EC 8854, Problem Set 4

Assignment

- Problem set based on EFC: Einav, Liran, Amy Finkelstein, and Mark R. Cullen. 2010. "Estimating Welfare in Insurance Markets Using Variation in Prices." The Quarterly Journal of Economics 125 (3):877-921. doi: 10.1162/qjec.2010.125.3.877.
- Use artificial data set insdata.csv. Each row corresponds to an individual, with id number in column 1. Column 2, "p" is the incremental price of the high coverage insurance plan. Column 3, "d", is zero if they chose the low coverage plan and one if they chose the high coverage plan. Column 4, "m" is the medical expenditure.
- Contract L pays 90% of health expenses, so $c_L(m_i) = 0.90m_i$. Contract H pays 96% of health expenses, so $c_H(m_i) = 0.96m_i$. EFC define the incremental cost of contract H to be $c^i = c_H(m_i) - c_L(m_i)$, which in this case is $c_i = 0.06m_i$. A first step will be to calculate these three values.
- Tasks:
  1. Estimate linear $D(p)$, $AIC_L(p)$, $AIC_H(p)$, and quadratic $TC_S(p)$ curves. Calculate intercept and slope of $MC_H(p)$, $MC_L(p)$, and $MC_S(p)$. In a table, report point estimates and standard errors for estimates. Bonus: Compute standard errors for the calculated MC coefficients using the delta method.
  2. Replicate Figure V, by plotting $D(p)$, $AIC_H(p)$, $MC_H(p)$, and data points. Is there adverse selection or advantageous selection? Assume there is no moral hazard: Indicate the efficient point and the competitive equilibrium point. In a competitive market would there be overprovision or underprovision of the high coverage plan? What area on the plot corresponds to deadweight loss?
  3. Figure V.2: Add the $MC_L(p)$ curve. How does it compare to $MC_H(p)$. What does this tell us about moral hazard?
  4. Figure V.3: Leave out $MC_L(p)$ to avoid clutter, but add $MC_S(p)$. How does it compare to $MC_H(p)$? What does this tell us about moral hazard? Indicate the efficient point, and equilibrium point. In a competitive market would there be overprovision or underprovision of the high coverage plan? What area on the plot corresponds to deadweight loss? Is there adverse selection or advantageous selection? How do your answers compare to those in part (2)?
  5. Bonus: In your figures, plot confidence intervals for each curve.
  6. Bonus: Discuss why calculating standard errors for DWL might be challenging.
- Hints
  1. See "Moral Hazard in EFC Framework and Problem Set Guidance"
  2. Remember, the average cost curve in EFC is an average *incremental* cost *conditional on choosing contract H*, which I denote $AIC_H(p)$.
  3. You are not expected to complete items marked "bonus".

Moral Hazard in EFC Framework and Problem Set Guidance

Moral Hazard

Let $m_{\theta i}$ be individual i's medical expenditure on contract θ, and let m_i be individual i's medical expenditure on the chosen contract (the only one for which it is observed). For consumers who choose contract H, we observe insurance cost $c_H(m_{Hi})$, and can compute the counterfactual $c_L(m_{Hi})$. For consumers who choose contract L, we observe cost $c_L(m_{Li})$ and can compute the counterfactual $c_H(m_{Li})$. Following EFC, define incremental cost to be $c_i = c_H(m_i) - c_L(m_i)$, which equals $c_i^H = c_H(m_{Hi}) - c_L(m_{Hi})$ for those who choose H and $c_i^L = c_H(m_{Li}) - c_L(m_{Li})$ for those who choose L.

To replicate Table III and Figure V, the first step is to estimate demand and average incremental cost, as specified in equations (11)-(12). EFC denote average incremental cost by AC. Here, however, I reserve AC for average cost, and denote average incremental cost for those who choose contract θ by AIC_θ. Thus $D(p)$ is the fraction of consumers who choose H, and $(1 - D(p))$ is the fraction who choose L. Average incremental cost $AIC_\theta(p)$ is the average c_i of those consumers who choose contract θ:

$$\begin{aligned} AIC_H(p) &= E\left[c_H(m_{Hi}) - c_L(m_{Hi}) \mid \text{choose } H\right], \\ AIC_L(p) &= E\left[c_H(m_{Li}) - c_L(m_{Li}) \mid \text{choose } L\right]. \end{aligned}$$

Under the assumption that the firm selling contract H is only responsible for incremental coverage over and above that in contract L, as is the case in the medigap market, then firms sell contract H iff $p \geq AIC_H(p)$. Thus the intersection of $D(p)$ and $AIC_H(D(p))$ gives equilibrium.

