

4.2 — An Economic Model of Precaution

ECON 315 • Economics of the Law • Spring 2021

Ryan Safner

Assistant Professor of Economics

✉ safner@hood.edu

🌐 [ryansafner/lawS21](https://github.com/ryansafner/lawS21)

🌐 lawS21.classes.ryansafner.com



Outline



A Recap of Our Approach So Far

Harm

Causation

Breach of Duty.

Precaution



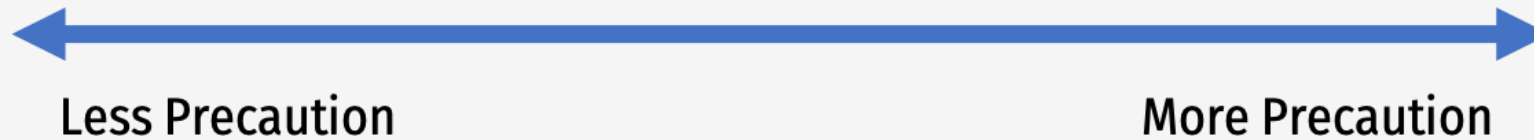
- As usual, our main concern is with the incentives these various liability rules create
- For torts, focus on parties' incentive to invest in (costly) precaution to avoid accidents
 - Driving/bicycling carefully, installing seatbelts, airbags, wearing helmets, etc.
 - Inspecting products carefully, quality control, independent audits, mandatory work breaks
 - All of these things are **costly** to parties, so there must be some **efficient** level



Precaution



- Actions by both injurer and victim impact the number of accidents
- Speed like hell, drive drunk, texting
- Bicycle in the dark wearing black, no helmet
- Manufacture cheap, shoddy product quickly
- Drive slowly and soberly
- Bicycle wearing helmet and reflectors
- Manufacture slow, quality controlled & inspected product



- **Precaution:** any activity either party can do to reduce probability of an accident (or severity of damage)
- **How much precaution is efficient?**
- **How do we design the law to get this amount?**

A Simple Economic Model of Accidents



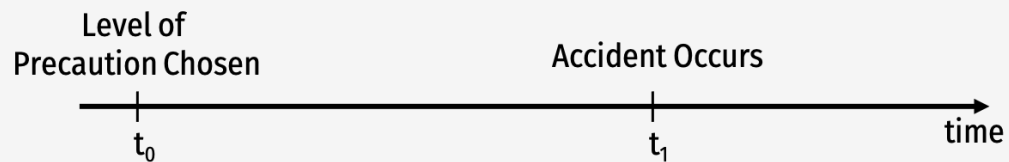
- Our main example was a car hitting a bicyclist, in real life:
 - Driver probably has insurance
 - Some damage to bicycle and to driver's car
 - Driver and bicyclist may not even know what the law is
- We will simplify a lot by assuming:
 - Only one party is harmed
 - Parties know the law
 - Parties don't have any insurance (for now)
 - Focus only on one party's precaution at a time



A Unilateral Care Model



- Unilateral harm (just one victim)
- **Precaution**: costly actions that make accident less likely
 - Could be taken by either **victim** or **injurer**
 - We'll consider both, but one at a time



A Unilateral Care Model: Definitions/Notation



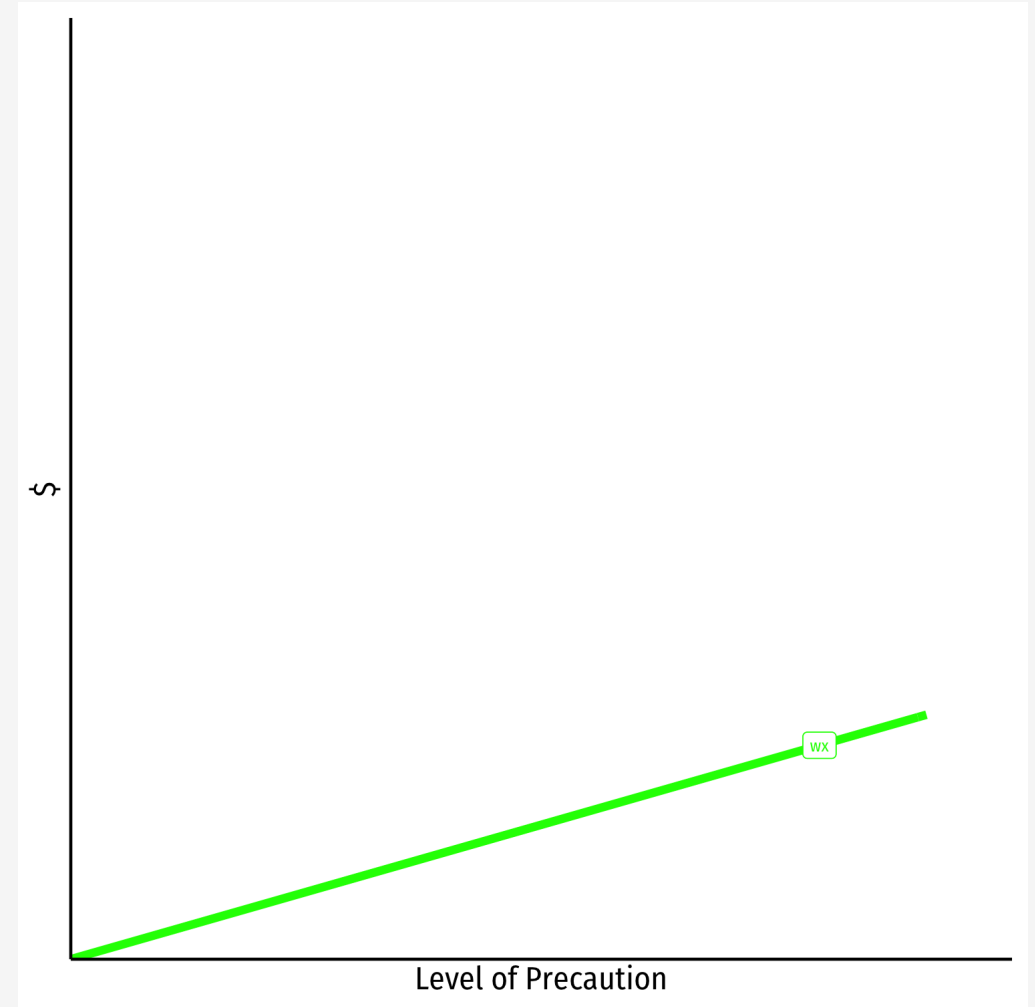
- x : amount of precaution taken
- w : cost of each “unit” or precaution
 - total cost of precaution is wx
- $p(x)$: probability of an accident, given level of x
 - $\frac{\partial p(x)}{\partial x} < 0$
- A : cost of accident (to victim)
 - expected cost of accidents is $p(x)A$
- When we examine **injurer** we will use x , when we examine **victim** we will use y
 - Your textbook uses x^i and x^v



A Unilateral Care Model



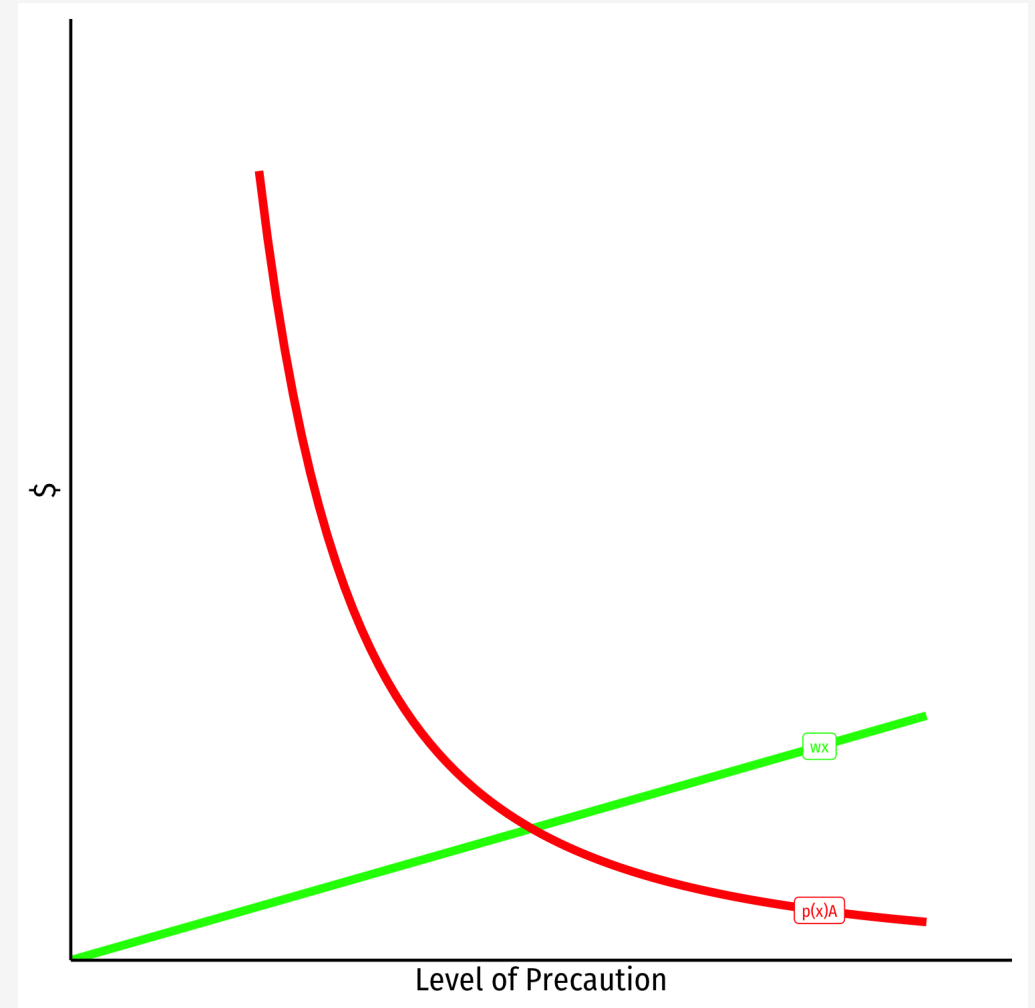
- Cost of precaution, wx



A Unilateral Care Model



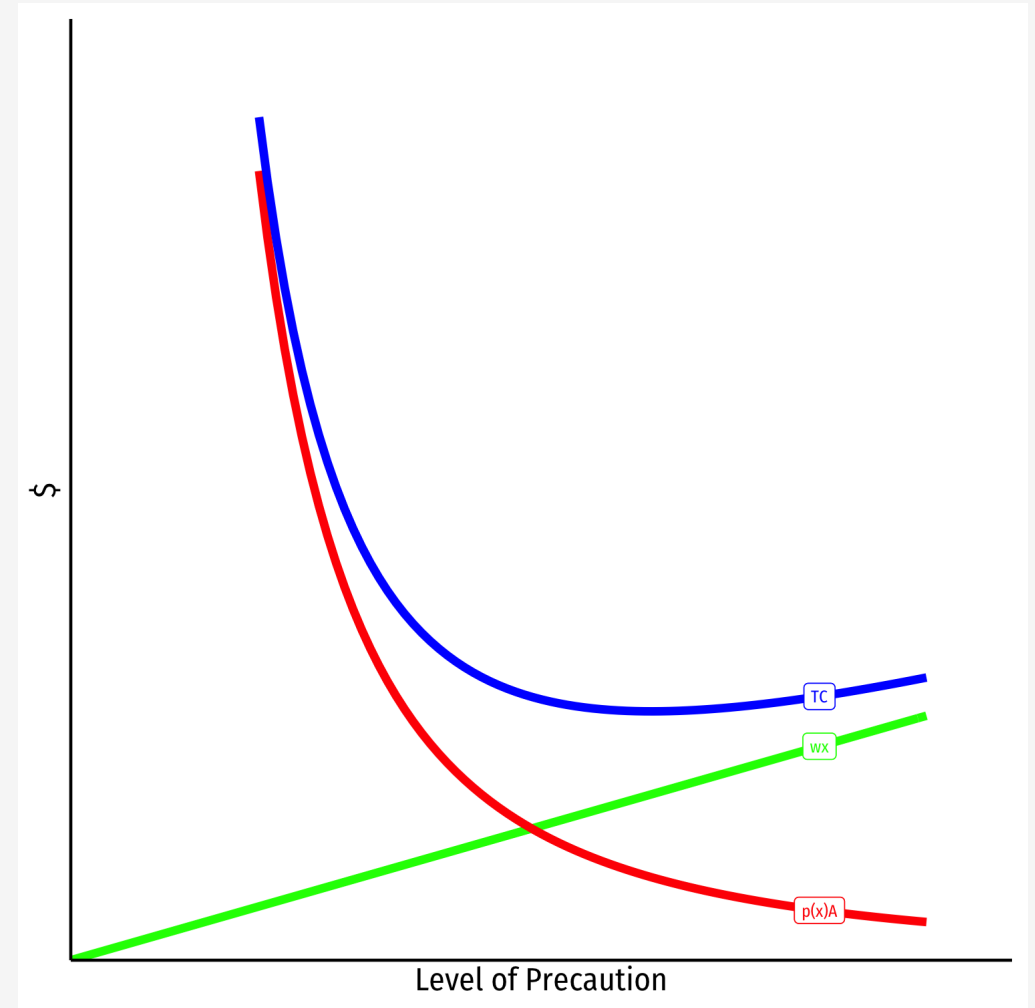
- Cost of precaution, wx
- Cost of accidents, $p(x)A$



