- **a)**

$$\begin{aligned}\hat{y}_o &= x_o^{'}\ \hat{\beta} \\ &= x_o^{'}\left(X^{'}X\right)^{-1}X^{'}Y \\ &= x_o^{'}\left(X^{'}X\right)^{-1}X^{'}\left(X\beta+\epsilon\right) \\ &= x_o^{'}\underbrace{\left(X^{'}X\right)^{-1}X^{'}X}_{I}\beta + x_o^{'}\left(X^{'}X\right)^{-1}X^{'}\epsilon \\ &= x_o^{'}\beta + \textstyle\sum_{i=1}^{n} l_i\,(x_o)\epsilon_i\end{aligned}$$

$$\begin{aligned}\hat{y}_o &= x_o^{'}\ \hat{\beta} + x_o^{'}\left(\hat{\beta}-\beta\right) \\ &= x_o^{'}\ \beta + x_o^{'}\left(\left(X^{'}X\right)^{-1}X^{'}Y-\beta\right) \\ &= x_o^{'}\ \beta + x_o^{'}\left(\left(X^{'}X\right)^{-1}X^{'}\left(X\beta+\epsilon\right)-\beta\right) \\ &= x_o^{'}\ \beta + x_o^{'}\left(\underbrace{\left(X^{'}X\right)^{-1}X^{'}X}_{I}\beta + \left(X^{'}X\right)^{-1}X^{'}\epsilon-\beta \right. \\ &= x_o^{'}\ \beta + x_o^{'}\left(\beta + \left(X^{'}X\right)^{-1}X^{'}\epsilon-\beta\right) \\ &= x_o^{'}\ \beta + x_o^{'}\left(X^{'}X\right)^{-1}X^{'}\epsilon \\ &= x_o^{'}\beta + \textstyle\sum_{i=1}^{m} l_i\,(x_o)\epsilon_i\end{aligned}$$

- **b)**

$$\begin{aligned}EPE\,(x_o) &= E_{x_o}\left[E_{y_o/x_o}\left(y_o-f(x_o)\right)^2\right] \\ &= E_\tau\left[E_{y_o/x_o}\left(y_o-x_o^{'}\beta\right)^2\right] \\ &= E_\tau\left[E_{y_o/x_o}\left(y_o^2-x_o^{'}\beta\beta^{'}x_o-2y_ox_o\beta\right)\right] \\ &= E_\tau\left[V_{y_o/x_o}(y_o)+x_o^{'}V_{y_o/x_o}(\beta)x_o^{'}-2Cov(y_o,x_o\beta)\right]\ \text{, where } V(\beta)=(X^{'}X)^{-1}\sigma^2 \\ &= E_\tau\left[\sigma^2+x_o^{'}\left(X^{'}X\right)^{-1}x_o\sigma^2-0\right] \\ &= \sigma^2+E_\tau\left[x_o^{'}\left(X^{'}X\right)^{-1}x_o\right]\sigma^2\end{aligned}$$

- **c)**

$$\begin{aligned}EPE\,(x_o) &= \sigma^2+E_\tau\left(x_o^{'}(X^{'}X)^{-1}x_o\right)\sigma^2 \\ &= \sigma^2+E_\tau\left(x_o^{'}\ Cov(X)^{-1}\ \tfrac{x_o}{N}\right)\sigma^2 \\ &= \sigma^2+\tfrac{\sigma^2}{N}\ E_\tau\left(x_o^{'}\ Cov(X)^{-1}x_o\right) \\ &= \sigma^2+\tfrac{\sigma^2}{N}\ tr\left(x_o^{'}\ Cov(X)^{-1}x_o\right) \\ &= \sigma^2+\tfrac{\sigma^2}{N}\ tr\left(x_ox_o^{'}\ Cov(X)^{-1}\right) \\ &= \sigma^2+\tfrac{\sigma^2}{N}\ tr\left(Cov(X)\ Cov(X)^{-1}\right) \\ &= \sigma^2+\tfrac{\sigma^2}{N}P \\ &= \sigma^2+\left(\tfrac{P+N}{N}\right)\end{aligned}$$