EFC define $MC_H(p)$ via equation (10) and $MC_L(p)$ via replacing $D(p)$ with $1 - D(p)$ in its analog:

$$MC_H(p) = \frac{\partial(AIC_H(p)\,D(p))}{\partial D(p)} = \frac{\partial(AIC_H(p)\,D(p))/\partial p}{\partial D(p)/\partial p} = AIC_H(p) + \frac{\partial AIC_H(p)/\partial p}{\partial D(p)/\partial p} D(p),$$

$$\begin{aligned} MC_L(p) &= \frac{\partial(AIC_L(p)(1 - D(p)))}{\partial(1 - D(p))} = \frac{\partial(AIC_L(p)(1 - D(p)))/\partial p}{\partial(1 - D(p))/\partial p} \\ &= AIC_L(p) - \frac{\partial AIC_L(p)/\partial p}{\partial D(p)/\partial p}(1 - D(p)). \end{aligned}$$

The intuition is like that for MR. Marginal cost is the average cost adjusted by the change in average cost over all units. If there is no moral hazard, such that $m_{Hi} = m_{Li}$ for all i, then $MC_H(p) = E\left[c_H(m_{Hi}) - c_L(m_{Hi}) \mid \text{on the margin}\right]$ is the social marginal cost of incremental coverage, and is used to form one edge of CDE.

If there is moral hazard, then the social marginal cost of individual i buying incremental coverage is not $c_H(m_{Hi}) - c_L(m_{Hi})$, but rather $c_H(m_{Hi}) - c_L(m_{Li})$. This is larger by the amount $c_L(m_{Hi}) - c_L(m_{Li})$, which is the externality imposed on the seller of contract L when i's medical expenditure increases with higher coverage. To compute the social marginal cost, begin with total social costs of all coverage, the cost figure relevant to both a social planner and Alcoa. First, I construct average costs, rather than average incremental costs:

$$\begin{aligned} AC_H(p) &= E\left[c_H(m_{Hi}) \mid \text{choose } H\right], \\ AC_L(p) &= E\left[c_L(m_{Li}) \mid \text{choose } L\right]. \end{aligned}$$

Next, these can be used to compute total social costs:

$$TC_S(p) = D(p)\, AC_H(p) + (1 - D(p))\, AC_L(p) = E\left[c_\theta(m_{\theta i})\right].$$

Marginal social cost measures the change in this total social cost:

$$\begin{aligned} MC_S(p) &= \frac{\partial TC(p)}{\partial D(p)} = \frac{\partial\left(D(p)\, AC_H(p) + (1 - D(p))\, AC_L(p)\right)}{\partial D(p)} \\ &= \frac{\partial\left(AC_H(p)\, D(p) + AC_L(p)\,(1 - D(p))\right)/\partial p}{\partial D(p)/\partial p} \\ &= \frac{\frac{\partial AC_H(p)}{\partial p} D(p) + AC_H(p)\frac{\partial D(p)}{\partial p} + \frac{\partial AC_L(p)}{\partial p}(1 - D(p)) - AC_L(p)\frac{\partial D(p)}{\partial p}}{\partial D(p)/\partial p} \\ &= AC_H(p) - AC_L(p) + \frac{\partial AC_H(p)/\partial p}{\partial D(p)/\partial p} D(p) + \frac{\partial AC_L(p)/\partial p}{\partial D(p)/\partial p}(1 - D(p)) \end{aligned}$$

EFC test for moral hazard by comparing $MC_L(p)$ and $MC_H(p)$, failing to reject a difference, while admitting noise in the estimated difference. This is a weak test because while a difference $MC_L(p)$ and $MC_H(p)$ implies moral hazard, the reverse need not be true. In their setting the incremental cost is exactly \$450 for $m_{\theta i} \in [500, 50000]$. Thus if the marginal individual has m_{Li} and m_{Hi} in $[500, 50000]$ we will find that

$$MC_L(p) = c_H(m_{Li}) - c_L(m_{Li}) = MC_H(p) = c_H(m_{Hi}) - c_L(m_{Hi}) = 450$$

and conclude that there is no moral hazard even if $m_{Li} = 600$ and $m_{Hi} = 49,900$. One might argue that there should be no difference in expenditure in this range, because in this range the marginal out-of-pocket cost of healthcare is the same on both contracts. However, this argument only holds assuming that consumers are rationally forward looking enough to realize the relevant marginal cost of healthcare is low even in January when they are still working their way through a deductible.[1] A more powerful test, then, may be to directly compare $MC_S(p)$ to $MC_H(p)$. If they differ then there is moral hazard even if $MC_L(p)$ does not differ from $MC_H(p)$. Moreover, area CDE may be computed with the estimate of $MC_S(p)$ used for the triangle boundary, rather than $MC_H(p)$, as $MC_S(p)$ is the right quantity whether or not there is moral hazard.