A Unilateral Care Model



- Cost of precaution, wx
- Cost of accidents, $p(x)A$
- Total Social Cost $p(x)A + wx$

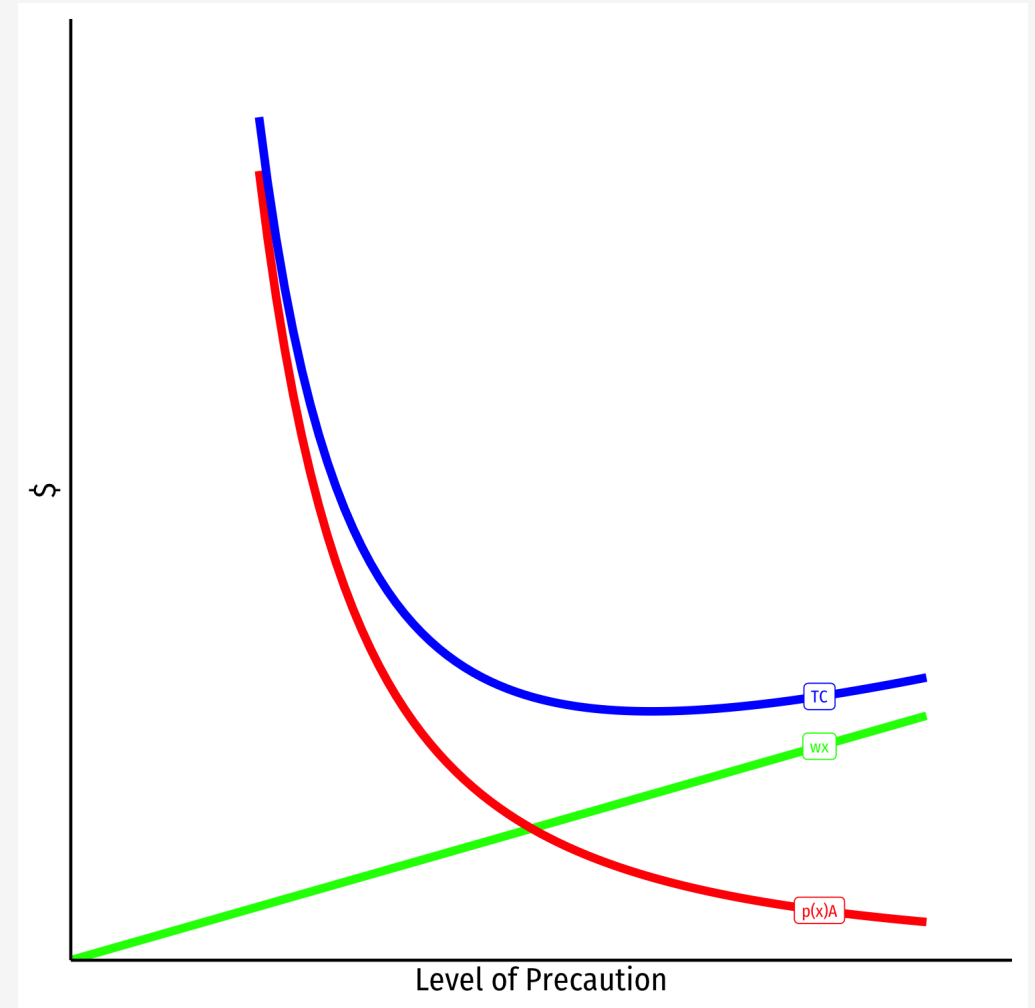


A Unilateral Care Model



- Cost of precaution, wx
- Cost of accidents, $p(x)A$
- Total Social Cost $p(x)A + wx$
- Efficient level of precaution:

$$\min_x p(x)A + wx$$



A Unilateral Care Model



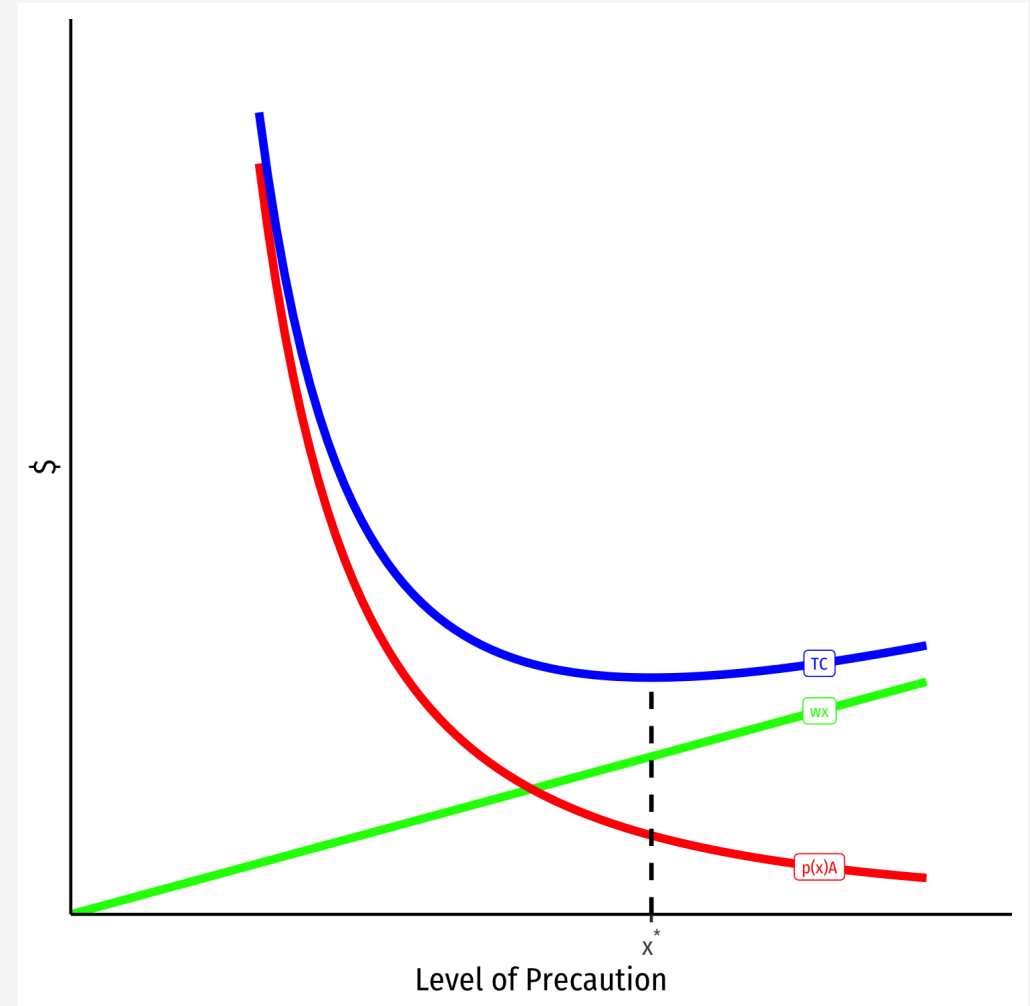
- Cost of precaution, wx
- Cost of accidents, $p(x)A$
- Total Social Cost $p(x)A + wx$
- Efficient level of precaution:

$$\min_x p(x)A + wx$$

- Optimum x^* :

$$w = -p'(x)A$$

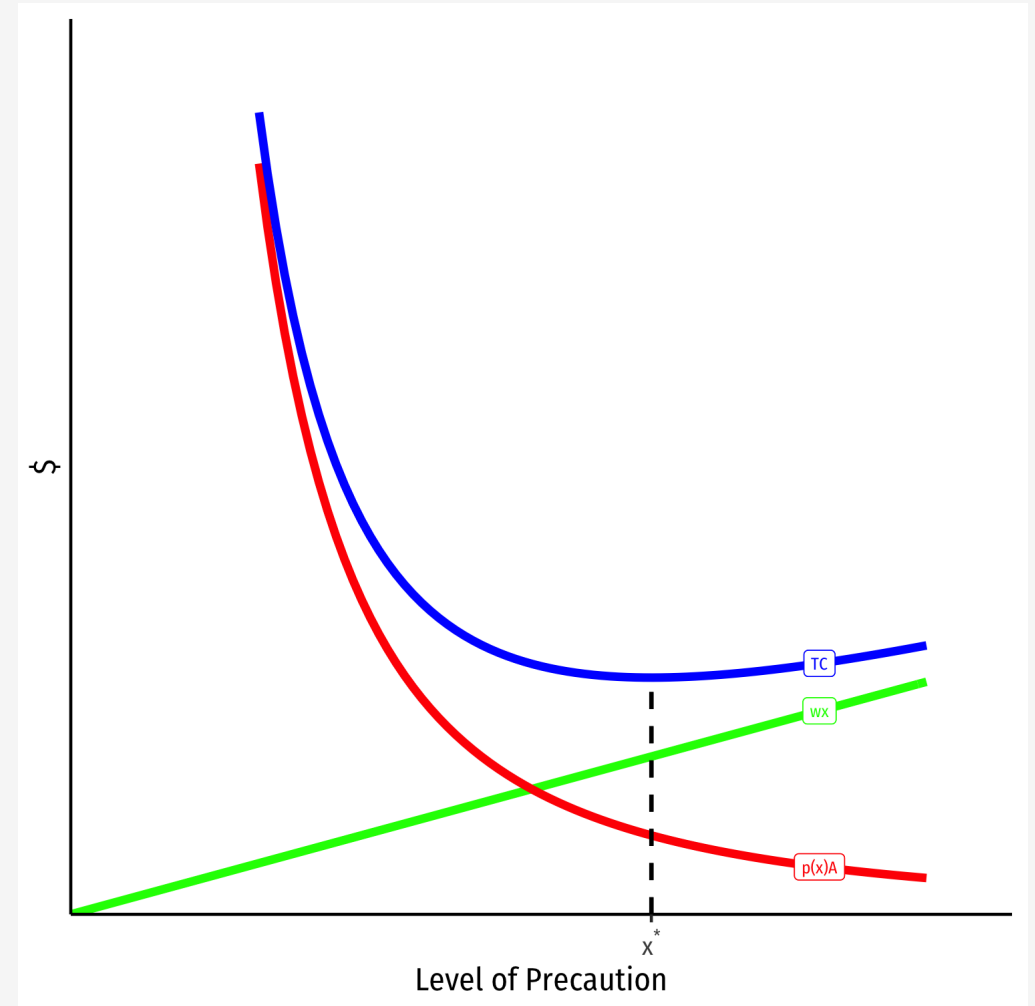
MSC of precaution = MSB of precaution



A Unilateral Care Model



- The efficient level of precaution, x^* minimizes **total social cost**
 - Balances the tradeoff between the **benefit of reduced accident likelihood** and the **cost of increased precaution**

