

ALL GAMES CAN BE ANALYZED AS SIMULTANEOUS-MOVE GAMES IN WHICH PLAYERS MOVE AT THE SAME TIME.



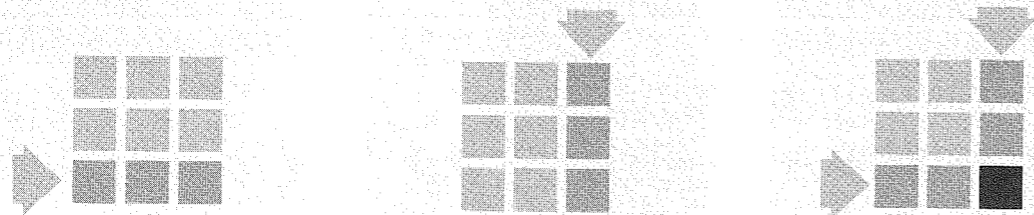
Klein and Bauman "Game Theory" (chap. 6) from: "The Cartoon Introduction to Economics" FSGBooks, 2010

WE CAN ANALYZE SIMULTANEOUS-MOVE GAMES BETWEEN TWO PLAYERS USING A **PAYOFF MATRIX**.

EACH CHOICE FOR THE FIRST PLAYER GETS A ROW...

...AND EACH CHOICE FOR THE SECOND PLAYER GETS A COLUMN...

...AND THE **OUTCOME** FROM THOSE CHOICES APPEARS AT THE INTERSECTION.



HERE'S A SIMPLE EXAMPLE: THE PAYOFF MATRIX FOR ROCK PAPER SCISSORS IF MOG AND OOGA PLAY FOR \$5.

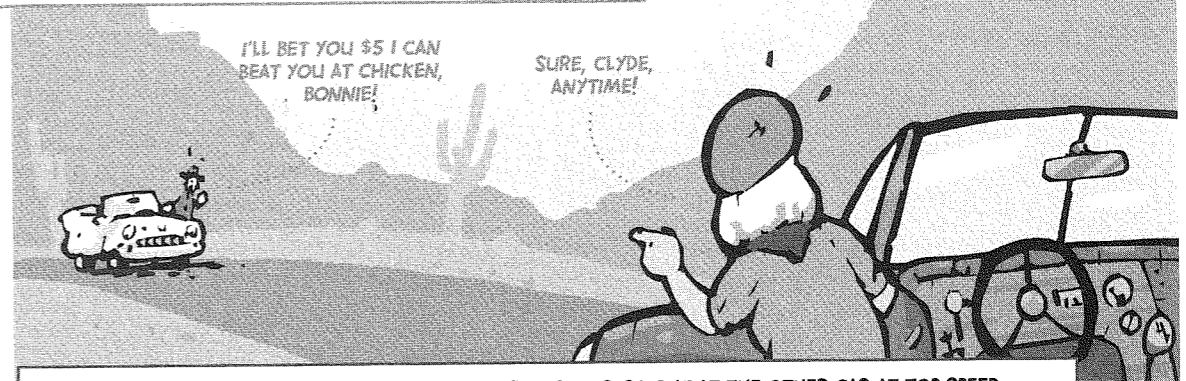
READY?

1...  
2...  
3...



	Mog		
	Rock	Paper	Scissors
Rock	Mog: \$0 Ooga: \$0	Mog: -\$5 Ooga: \$5	Mog: \$5 Ooga: -\$5
Paper	Mog: \$5 Ooga: -\$5	Mog: \$0 Ooga: \$0	Mog: -\$5 Ooga: \$5
Scissors	Mog: -\$5 Ooga: \$5	Mog: \$5 Ooga: -\$5	Mog: \$0 Ooga: \$0

ANOTHER EXAMPLE OF A SIMULTANEOUS-MOVE GAME IS THE GAME OF **CHICKEN**.



IN CHICKEN, EACH PLAYER CHOOSES TO **EITHER** DRIVE STRAIGHT AT THE OTHER CAR AT TOP SPEED **OR** CHICKEN OUT BY TURNING AWAY.

