Lecture Note 14 - Two Applications of Risk and Safety Regulation: Airplane Seats for Infants and the Value of a Statistical Life

David Autor, MIT Economics and NBER

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1 Estimating the Value of a Statistical Human Life

- This is a topic that makes non-economists uncomfortable. But for policy analysis, there is no way around it. How much should society spend, at the margin, to save a 'statistical life?'

- A statistical life is a probabilistic concept. When we save a statistical life, we reduce the number of deaths by one *in expectation.* The value of a statistical life (VSL) is clearly very different from what we would spend to save a specific individual who was in grave danger of death. [And it is emphatically *not* the answer to the question, "What would I have to pay you to kill you?" or "What should we spend to save baby James who was fallen down the well?"]

- It is critical to have some knowledge of the Value of a Statistical Life because we must make regularly societal decisions about how much risk we should tolerate and how much we should spend in tax revenue or how much we should curtail freedom of choice to abate risk.

- In general, economic reasoning says that society should undertake safety improvements that cost less than the VSL per life saved and should not undertake safety projects improvements that cost more than the VSL per life saved.

- There is no 'correct' answer to the value of a statistical life. This value is something that arises out of people's preferences (and their wealth). The only thing that is certain is that the value of a statistical life is not infinite.

- How do you get a credible estimate of the VSL? Not easy. Asking people will not be very informative (they'll be horrified). But the Weak Axiom of Revealed Preference says that we can observe the VSL from the trade-offs that people (or governments) make between cost and safety.

- Speed limits are one place where that choice is very apparent. The faster people drive, the less time they spend getting from place to place. Since time has value, going slower is costly in foregone opportunities. However, going faster increases the probability of death.

- (Why doesn't the decreased time spent at risk when traveling at higher speed wash out the additional risk borne from driving faster? Because the kinetic energy of a moving body is $E = \frac{1}{2} \times \text{Mass} \times \text{Velocity}^2$. So, the expected fatality of an accident increases quadratically with velocity whereas the time savings is linear in velocity—and this

does not take account of the fact that accident risk per mile travel also increases with velocity.)

1.1 Context

- Prior to 1973, speed limits in the U.S. were set by states. There was no national speed limit.
- With the oil crisis in 1973, the federal government imposed a national speed limit of 55 MPH.
- Although this was probably not the intention, highway fatalities fell 15 percent the following year (a reduction of nearly $10,000$ fatalities!).
- [Fatalities were also trending downward before and after 1973. This in large part reflect advances in auto safety.]
- In 1987, with oil prices low, the federal government allowed states to raise their speed limits to 65 MPH if they wished to.
- 37 states raised their speed limits in 1987 and 3 more did so in 1988.
- It's critical for the research design that *not all* states raised their speed limits. If they had, the revealed preference argument would not be relevant. The 'treatment' here is to *offer* state legislatures the option to relax speed limits in their states. If either no state *or* every state took up this offer, we wouldn't be able to bound the implied *VSL*. If no state took up, then we could only infer that the expected loss in life was not worth the time savings. If all states took up, we would infer that they are probably also constrained at 65 miles per hour. Hence, we would not learn about their unconstrained preference for safety versus time-savings.

1.2 Research design

- Though there is considerable technical material in this paper, the research design is straightforward.
- The plan:
    1. Contrast the change in fatalities in adopting versus non-adopting states.
    2. Contrast the change in actual speeds traveled in adopting versus non-adopting states.

3. Use these two contrasts to develop an estimate of the hours saved in driving time per statistical life lost.

- Now, multiply time saved by some monetary value per hour to obtain an estimate of the VSL. Ashenfelter and Greenstone use the state mean wage as the value of an hour saved. We can discuss whether this is appropriate.

- A&G refer to their approach as an 'instrumental variables' estimation, and this is one valid way to interpret it. The adoption of the higher speed limit raises speed (the endogenous variable) and raises fatalities (the outcome variable) by raising speed but probably does not affect fatalities through any channel other than speed.