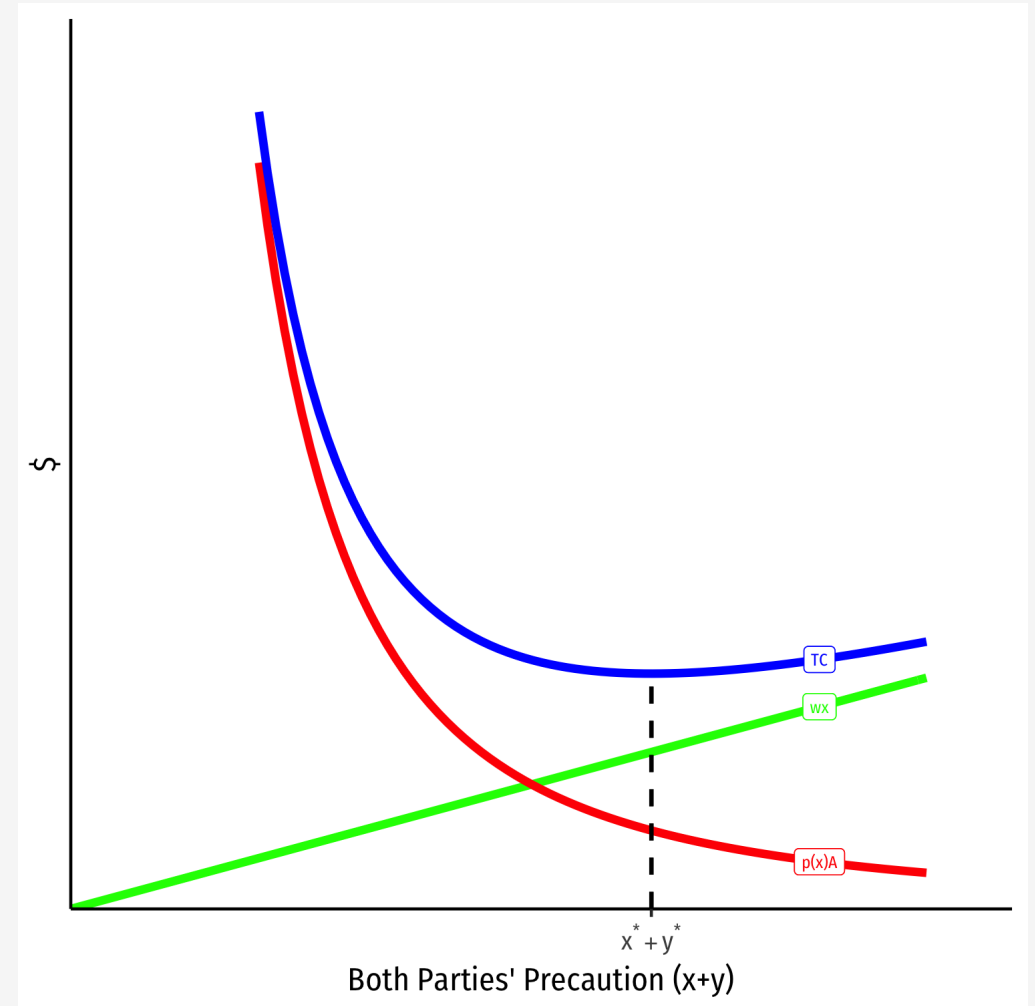


A Unilateral Care Model: Technical Note



- We are thinking of bilateral precaution, just “one party at a time”; again:
 - x represent level of precaution by injurer
 - y represent level of precaution by victim
- Really, the social problem between both parties:

$$\min_{x,y} p(x,y)A - wx - wy$$



A Unilateral Care Model: Technical Note



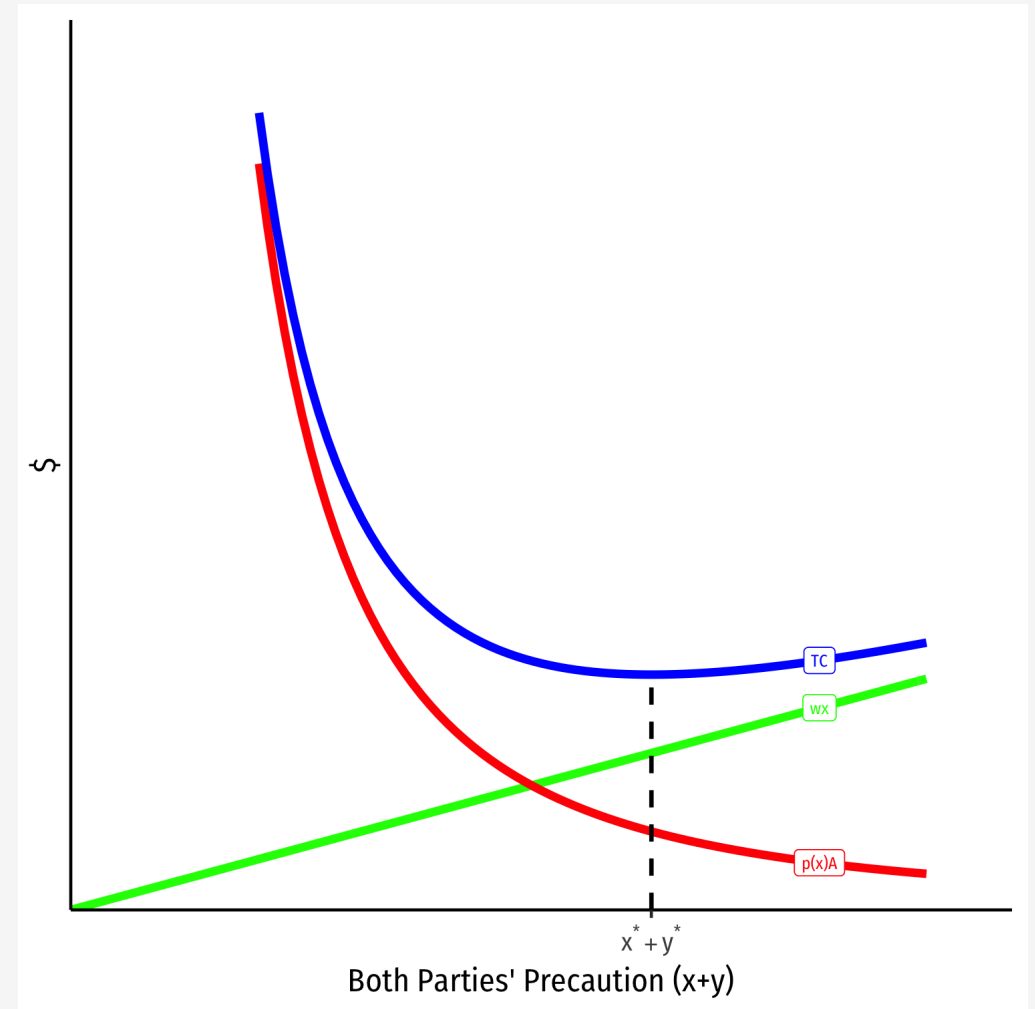
- “Hold fixed” one party’s solution and consider the other, e.g.

$$\min_x p(x, y)A - wx - wy \quad \text{given } y$$

which has same solution as

$$\min_x p(x)A - wx$$

- Results will generally be efficient *given* what the other party is doing



Effect of Liability Rules on Precaution



- We know the **efficient** level of precaution is x^* , which minimizes total social cost
- Now let's consider the effect of **different liability rules** have on the **chosen** amount of precaution



No Liability



- Imagine a world of **no liability** (NL)
- **Injurer** pays nothing for accidents
 - Bears the **cost** of his precaution
 - But no **benefit** (of avoided damages)
 - **Has no incentive to take any precaution**
- **Victim** bears cost of any accidents, plus cost of her precaution taken
 - **Victim** precaution imposes no externality on **Injurer**
 - **Victim** will invest in efficient amount of precaution y^*