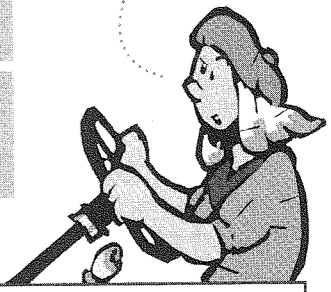
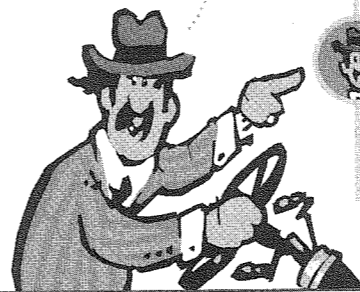


YOU CAN SEE THE 4 POSSIBLE OUTCOMES IN THIS PAYOFF MATRIX.

	Bonnie	
	Chicken Out	Speed Ahead
Chicken Out	Clyde: \$0 Bonnie: \$0	Clyde: -\$5 Bonnie: \$5
Speed Ahead	Clyde: \$5 Bonnie: -\$5	Both players perish in a horrible fiery crash!

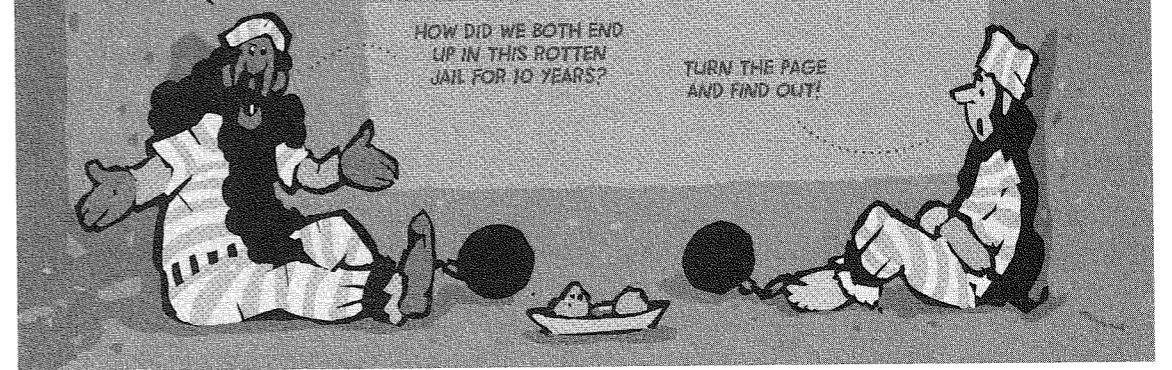
WAIT A MINUTE...

...MAYBE THIS ISN'T SUCH A GREAT IDEA.

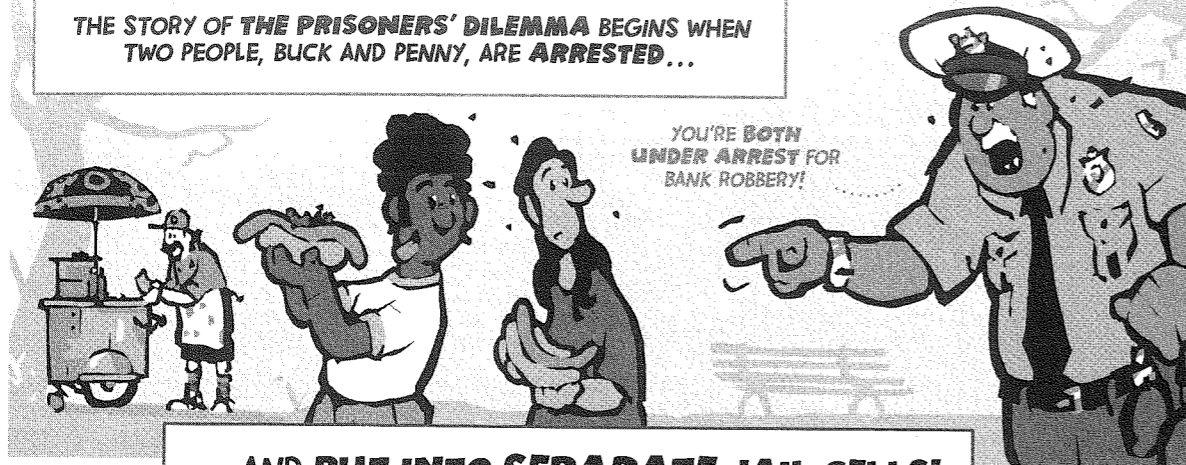


IN THIS CHAPTER WE'RE GOING TO FOCUS ON THE MOST FAMOUS SIMULTANEOUS-MOVE GAME:

## THE PRISONERS' DILEMMA!



THE STORY OF THE PRISONERS' DILEMMA BEGINS WHEN TWO PEOPLE, BUCK AND PENNY, ARE ARRESTED...