See page 891, EFC let $c^j(\zeta_i)$ "always measures the incremental insurable costs under contract H compared to contract L, whereas the superscript j denotes the underlying behavior, which depends on coverage." That is $c^\theta(\zeta_i) = c_H(m_{\theta i}) - c_L(m_{\theta i})$ is an incremental cost of coverage holding expenditure $m_{\theta i}$ fixed. Thus $MC_\theta(p)$ is $c^\theta(\zeta_i)$ for the marginal customer i. On page 896, the state that "$c^H(\zeta_i) - c^L(\zeta_i)$ is the moral hazard effect from the **insurer's perspective**" (emphasis added). This may be correct, but is not a very interesting number because it is not what helps us calculate DWL triangle CDE correctly. For that welfare calculation, we need $MC_S(p)$ not $MC_L(p)$.

[1] See Aron-Dine, Aviva, Liran Einav, Amy Finkelstein, and Mark Cullen. 2015. "Moral Hazard in Health Insurance: Do Dynamic Incentives Matter?" Review of Economics and Statistics 97 (4):725-741. doi: 10.1162/REST_a_00518. for evidence of such *spotlighting* in health insurance.

Problem Set Guidance

Building on EFC's framework, suppose that

$$\begin{aligned} D(p) &= \alpha + \beta p \\ AIC_H(p) &= \gamma_H + \delta_H p \\ AIC_L(p) &= \gamma_L + \delta_L p \end{aligned}$$

As shown by EFC, this linearity implies $MC_L(p)$ and $MC_H(p)$ are linear and it turns out that $MC_S(p)$ will also be linear. Let

$$\begin{aligned} MC_H(p) &= \mu_H + \nu_H p \\ MC_L(p) &= \mu_L + \nu_L p \\ MC_S(p) &= \mu_S + \nu_S p \end{aligned}$$

EFC provide formulas for the $MC_H(p)$ coefficients: $\mu_H = \gamma_H + (\alpha/\beta)\,\delta_H$ and $\nu_H = 2\delta_H$. Moreover, one can compute

$$\begin{aligned} MC_L(p) &= AIC_L(p) - \frac{\partial AIC_L(p)/\partial p}{\partial D(p)/\partial p}(1 - D(p)) \\ &= \gamma_L + \delta_L p - \frac{\delta_L}{\beta}(1 - \alpha - \beta p) = \gamma_L - \frac{1-\alpha}{\beta}\delta_L + 2\delta_L p. \end{aligned}$$

so that $\mu_L = \gamma_L - \frac{1-\alpha}{\beta}\delta_L$ and $\nu_L = 2\delta_L$. Now to plot these quantities as a function of $q = D(p)$, we need to invert demand, $p(q) = (q - \alpha)/\beta$, and substitute this in place of p in the preceding formulas.

Let $d_i = 1$ if i chooses H and zero otherwise. The first task in the problem set is to (1) regress d_i on p to estimate α and β; (2) regress c_i on p conditional on choosing contract θ to estimate γ_θ and δ_θ for $\theta \in \{L, H\}$; and (3) compute μ_θ and ν_θ for $\theta \in \{L, H\}$ and plot $p(q) = (q - \alpha)/\beta$, $AIC_\theta(p(q))$, and $MC_\theta(p(q))$ for $\theta \in \{L, H\}$. The next task is to estimate $MC_S(p)$. A straight-forward approach is to estimate total social cost

$$TC_S(p) = \phi_1 + \phi_2 p + \phi_3 p^2,$$

assuming it is quadratic. This makes sense, as it is a product of demand and average costs, which I have assumed are both linear. Estimating $TC_S(p)$ simply requires regressing total cost $TC_i = c_\theta(m_{\theta i})$ (not incremental cost) on p and p^2 including all observations to estimate ϕ_1, ϕ_2, and ϕ_3. Then for MC_S one can use the expression

$$MC_S(p) = \frac{\partial TC(p)/\partial p}{\partial D(p)/\partial p} = \frac{\phi_2}{\beta} + 2\frac{\phi_3}{\beta}p.$$

to compute $\mu_S = \phi_2/\beta$ and $\nu_S = 2\phi_3/\beta$. $MC_S(p)$ can then be plotted against $D(p)$ just as the other marginal cost curves.