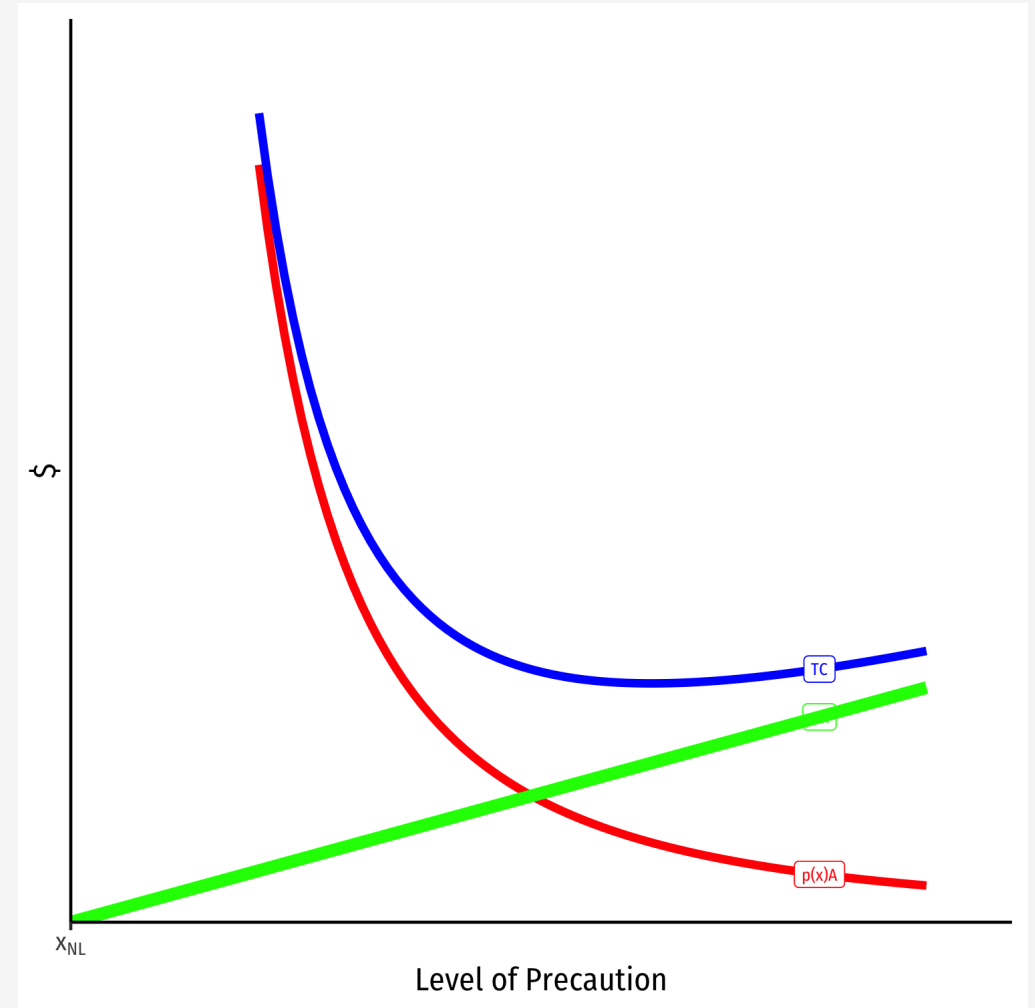


No Liability



- **Injurer's** private costs: wx

$$\min_x wx \implies x_{NL} = 0$$



No Liability



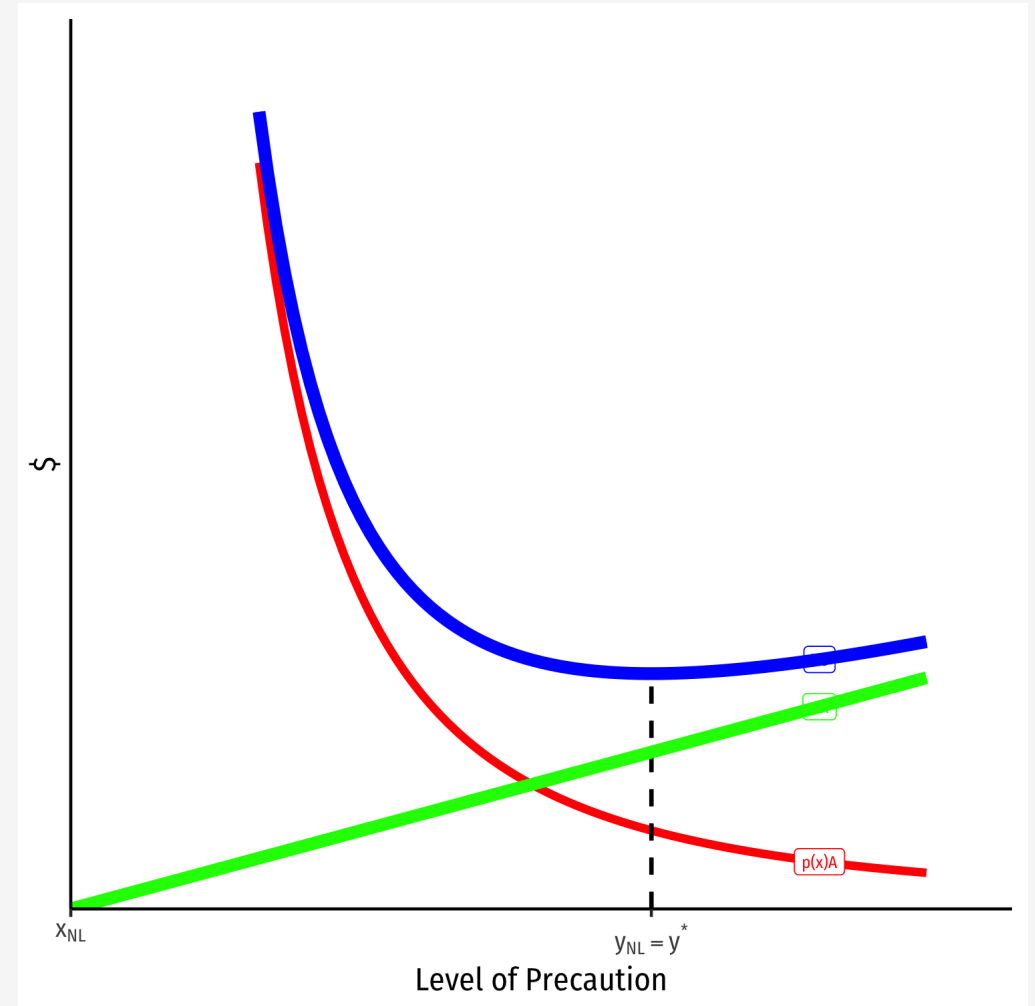
- **Injurer's** private costs: wx

$$\min_x wx \implies x_{NL} = 0$$

- **Victim's** private costs: $p(y)A + wy$

$$\min_y p(y)A + wy \implies y_{NL} = y^*$$

- chooses efficient precaution
- Rule of **no liability** leads to:
 - efficient precaution by **Victims**
 - no precaution by **Injurers**



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution
No liability	Zero	Efficient

Determining Accidents



- Precaution isn't the only thing that affects the number of accidents
 - Precautions are extra actions that make our activity less dangerous
- Also the **amount of activities** we do affects the number of accidents
 - I decide how often to drive
 - You decide how often to bike
- Liability rules also create incentives for **activity levels**



Determining Accidents: No Liability



- With **no liability**, I am not liable if I hit you
 - I don't consider cost of accident when I decide **how fast** to drive
 - nor when I decide **how much** to drive
 - **So I drive too recklessly and too often**
- My driving imposes a negative externality on others
 - With no liability, **Injurer's** activity level is inefficiently high



Determining Accidents: No Liability



- With. hi[no liability], you bear the full cost of an accident
 - More activity by victim (bicycling) leads to more accidents
 - You weigh cost of accidents when deciding **how carefully** to ride, and **how much** to ride
 - Your private cost equals the social cost
 - You take the efficient level of precaution, and efficient level of activity



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution	Injurer Activity	Victim Activity
No liability	Zero	Efficient	Too High	Efficient



Strict Liability

Strict Liability



- Imagine a world of **strict liability** (SL) with perfect compensation
 - $D = A$ damages equal to the cost of the accident
- **Injurer** pays for any accidents he causes
 - Bears the full **cost of accidents** plus his **precautions** taken
 - Receives **benefit** (of avoided damages)
 - Internalizes externality his actions cause, chooses the efficient level of precaution
- **Victim** is fully insured
 - Has **no incentive** to invest in any precaution



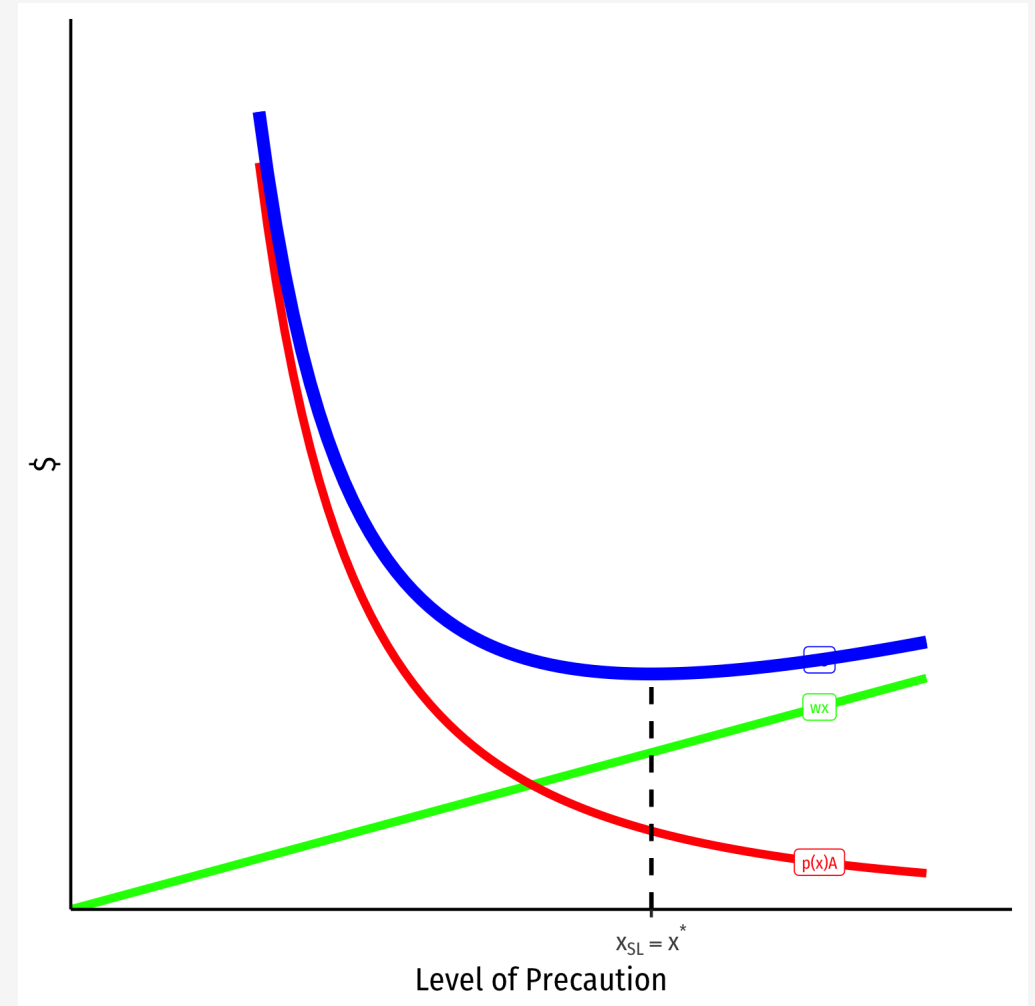
Strict Liability



- **Injurer's** private costs: $p(x)A + wx$

$$\min_x p(x)A + wx \implies x_{SL} = x^*$$

- chooses efficient precaution



Strict Liability



- **Injurer's** private costs: $p(x)A + wx$

$$\min_x p(x)A + wx \implies x_{SL} = x^*$$

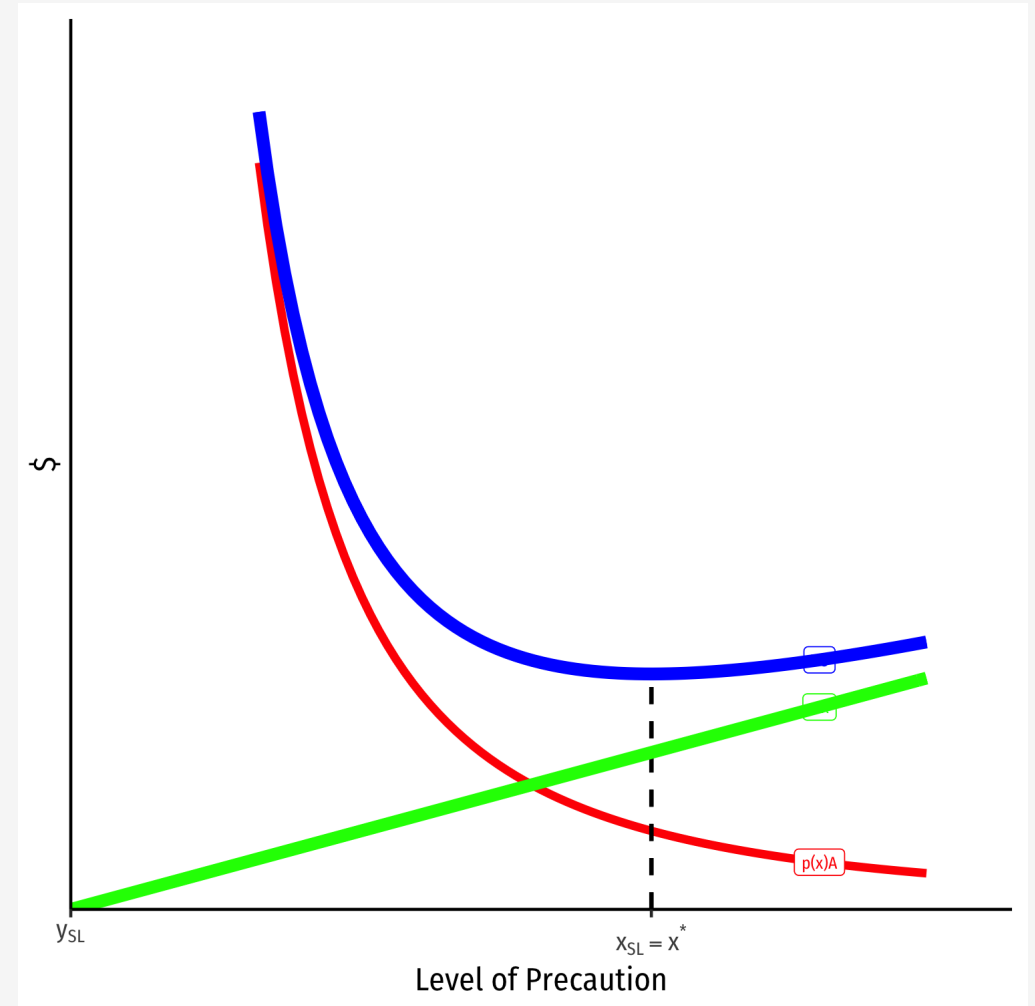
- chooses efficient precaution

- **Victim's** private costs: wy

$$\min_y wy \implies y_{SL} = 0$$

- Rule of **strict liability** leads to:

- efficient precaution by **Injurers**
- no precaution by **Victims**



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution
No liability	Zero	Efficient
Strict liability	Efficient	Zero

Strict Liability: Activity Levels



- Under strict liability, **injurer** internalizes cost of accidents
 - Weighs benefit from driving against cost of accidents
 - Takes **efficient** activity level
- Under strict liability, **victim** does not bear cost of accidents
 - Ignores cost of accidents when deciding how much to bicycle
 - Takes **inefficiently high** activity level
- **Strict liability leads to efficient level of injurer activity, inefficiently high level of victim activity**



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution	Injurer Activity	Victim Activity
No liability	Zero	Efficient	Too High	Efficient
Strict liability	Efficient	Zero	Efficient	Too High

Comparing Incentives Under Different Liability Rules



- So for both precaution & activity level:
- **No liability** leads to **inefficient** behavior by **injurer**, **efficient** behavior by **victim**
- **Strict liability** leads to **efficient** behavior by **injurer**, **inefficient** behavior by **victim**
- Like the **paradox of compensation** from contract law!
 - One rule sets multiple incentives...we can't get them all right
 - ...or can we? Tort law has this One Weird Trick™