YOU'RE BOTH UNDER ARREST FOR BANK ROBBERY!

... AND PUT INTO SEPARATE JAIL CELLS!

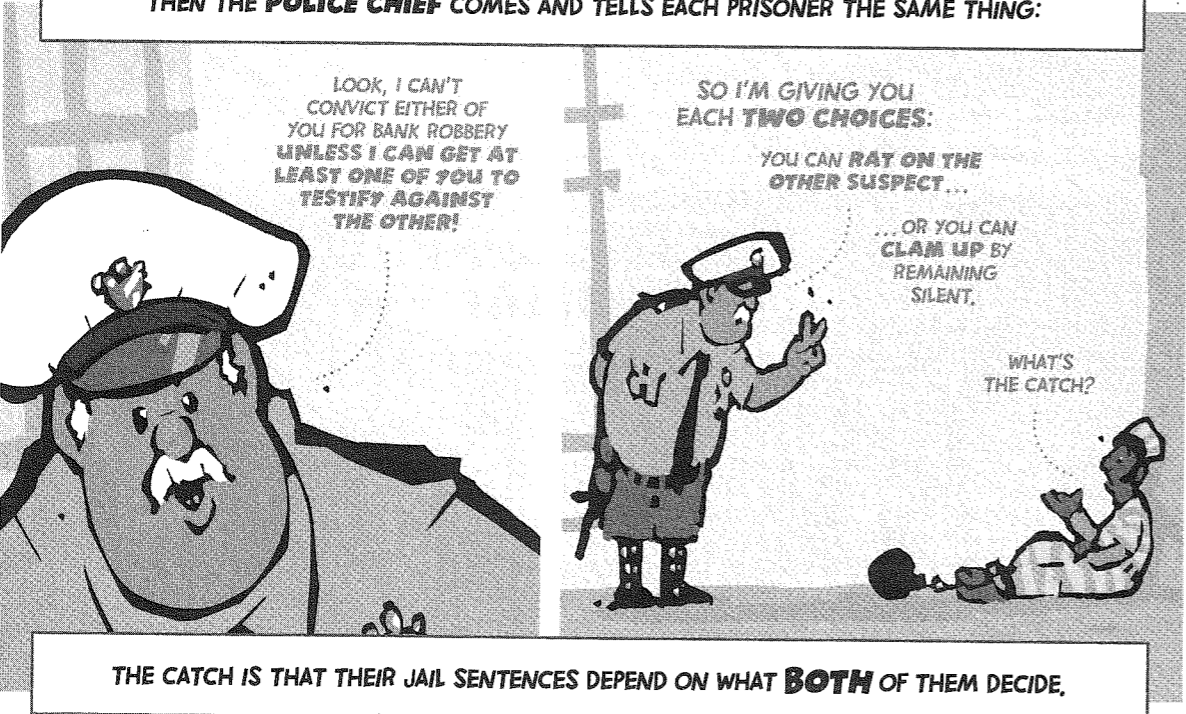


I JUST WANT TO GO HOME!

**QUIET!  
NO TALKING!**

I MISS MY FAMILY, LET ME OUT OF HERE!

THEN THE POLICE CHIEF COMES AND TELLS EACH PRISONER THE SAME THING:



LOOK, I CAN'T CONVICT EITHER OF YOU FOR BANK ROBBERY UNLESS I CAN GET AT LEAST ONE OF YOU TO TESTIFY AGAINST THE OTHER!

SO I'M GIVING YOU EACH TWO CHOICES:

YOU CAN RAT ON THE OTHER SUSPECT...

... OR YOU CAN CLAM UP BY REMAINING SILENT.