- What's unusual about the setup is that the decision to 'take-up' the higher speed-limit is *chosen* by states—it is not randomly assigned (this is unlike a conventional IV).

- The choice aspect is crucial for interpreting the results through the lens of Revealed Preference. Revealed Preference allows us to say that any state that *chose* to take up the higher speed limit *must* have valued the time savings at greater than or equal to the lives lost (otherwise, by Revealed Preference, it would not have made this choice). If this time savings was \$1 million per life lost, then the VSL could be no higher than \$1 million.

- There is also an important discussion in the paper of whether political decision making about speed limits is efficient. It's crucial to the interpretation to know whether:

  - Legislators roughly understood the trade-offs between time-savings and safety when deciding on the speed limit.
  - Legislators' choices roughly represent the preferences of 'average' citizens ("the median voter") rather than of some interest group that has very different preferences about the VSL.

- Why isn't it enough to assume that individuals optimally choose their speed as a function of time savings and safety?

1.3 Theoretical framework

- States face a Production Possibility Frontier in Time Saved-Lives Saved space.

- They want to choose their most preferred point on this frontier

- If the speed limit is capped at 55 MPH, states may not be able to select their optimal point on the PPF.
- The 1987 law expands the feasible choice set.
- For states that choose to move to the new location on the PPF, we can say that this point is Revealed Preferred to the old location.
- We can observe the gains they make in time savings and the loss of life as they make this movement. That forms the basis for our calculations

1.4 Results

See:

- Figure 1
- Figure 3
- Figure 4
- Table 1
- Table 2
- Table 3 (bottom row)
- Table 4 (bottom row)
- Table 6 (panel A)
- Table 7

2 Optional: Should Infant Seats be Required on Airplanes?[1]

The U.S. National Transportation Safety Board [NTSB] has for many years been considering a regulation whereby all children younger than two years old would be required to travel in

[1]This section draws on Newman, Thomas B., Brian D. Johnson and David C. Grossman. 2003. "Effects and Costs of Requiring Child-Restraint Systems for Young Children Traveling on Commercial Airplanes." *Archive of Pediatric & Adolescent Medicine*, 137, October, 969–974. This article is posted on the 14.03/14.003 web site.

child safety restraint systems (CSR) on airplanes. This rule would require adults to purchase seats specifically for children younger than two years instead of allowing these children to travel on an adult's lap for free (which is the current regulation).

Consider first: Assume that parents have full information about the risks of traveling with their babies on their laps. Is it socially efficient to allow parents to make a decision to buy a seat for their babies or should the government make it mandatory?

Now let's ask, what are the costs and benefits of this regulation?

- The NTSB calculates that there are 6.5 million 'enplanements' (plane trips) per year by children younger than 2 years.
- It also calculates that the expected number of child fatalities averted per year by use of CSR is 0.4. Assume that the price of an airline ticket for a child of \$200 (and ignore the direct cost of the CSR).
- What is the total cost per child airline fatality averted? Answer:

$$(6,500,500 \times \$200)\,/0.4 = \$3.25 \text{ billion per life saved}$$

  So, from a pure cost-benefit perspective, this does not appear attractive. If you believe that saving one life is worth \$3.25 billion, consider that you could save many more lives by spending \$3.25 billion elsewhere, for example, by improving drinking water quality in the developing world or by building fences around backyard swimming pools (many multiples more children die each year from accidental backyard drownings than from plane crashes).

- However, this is not the end of the story. Notice that the airline seat regulation also changes *incentives* by making it more costly for parents with children to travel by air. How would you expect families to respond?
- Consider that some families will switch from air to car travel or vice versa depending on the relative costs of the two. Newman et al. (2003) estimate that:
  - Approximately 6% of families with infants will choose to drive rather than pay \$200 for a child seat on the plane. (This seems a conservative estimate.)
  - The average net increase in car travel per enplanement for families switching from planes to cars is 300 miles.
  - The average vehicle occupancy for extra trips is 2.4.

- Recent estimates of motor vehicle safety put the risk of auto deaths at 0.5 fatalities per 100 million vehicle miles traveled.