Negligence

Negligence



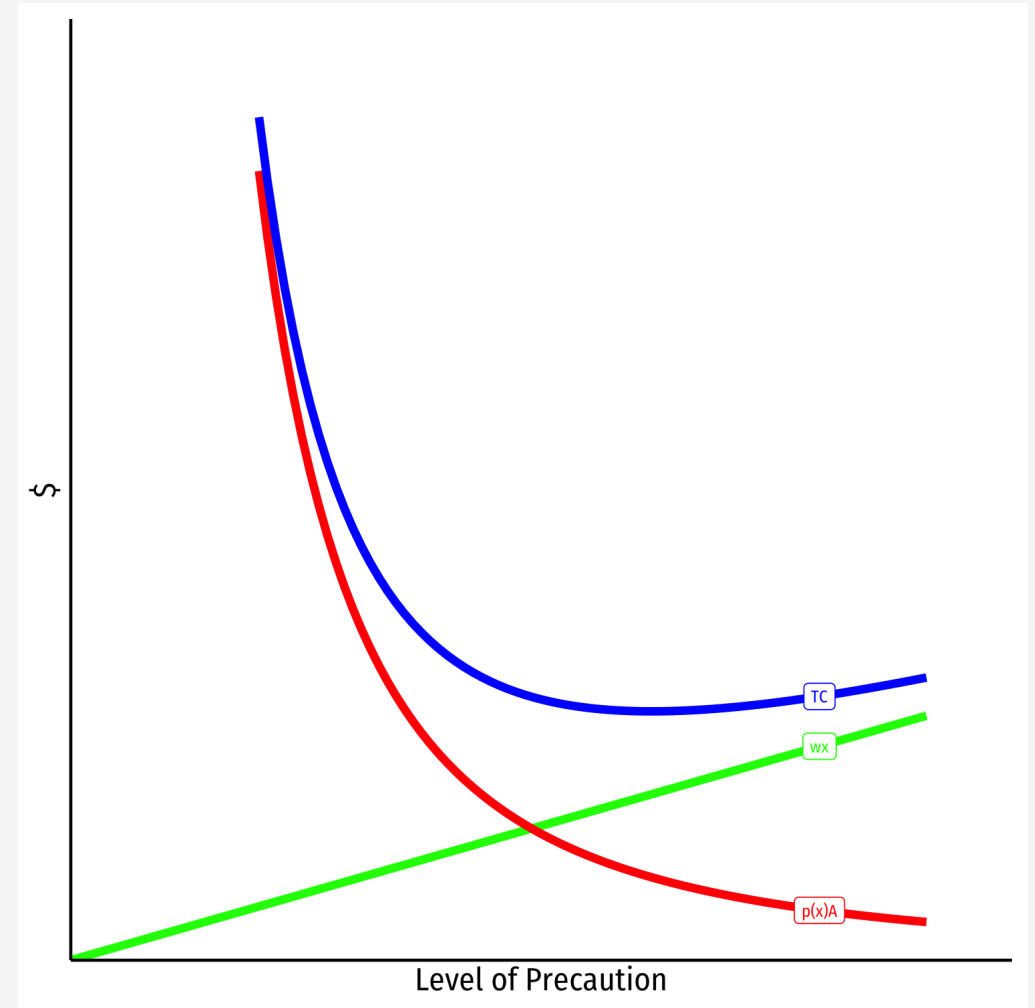
- **Negligence rule:** Injurer is only liable **if he breached his duty of due care**
 - Put alternatively, liable only if accident is “his fault”
- Within our model:
 - Legal standard of care x^l
 - Injurer owes damages if $x < x^l$
 - If $x < x^l \rightarrow D = A$
 - If $x \geq x^l \rightarrow D = 0$



Negligence



- Private cost to injurer is:

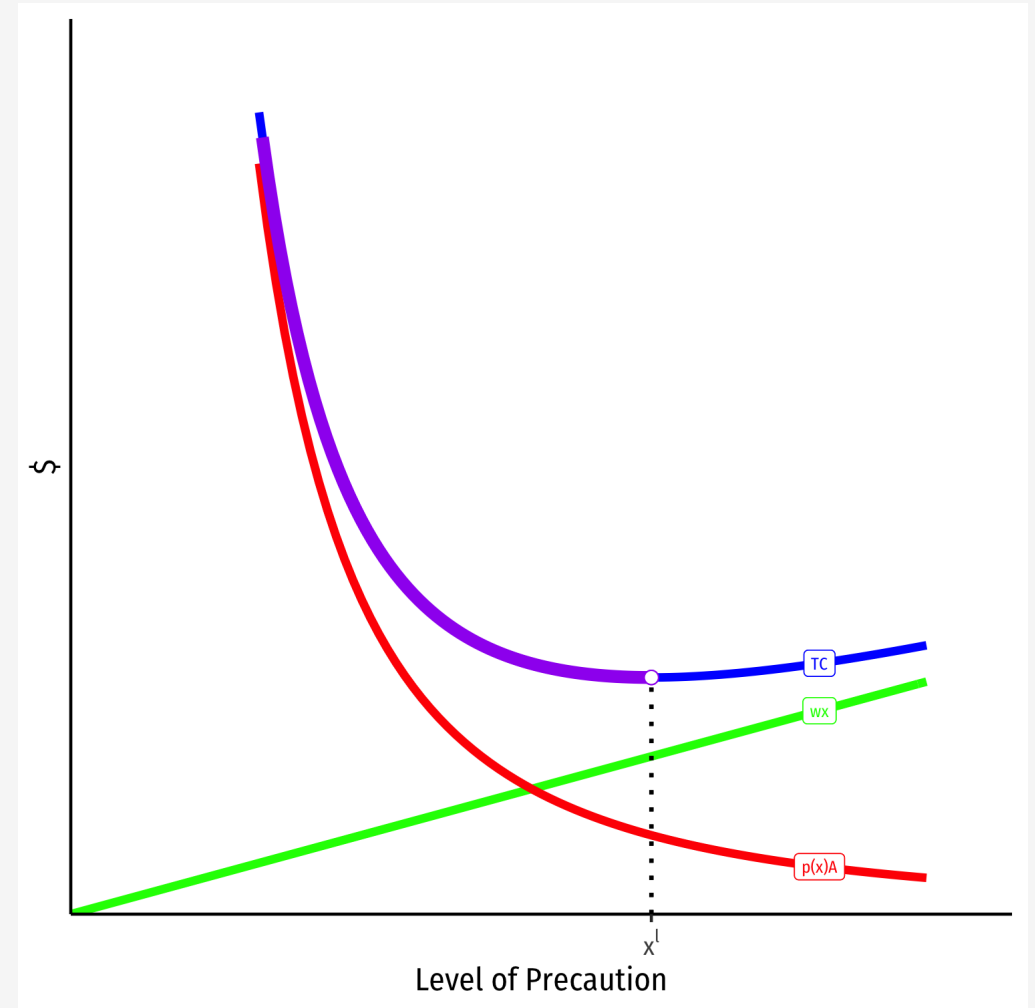


Negligence



- Private cost to **injurer** is:

$$\begin{cases} p(x)A + wx & \text{if } x < x^l \end{cases}$$

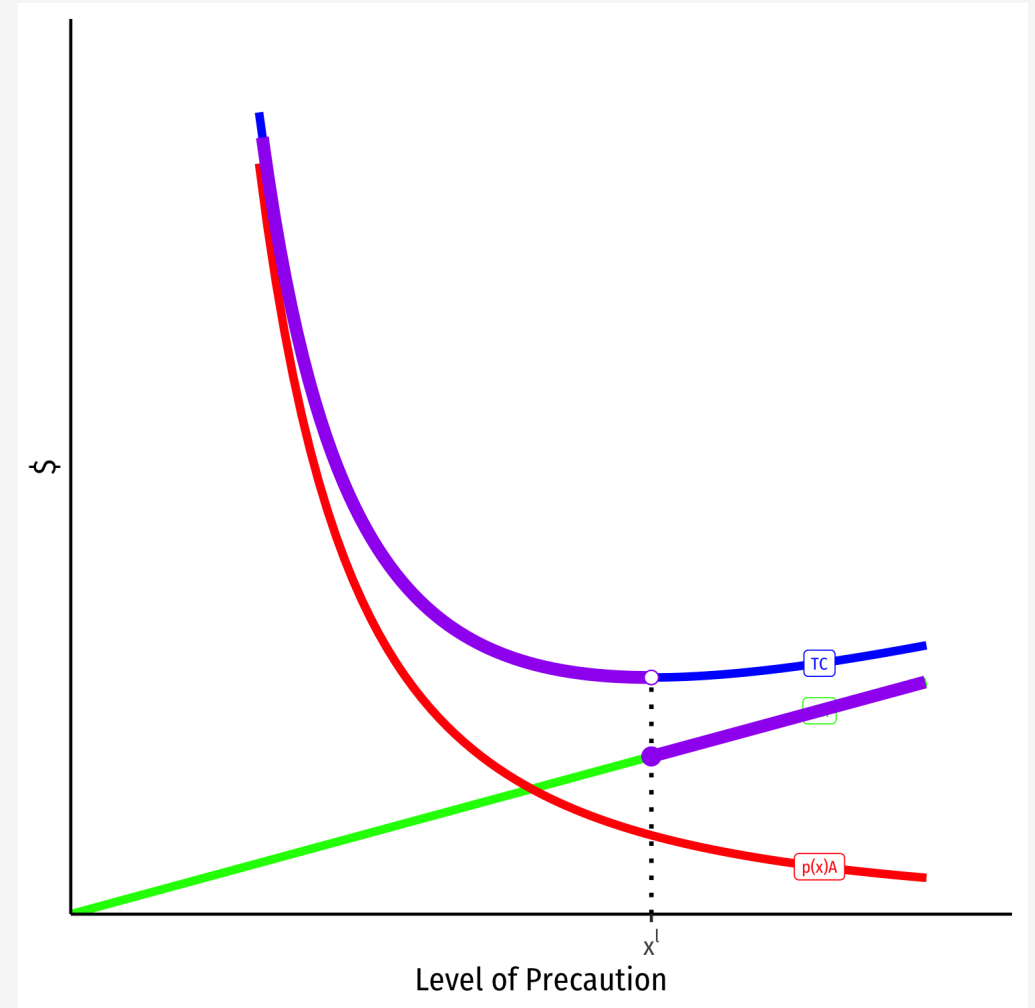


Negligence



- Private cost to **injurer** is:

$$\begin{cases} p(x)A + wx & \text{if } x < x^l \\ wx & \text{if } x \geq x^l \end{cases}$$