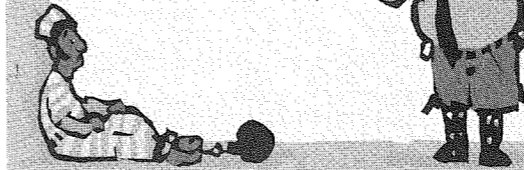
WHAT'S THE CATCH?

THE CATCH IS THAT THEIR JAIL SENTENCES DEPEND ON WHAT **BOTH** OF THEM DECIDE.

HERE'S WHAT THE POLICE CHIEF TELLS THE FIRST PRISONER:

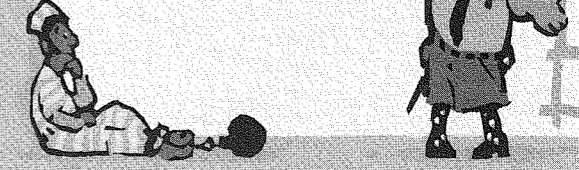
IF YOU RAT ON THE OTHER PRISONER AND SHE RATS ON YOU...

... YOU BOTH GET 10 YEARS IN JAIL.



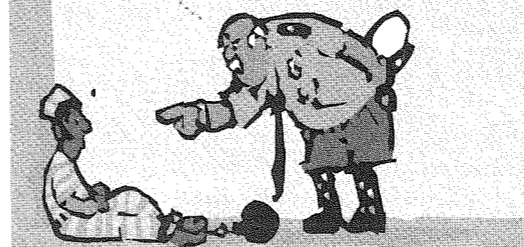
IF YOU RAT ON THE OTHER PRISONER AND SHE CLAMS UP...

... YOU GET OFF FREE, BUT SHE GETS 20 YEARS IN JAIL FOR THE ROBBERY.



IF YOU CLAM UP AND SHE RATS ON YOU...

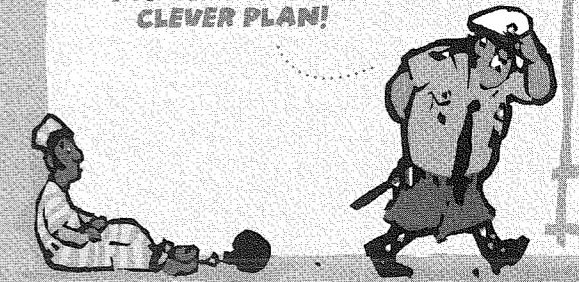
... YOU GET 20 YEARS IN JAIL FOR THE ROBBERY, AND SHE GETS OFF FREE.



AND IF YOU BOTH CLAM UP...

... YOU BOTH GET A YEAR IN JAIL FOR SPOILING MY CLEVER PLAN!

I'LL GET YOU CONVICTED FOR LITTERING OR SOMETHING.



HE THEN TELLS THE SECOND PRISONER THE SAME STORY AND GIVES HER THE SAME CHOICE: RAT OR CLAM UP!

I JUST WANT TO GET OUT OF JAIL AS FAST AS POSSIBLE...

... WHAT SHOULD I DO?

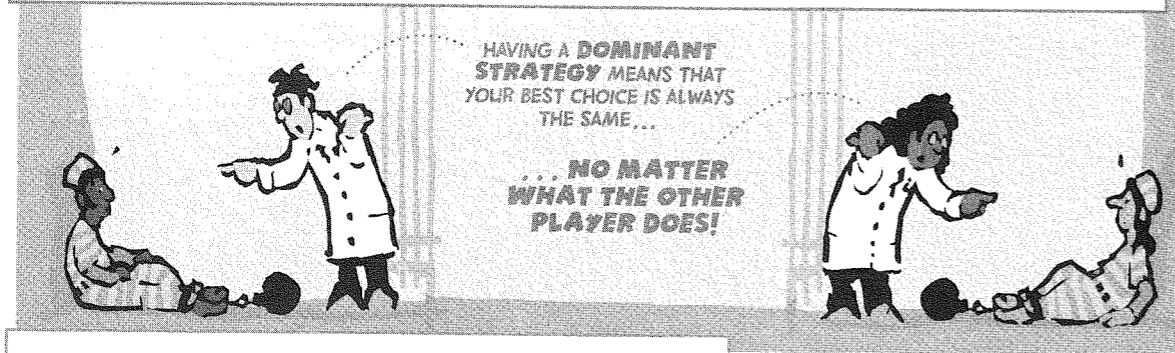
STUDY THIS PAYOFF MATRIX!

