Chapter 15 #3: Derive the conditions for cost minimization when there are two inputs into the reduction of the damage. Discuss the signs of the first and second partial derivatives and derive the first-order conditions. Provide an intuitive understanding of all the relationships.

Society minimizes the expected total cost, C^S, which is equal to the expected cost of the damage plus the cost of damage prevention by the victim and the injurer,

$$C^S = D(x, y) + x + y$$

where x is the dollar amount that X, the injurer, spends on damage prevention, y is the dollar amount that Y, the injured, spends on damage prevention, and D is the expected level of damage to Y given x and y.

Let $D_x = \frac{\partial y}{\partial x}$ be the partial derivative of damage, $D(x, y)$, with respect to x. It is the effect of an increase of x, damage prevention by X, on the amount of the expected damage, holding everything else constant. If X spends more on damage prevention, then expected damage should decrease. That is, $D_x < 0$. Similarly, $D_y < 0$.

As in other areas of economics, marginal productivity is decreasing. That is, additional dollars spent on damage prevention reduce (expected) damage at a decreasing rate. More formally, $D_{xx} > 0$ and $D_{yy} > 0$. We also assume $D_{xy}D_{yx} < D_{xx}D_{yy}$. This implies that inputs are substitutes. That is, when one input goes up, the marginal productivity of the other goes down and vise versa.

Now, the first order conditions for expected cost minimization are

$$C_x^S = 1 + D_x(x, y) = 0$$

$$C_y^S = 1 + D_y(x, y) = 0$$

That is, the cost minimization requires that expenditures on damage prevention increase until the last dollar spent on damage prevention by X, the injurer (and Y, the victim) reduces expected damage also by a dollar. In other words, if a dollar's worth of damage prevention reduces expected damage by more than a dollar, you will/should spend the extra dollar. However, you will choose not to spend an additional dollar on damage prevention if it reduces expected damage by less than a dollar.

Chapter 15 #4: What is the Cournot-Nash equilibrium when the rule is strict liability? Explain. Provide an example where strict liability is efficient. Provide an example where strict liability is inefficient.

The Cournot-Nash equilibrium in this situation is that $x^e = x^\Omega$ while $y^e = 0$. In words, this indicates that since the only cost that Y faces is the cost of prevention under strict liability (not liable for the harm), Y will not undertake any cost of prevention.

On the other hand, X will try to minimize his cost, given that Y has set y equal to 0. X will therefore continue to spend on damage prevention until the last dollar spent on damage prevention reduces damage by $1.

Strict liability occurs with nuclear power plants since it is optimal for the potential victims of power plant explosions not to take any precautions.

Strict liability is inefficient, however, when the optimal amount of prevention by the victim is greater than zero (that is, $y^\Omega > 0$). An example of this would be getting into vehicular accidents.

Chapter 15 #5: What is the Cournot-Nash equilibrium when the rule is no liability (by the injurer)? Explain. Provide an example where no liability is efficient. Provide an example where no liability is inefficient.

Again, we have a corner solution, but this time for X. X is not liable for damage to Y, and therefore X will minimize his/her cost by choosing not to spend anything ($x = 0$) on preventing damage to Y. On the other hand, Y will spend money on damage prevention until the last dollar spent on damage prevention reduces damages by $1. An example of when no liability is efficient is catching a cold. An example of when the no liability rule is inefficient is food poisoning from restaurants.

Chapter 16 #2: In *Guille v. Swan*, 19 Johns. 381 (1822), a balloonist crash-landed his hot-air balloon in the plaintiff's vegetable garden. The plaintiff sued the balloonist for the damage both from the landing and from the spectators who had originally come to see him ascend nearby. Who should be liable?

It is very costly (suboptimal) for an individual who owns a vegetable garden to provide precautions against damages from hot-air balloon crashes, especially since the probability of this happening is very small. Therefore, balloonists who use hot-air balloons should be strictly liable and should take the optimal amount of precaution.

However, the damages that spectators have made cannot be prevented by the balloonist at an efficient cost. Therefore, it is inappropriate for the balloonist to be liable for those damages and therefore, the vegetable garden owner should bear the costs of these damages. At any rate, the spectators should be liable for their damages if the vegetable garden owner took the optimal amount of care (like placing fences around the garden) and he is able to make the spectators accountable at a low transaction cost.

Chapter 16 #4: What is the economics interpretation of "acts of God?"

An Act of God is a scenario that is highly unpredictable and is not cost-effective to prepare for. When it occurs, whatever the liability ruling may be, the same level of prevention would be undertaken by both sides: $x^{\Omega} = 0 = y^{\Omega}$.