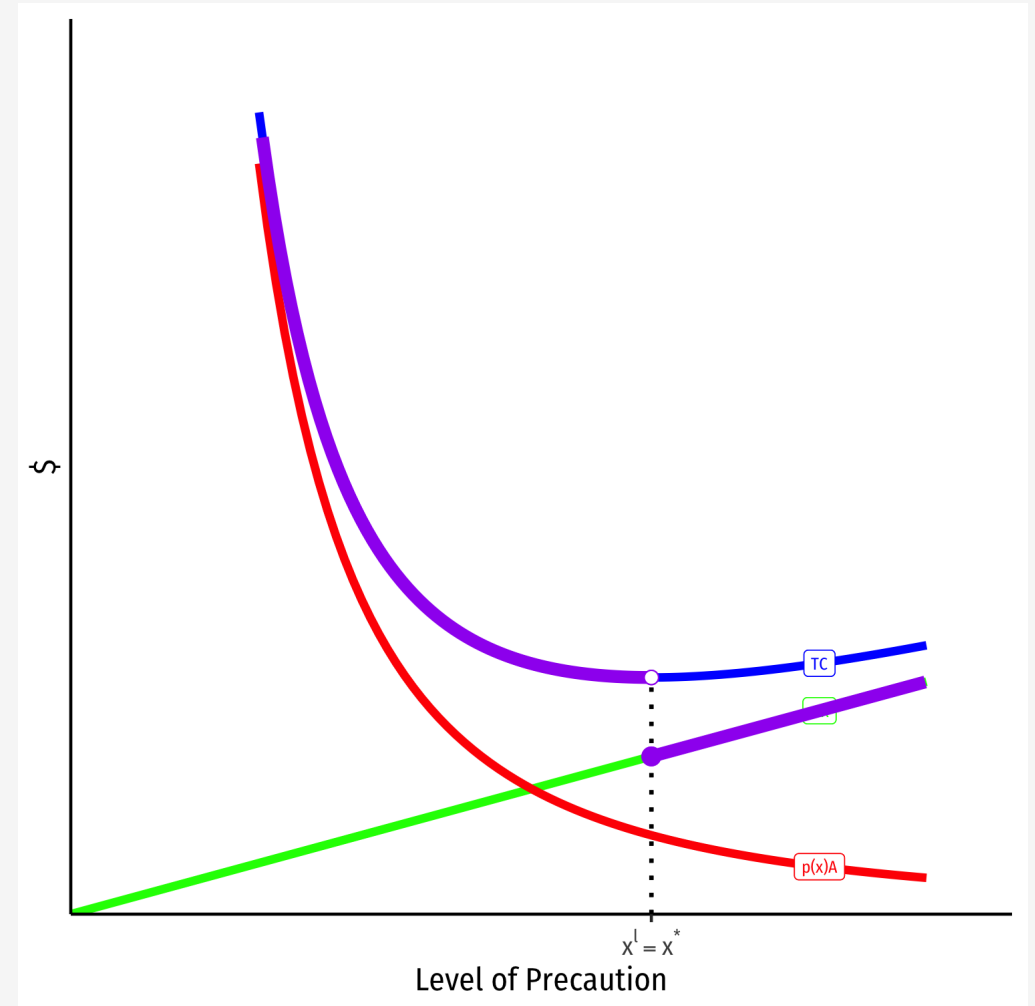
Negligence



- Private cost to **injurer** is:

$$\begin{cases} p(x)A + wx & \text{if } x < x^l \\ wx & \text{if } x \geq x^l \end{cases}$$

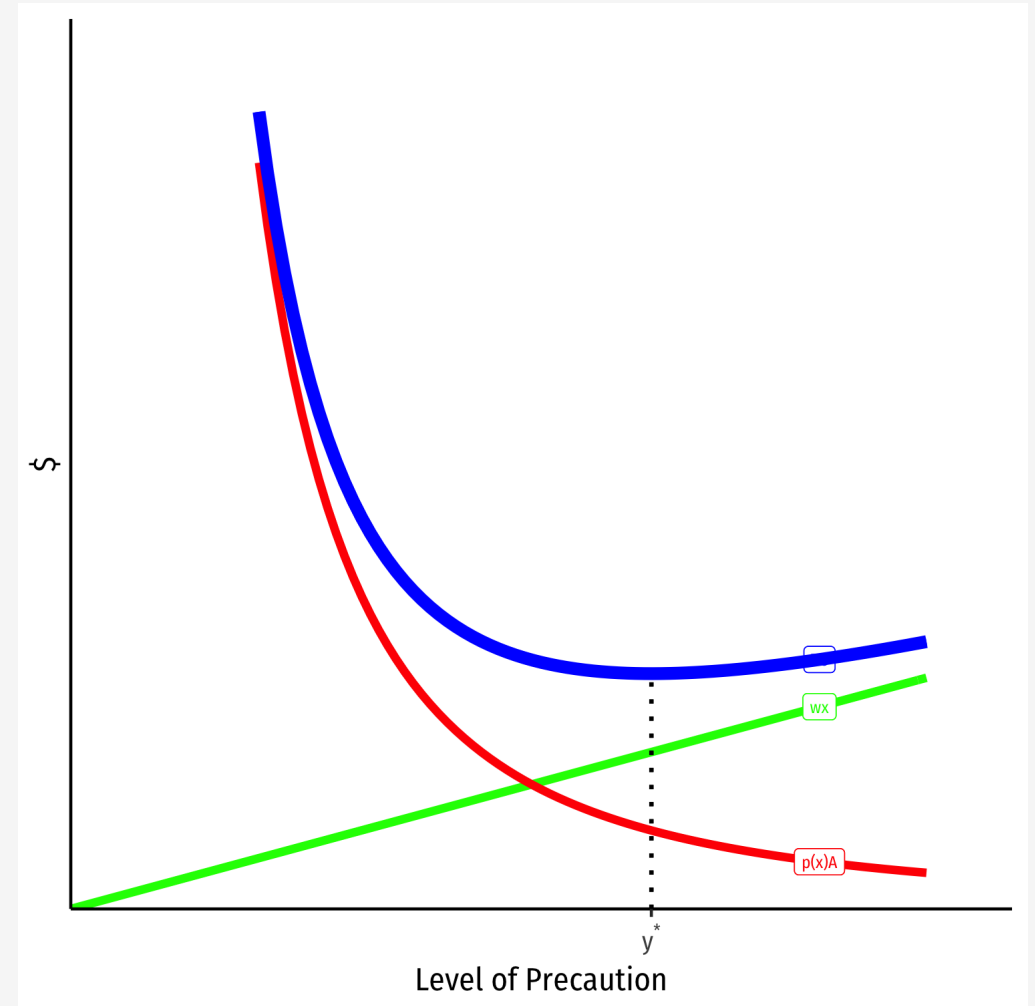
- If standard of care x^l is set to x^* , **injurer** minimizes private cost by taking efficient caution



Negligence: Injurer Precaution



- What about **victim**'s incentives?
 - We saw **injurer** will exercise due care and *not* be liable!
 - **Victim** now bears cost of any accidents! (**residual risk**)
- Private cost to **victim** is: $p(y)A + wy$
 - **Victim** chooses y^* , efficient precaution too!



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution	Injurer Activity	Victim Activity
No liability	Zero	Efficient	Too High	Efficient
Strict liability	Efficient	Zero	Efficient	Too High
Negligence [†]	Efficient	Efficient		

[†] Assuming standard of care is set at the efficient level ($x^l = x^*$)

Other Negligence Rules



- The rule we just considered is “simple” negligence
 - Only consider **injurer**'s actions in determining liability
- But in deciding whether **injurer** should be liable, we could also consider whether the **victim** was negligent



Contributory Negligence: *Butterfield v. Forrester*



- *Butterfield v. Forrester*, 11 East. 60, 103 Eng. Rep. 926 (K.B. 1809)
- Forrester (Defendant) placed a pole in road next to his house while making repairs
- Butterfield (Plaintiff) was riding at high speed at night, hit the pole, fell off his horse, sued for damages
- Witness said that if Forrester had not been riding fast, would have seen the pole
- Jury ruled Plaintiff should not be able to collect damages from Plaintiff due to their own **contributory negligence**



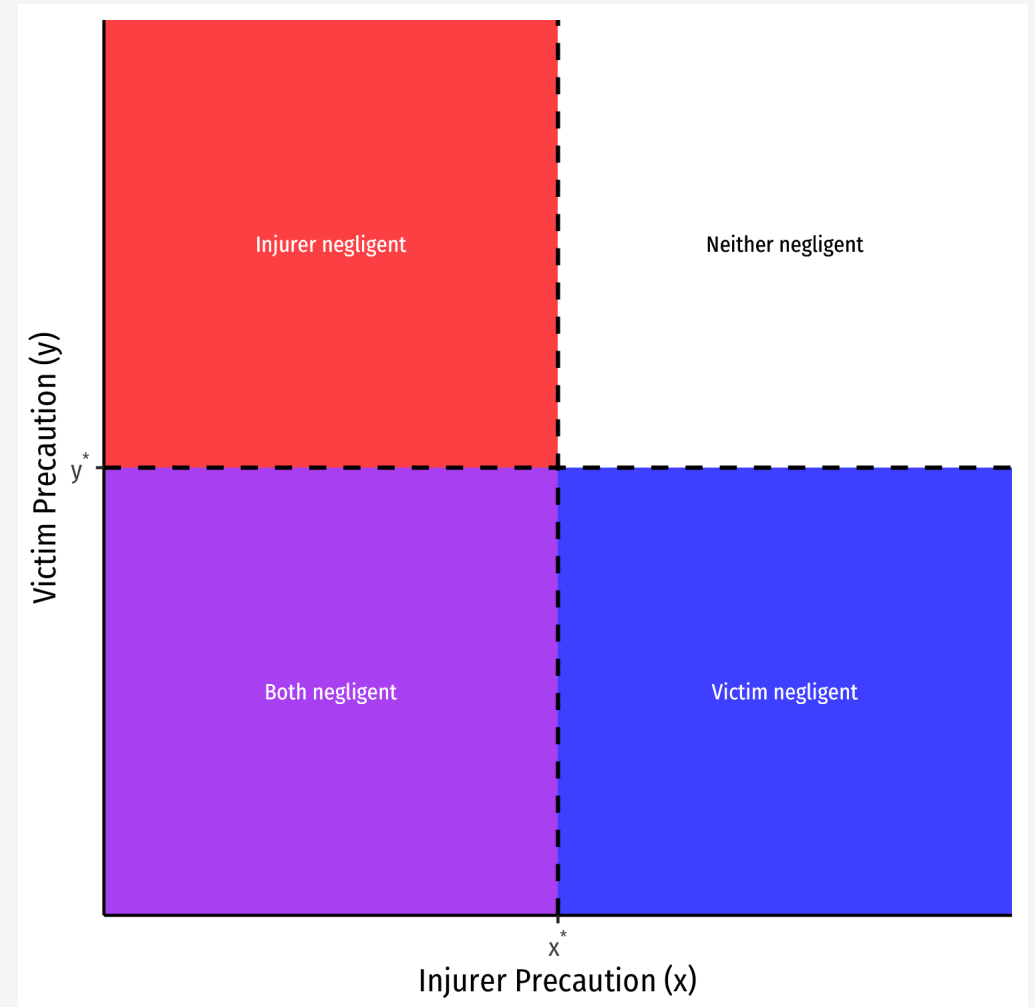
“One person being in fault will not dispense with another’s using ordinary care for himself.”

Family of Negligence Rules



- Let's compare the whole family of negligence rules
- **Injurer** is **negligent/at fault** when they fail to take due care, $x < x^*$ †
- **Victim** is **negligent/at fault** when they fail to take due care, $y < y^*$ †
- Now let's consider who is **liable** for the accident under various negligence rules

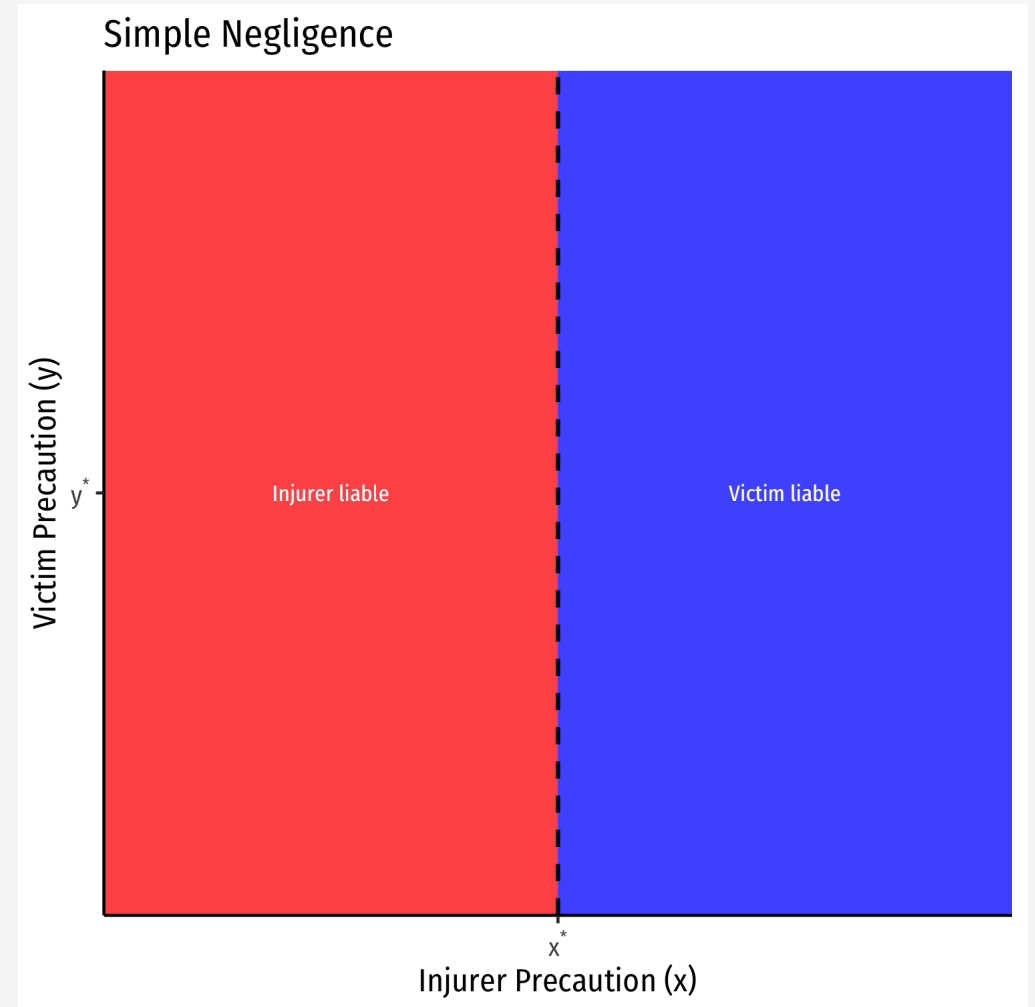
† Assuming standards of care are set at the efficient levels $x^l = x^*$ and $y^l = y^*$