- From these numbers, the estimated annual effect of the seat mandate on motor vehicle deaths is:

$$6,500,000 \times 0.06 \times 2.4 \left(\frac{300 \times 0.5}{100,000,000} \right) = +1.40 \text{deaths}$$

  In words, the estimated number of additional motor vehicle deaths induced by the air safety policy is roughly three and a half times as large as the number of airplane deaths averted. If we assume that more than 6% of families switch from plane to cars, the policy only looks worse.

- Now, if we want to consider total lives saved/lost from the CSR mandate, we need to also account for the deaths averted due to families *not* traveling by air. Recent estimates of the fatality risk from air travel (not car-seat avertible) are 117 deaths per billion passenger journeys. So, the lives saved due to averted air travel (crash-related + car-seat related) deaths are:

$$-0.4 + 6,500,000 \times 0.06 \times 2.4 \times \left(\frac{-117}{1,000,000,000} \right) = -0.51 \text{ deaths}$$

- Thus, this policy would be expected to increase total travel related fatalities by approximately 0.9 per year at a cost of about 3 billion dollars.

- For this reason, the Federal Aviation Administration [FAA] has so far resisted the NTSB's regulatory recommendation.

- Not all supporters of the NTSB policy find this type of argument compelling. For example, Ralph Nader and Wesley Clark in their 1994 book, *Collision Course: The Truth about Airline Safety*, write

  "The argument in support of the FAA's resistance to the NTSB [National Transportation Safety Board] recommended rule mandating child safety seats is unreasonable on its face, and ridiculous in its justification. *It protects theoretical children driving in cars at the expense of real flesh-and-blood infants whose safety is unquestionably compromised when flown as a lap-baby* [italics by Autor, not by authors]."

- A high ranking regulatory official in the Food and Drug Administration said of the child seat policy and the statistics above that,

"It identifies a classic regulator's dilemma of which risks to protect against. While the NTSB may well recognize that there could be more auto fatalities if they require car seats, those fatalities will not be blamed on them. Assuming the study above is accurate, if the NTSB does the right thing from the point of view of mitigating "total risk," they face the prospect of getting all of the blame for allowing child fatalities on aircraft and none of the credit for preventing child fatalities on the road. Of course, if the airlines wanted to provide seats for kids under age two at a nominal cost, they might at least break even financially because parents would fly more and kids could fly safely."

- The attorney above recommends that airlines should subsidize infant tickets rather than charge for them. For example, imagine that the FAA paid the $200 per seat so that parents incurred no additional cost to travel with infants in *CSR's*. Would this make the policy any more attractive from a cost-benefit perspective? It would still cost $3.25 billion per life saved. However, it would reduce the likelihood that parents of infants would substitute towards auto travel, so it would eliminate the perverse effects of the policy.

- Now, consider a policy where the FAA instead paid parents $200 to travel with their children *on their laps* **instead of** driving in their cars? This policy appears perverse: it would surely *increase* the number of infants killed in aircraft accidents! (What would Ralph Nader say?)

- But, if this policy were feasible, it would be more efficient from a lives-saved-per-dollar perspective.

  - As we know, the chance of a carseat-avertable airplane fatality for an infant is $0.4/6,500,000$ per enplanement
  - The chance of an auto-fatality is $0.5/100,000,000$ per mile.
  - The chance of an air-related fatality is 117 per billion enplanements.
  - We assume that there are 2.4 members of a family traveling together.
  - The crossover point where an airplane trips is safer than a car-trip (inclusive of non-buckled infant deaths) is:

$$\frac{M \times 2.4 \times 0.5}{100,000,000} > \frac{0.4}{6,500,500} + \frac{2.4 \times 117}{1,000,000,000} \Rightarrow M > 28.5$$

– This means (very roughly) that any trip over roughly 30 miles, it is safer for a family with a lap child (without a CSR) to travel by air than by car. So, if we want to minimize travel fatalities, we should pay people to fly rather than drive. (And requiring *CSRs* on airplanes would be a waste of money under such a policy—better to use the money to subsidize more people to fly rather than drive.)