrm{d}v'}{\mathrm{d}T}\right)\right)}{(v'' - v')^2}$$

$$= \frac{\left(\frac{\mathrm{d}v'}{\mathrm{d}T}\right) + x\left(\left(\frac{\mathrm{d}v''}{\mathrm{d}T}\right) - \left(\frac{\mathrm{d}v'}{\mathrm{d}T}\right)\right)}{(v' - v'')}$$

$$= \frac{x\left(\frac{\mathrm{d}v''}{\mathrm{d}T}\right) + (1 - x)\left(\frac{\mathrm{d}v'}{\mathrm{d}T}\right)}{(v' - v'')}$$

$$\left(\frac{\partial x}{\partial p}\right)_h = \frac{-\left(\frac{\mathrm{d}h'}{\mathrm{d}p}\right)(h'' - h') - (h - h')\left(\left(\frac{\mathrm{d}h''}{\mathrm{d}p}\right) - \left(\frac{\mathrm{d}h'}{\mathrm{d}p}\right)\right)}{(h'' - h')^2}$$

$$= \frac{\left(\frac{\mathrm{d}h'}{\mathrm{d}p}\right) + x\left(\left(\frac{\mathrm{d}h''}{\mathrm{d}p}\right) - \left(\frac{\mathrm{d}h'}{\mathrm{d}p}\right)\right)}{(h' - h'')}$$

$$= \frac{x\left(\frac{\mathrm{d}h''}{\mathrm{d}p}\right) + (1 - x)\left(\frac{\mathrm{d}h'}{\mathrm{d}p}\right)}{(h' - h'')}$$

$$\left(\frac{\partial x}{\partial p}\right)_s = \frac{-\left(\frac{\mathrm{d}s'}{\mathrm{d}p}\right)(s'' - s') - (s - s')\left(\left(\frac{\mathrm{d}s''}{\mathrm{d}p}\right) - \left(\frac{\mathrm{d}s'}{\mathrm{d}p}\right)\right)}{(s'' - s')^2}$$

$$= \frac{\left(\frac{\mathrm{d}s'}{\mathrm{d}p}\right) + x\left(\left(\frac{\mathrm{d}s''}{\mathrm{d}p}\right) - \left(\frac{\mathrm{d}s'}{\mathrm{d}p}\right)\right)}{(s' - s'')}$$

$$= \frac{x\left(\frac{\mathrm{d}s''}{\mathrm{d}p}\right) + (1 - x)\left(\frac{\mathrm{d}s'}{\mathrm{d}p}\right)}{(s' - s'')}$$