Simple Negligence



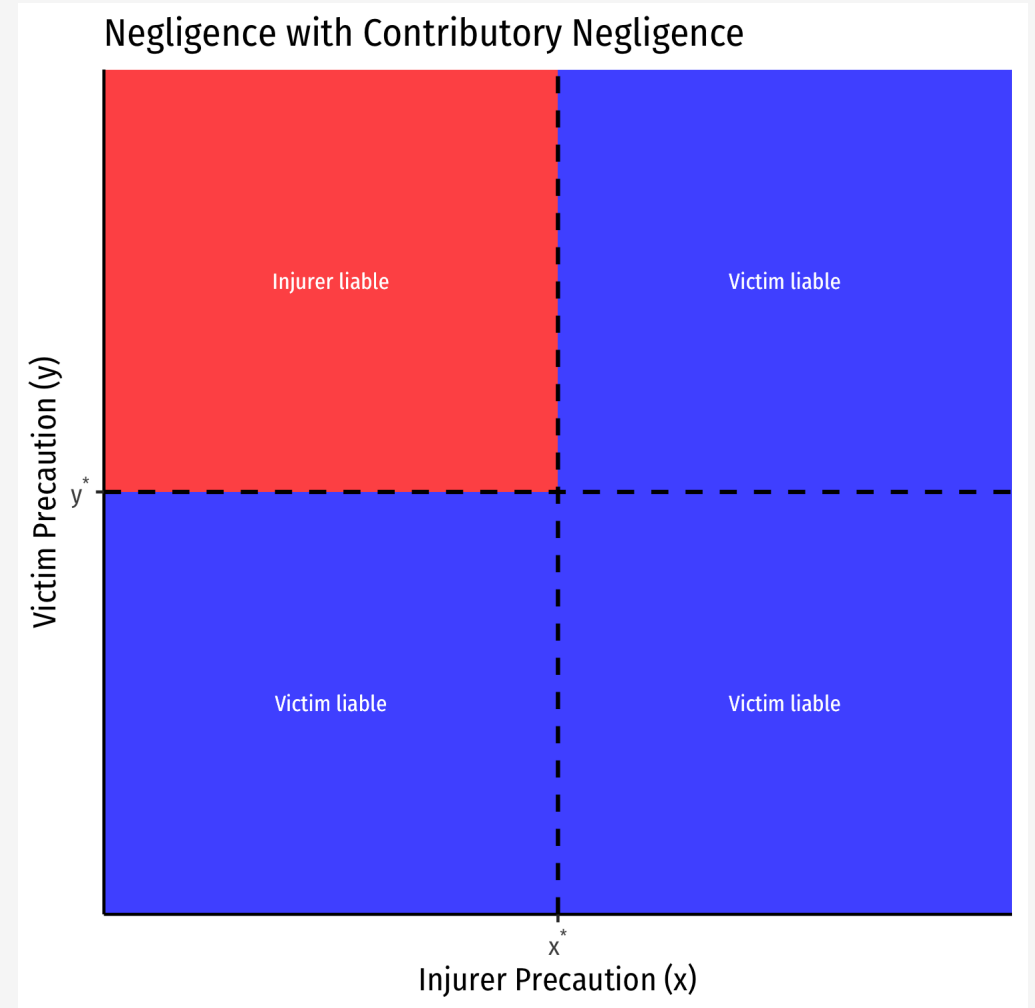
- **Simple negligence:**
- **Injurer** is liable if they do not take due care $x < x^*$
- **Injurer** is *not* liable if they *do* take due care $x \geq x^*$
 - **Victim** cannot collect damages for any accident



Negligence With a Defense of Contributory Negligence



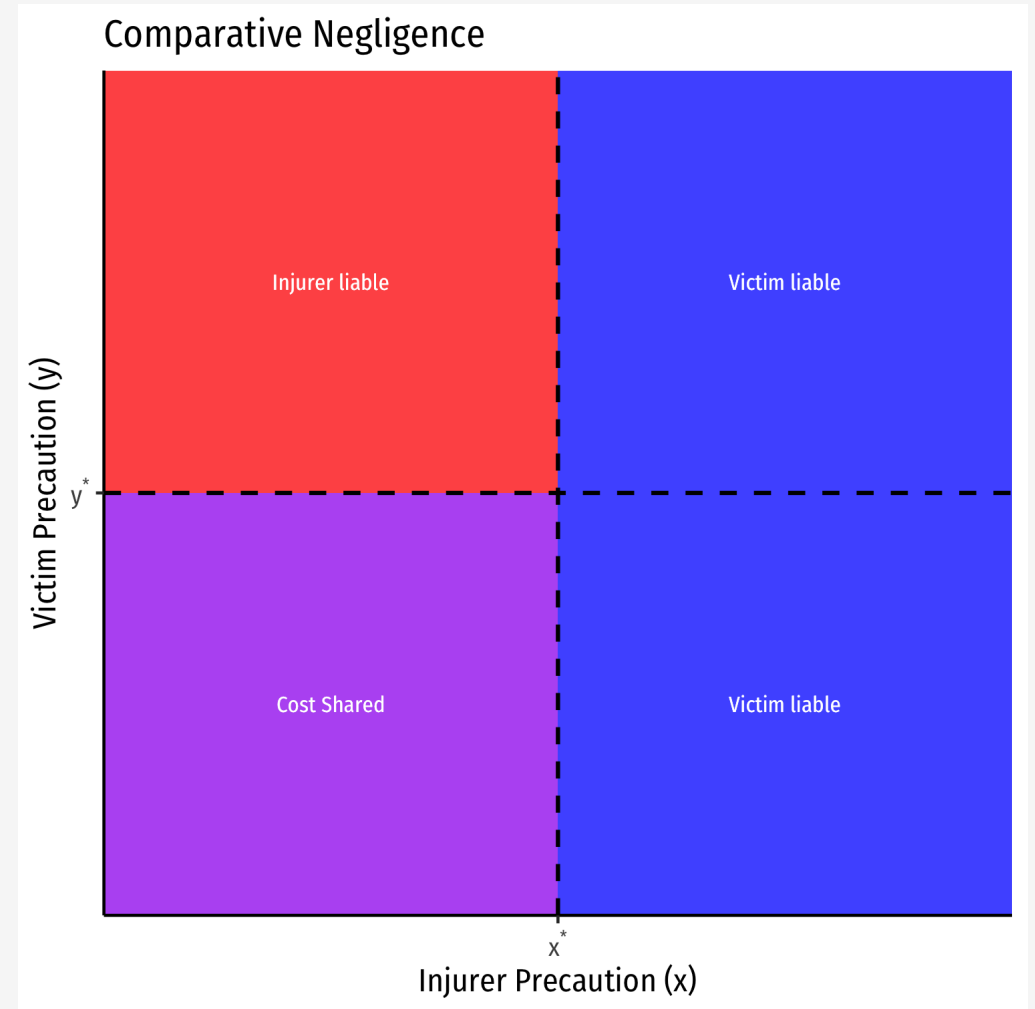
- **Negligence with a defense of Contributory Negligence:**
- **Injurer** is liable if they do not take due care $x < x^*$
- **Injurer** is *not* liable if **Victim** does not take due care $y < y^*$



Family of Negligence Rules



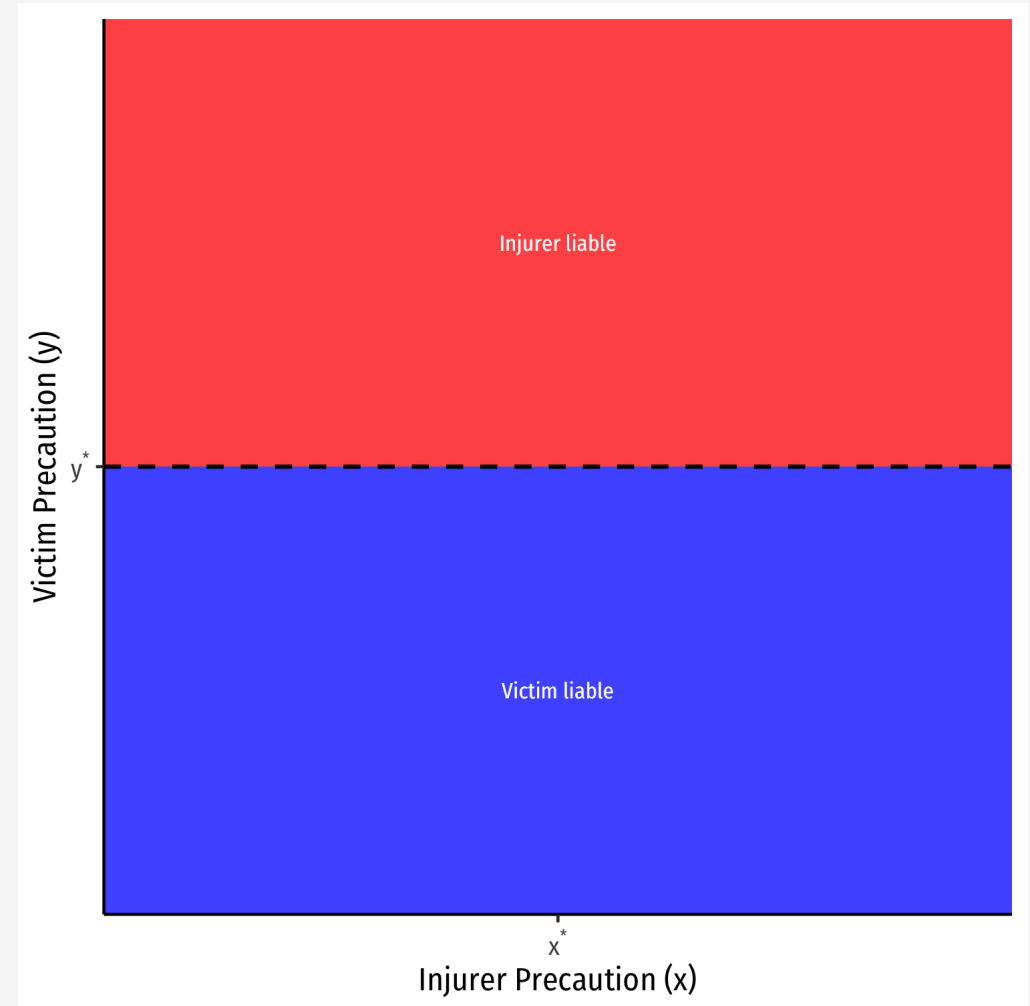
- **Comparative Negligence:** if both parties are negligent, they share the cost of the accident (possibly proportionately)



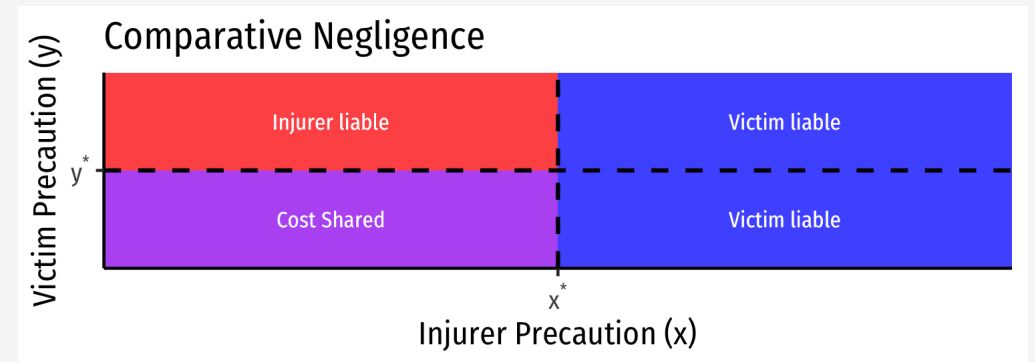
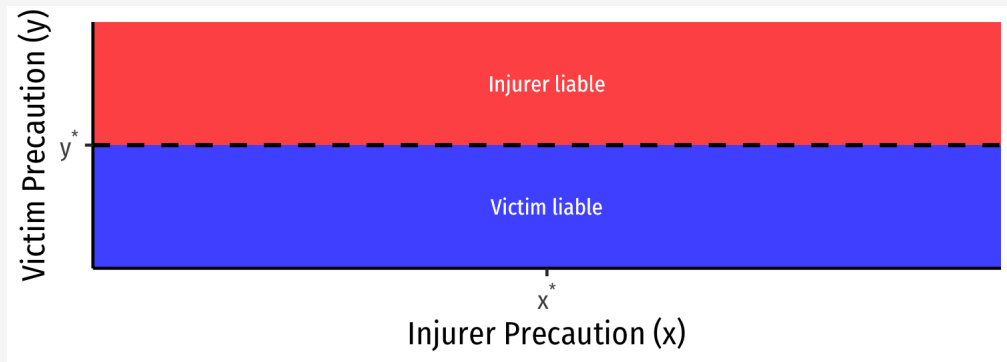
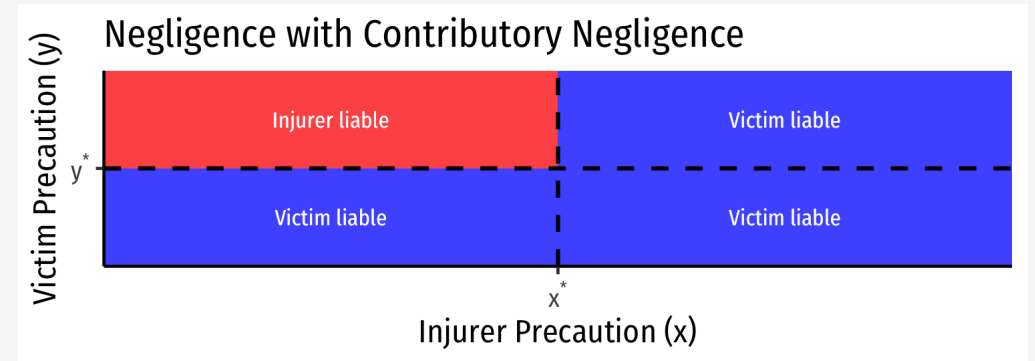
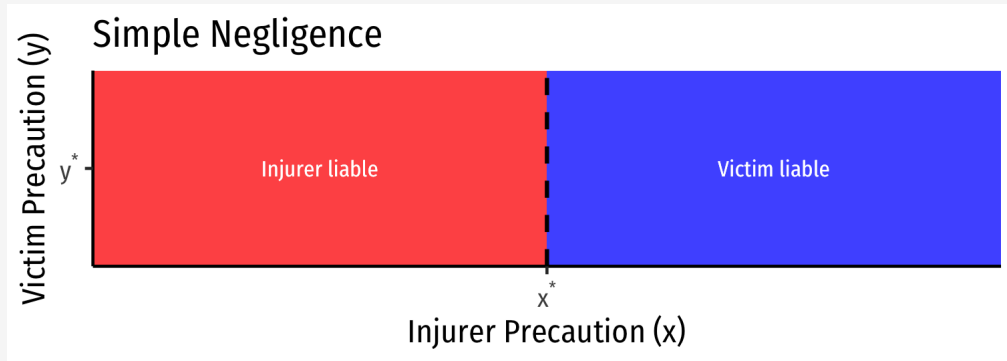
Family of Negligence Rules



- **Strict liability with defense of Contributory Negligence:**
- **Injurer** is liable (regardless of their level of precaution x) *unless* **Victim** does not take due care $y < y^*$



Family of Negligence Rules



- These rules differ only in distribution of income
- **Any of these rules (with efficient standard of care) incentivize efficient precaution by both parties!**
 (x^*, y^*)



Comparing Negligence Rules, A Discrete Example of Bilateral Caution

Discrete Example of Bilateral Precaution



- Let's compare with a discrete example
- Each party **Injurer** and **Victim** can either take **precaution** or **not**
 - Precaution costs each party \$20
 - Each accident costs \$1,000 in harm
- Chance of accident is:
 - 10% if nobody takes precaution
 - 6% if one party takes precaution
 - 2% if both parties take precaution
- Note: precaution is efficient for each party: costs \$20; reduces expected damage by $0.04(\$1,000) = \40



A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **negligence with defense of contributory negligence**
- **Injurer** is liable if he failed to take precaution...unless **blue** victim failed too

		Victim	
		Precaution	None
Injurer	Precaution	-20 -40	-20 -60
	None	-60 -20	0 -100

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **negligence with defense of contributory negligence**
- **Injurer** is liable if he failed to take precaution...unless **blue** victim failed too
- Notice **Victim**'s dominant strategy is **Precaution**
 - If **Injurer** not taking precaution, **victim** wants to avoid liability
 - If **Injurer** takes precaution, **victim** bears residual risk, wants to minimize accidents

		Victim	
		Precaution	None
Injurer	Precaution	-20 <u>-40</u>	-20 -60
	None	-60 <u>-20</u>	0 -100

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **negligence with defense of contributory negligence**
- **Injurer** is liable if he failed to take precaution...unless **blue** victim failed too
- Notice **Victim**'s dominant strategy is **Precaution**
 - If **Injurer** not taking precaution, **victim** wants to avoid liability
 - If **Injurer** takes precaution, **victim** bears residual risk, wants to minimize accidents
- For **Injurer**, best response to **Victim**'s precaution is precaution
- **Nash Eq.:** (**Precaution**, **precaution**), efficient!

		Victim	
		Precaution	None
Injurer	Precaution	<u>-20</u>	-20
	None	-40	-60
		Precaution	-60
		None	<u>-20</u>
			-100

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **comparative negligence**, cost of accident divided proportionately

		Victim	
		Precaution	None
Injurer	Precaution	-20 -40	-20 -60
	None	-60 -20	-50 -50

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **comparative negligence**, cost of accident divided proportionately
- Notice **Victim's** dominant strategy is **Precaution**

		Victim	
		Precaution	None
Injurer	Precaution	-20 <u>-40</u>	-20 -60
	None	-60 <u>-20</u>	-50 -50

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **comparative negligence**, cost of accident divided proportionately
- Notice **Victim**'s dominant strategy is **Precaution**
- For **Injurer**, best response to **Victim**'s precaution is precaution
- **Nash Equilibrium**: (**Precaution**, precaution) and is efficient!

		Victim	
		Precaution	None
Injurer	Precaution	<u>-20</u>	-20
	None	-40	-60
		Precaution	None
Victim	Precaution	-60	-50
	None	-20	-50

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **strict liability with defense of contributory negligence**
- **Injurer** is liable regardless of his precaution ... unless **blue** victim was negligent

		Victim	
		Precaution	None
Injurer	Precaution	-40 -20	-20 -60
	None	-60 -20	0 -100

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **strict liability with defense of contributory negligence**
- **Injurer** is liable regardless of his precaution ... unless **blue** victim was negligent
- Notice **Victim**'s dominant strategy is **Precaution**

		Victim	
		Precaution	None
Injurer	Precaution	-40 <u>-20</u>	-20 -60
	None	-60 <u>-20</u>	0 -100

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Discrete Example of Bilateral Precaution



- Consider rule of **strict liability with defense of contributory negligence**
- **Injurer** is liable regardless of his precaution ... unless **blue** victim was negligent
- Notice **Victim**'s dominant strategy is **Precaution**
- For **Injurer**, best response to **Victim**'s precaution is precaution
- **Nash Equilibrium**: (**Precaution**, **precaution**) and is efficient!

		Victim	
		Precaution	None
Injurer	Precaution	<u>-40</u>	-20
	None	-20	-60
		Precaution	None
Victim	Precaution	-40	0
	None	-20	-100

A: \$1,000

w: \$20 (each party)

p: 10% (neither), 6% (one careful), 2% (both)

Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution	Injurer Activity	Victim Activity
No liability	Zero	Efficient	Too High	Efficient
Strict liability	Efficient	Zero	Efficient	Too High
("Simple") Negligence	Efficient	Efficient		
Negligence w/Contributory Negligence	Efficient	Efficient		
Comparative Negligence	Efficient	Efficient		
Strict Liability w/Contributory Negligence	Efficient	Efficient		

Assuming all relevant standards of care are set at the efficient levels ($x^l = x^*$)

Activity Levels under Negligence Rules



- **Simple negligence:** injurer liable if he was negligent
- Leads injurer to take efficient precaution, so **injurer expects to not be liable for any accidents**
- So Injurer ignores cost of accidents when deciding on activity level
 - Drives carefully, but still **drives too much**
- Victim bears residual risk
 - Bikes carefully, and bikes **efficient amount**



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution	Injurer Activity	Victim Activity
No liability	Zero	Efficient	Too High	Efficient
Strict liability	Efficient	Zero	Efficient	Too High
("Simple") Negligence	Efficient	Efficient	Too High	Efficient
Negligence w/Contributory Negligence	Efficient	Efficient		
Comparative Negligence	Efficient	Efficient		
Strict Liability w/Contributory Negligence	Efficient	Efficient		

Assuming all relevant standards of care are set at the efficient levels ($x^l = x^*$)

Activity Levels under Negligence Rules



- **Contributory Negligence** and **Comparative negligence**: efficient precaution by both parties
- Leads **injurer** to take efficient precaution, so **injurer expects to not be liable for any accidents**
- So **Injurer** ignores cost of accidents when deciding on activity level
 - Drives carefully, but still **drives too much**
- **Victim** bears residual risk
 - Bikes carefully, and bikes **efficient amount**



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution	Injurer Activity	Victim Activity
No liability	Zero	Efficient	Too High	Efficient
Strict liability	Efficient	Zero	Efficient	Too High
("Simple") Negligence	Efficient	Efficient	Too High	Efficient
Negligence w/Contributory Negligence	Efficient	Efficient	Too High	Efficient
Comparative Negligence	Efficient	Efficient	Too High	Efficient
Strict Liability w/Contributory Negligence	Efficient	Efficient		

Assuming all relevant standards of care are set at the efficient levels ($x^l = x^*$)

Activity Levels under Negligence Rules



- **Strict liability w/comparative negligence defense:** if **victim** is not negligent, **injurer** is liable regardless of precaution
- Leads both parties to take efficient precaution, so **injurer** is residual risk bearer, and is **liable for any accidents**
 - So **injurer** weighs cost of accidents against benefits, drives **efficient amount**
- **Victim**, fully insured, ignores cost of accidents when deciding on activity level
 - Bikes carefully, but still **bikes too much**



Comparing Incentives Under Different Liability Rules



Rule	Injurer Precaution	Victim Precaution	Injurer Activity	Victim Activity
No liability	Zero	Efficient	Too High	Efficient
Strict liability	Efficient	Zero	Efficient	Too High
("Simple") Negligence	Efficient	Efficient	Too High	Efficient
Negligence w/Contributory Negligence	Efficient	Efficient	Too High	Efficient
Comparative Negligence	Efficient	Efficient	Too High	Efficient
Strict Liability w/Contributory Negligence	Efficient	Efficient	Efficient	Too High

Assuming all relevant standards of care are set at the efficient levels ($x^l = x^*$)