THE PAYOFFS ARE YEARS IN JAIL, AND THEY'RE NEGATIVE BECAUSE SPENDING TIME IN JAIL IS BAD.

		RAT	CLAM UP
	RAT	Buck: -10 Penny: -10	Buck: 0 Penny: -20
	CLAM UP	Buck: -20 Penny: 0	Buck: -1 Penny: -1



**TWO THINGS MAKE THE PRISONERS' DILEMMA SPECIAL. THE FIRST IS THAT EACH PLAYER HAS A DOMINANT STRATEGY IF THEY JUST WANT TO GET OUT OF JAIL AS SOON AS POSSIBLE.**



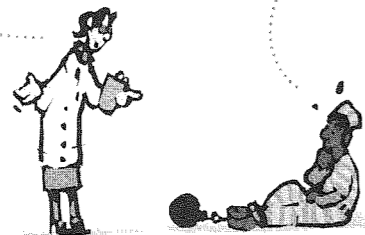
HAVING A **DOMINANT STRATEGY** MEANS THAT YOUR BEST CHOICE IS ALWAYS THE SAME...


... **NO MATTER WHAT THE OTHER PLAYER DOES!**

TO SEE THE **FIRST PRISONER'S DOMINANT STRATEGY**, WE JUST ASK HIM THESE QUESTIONS:

IF PENNY CHOOSES TO **RAT ON YOU**, WHAT'S YOUR BEST CHOICE?

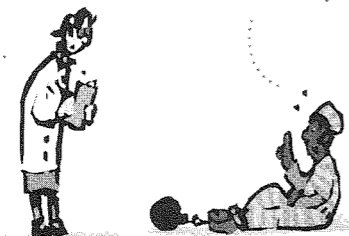
TO **RAT ON HER**, BECAUSE THEN I GET **TEN YEARS** IN JAIL INSTEAD OF THE **TWENTY** I GET IF I CLAM UP.




		<b>RAT</b>	<b>CLAM UP</b>
<b>RAT</b>		Buck: -10 Penny: -10	Buck: -10 Penny: -20
<b>CLAM UP</b>		Buck: -20 Penny: 0	Buck: -10 Penny: 0

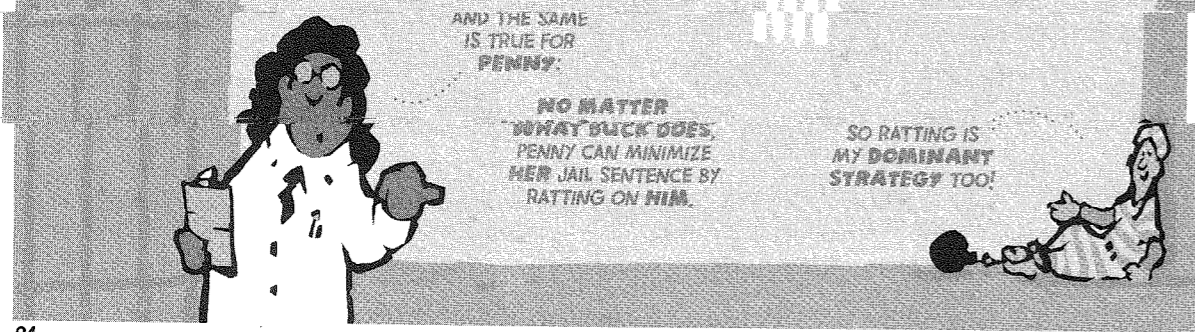
AND IF PENNY CHOOSES TO **KEEP QUIET**, WHAT'S YOUR BEST CHOICE?

TO **RAT ON HER**, BECAUSE THEN I GET **ZERO YEARS** IN JAIL INSTEAD OF THE **ONE** I GET IF I CLAM UP.



		<b>RAT</b>	<b>CLAM UP</b>
<b>RAT</b>		Buck: 0 Penny: -20	Buck: 0 Penny: -1
<b>CLAM UP</b>		Buck: -1 Penny: -1	Buck: -1 Penny: 0

**REGARDLESS OF WHAT PENNY DOES, BUCK CAN MINIMIZE HIS JAIL SENTENCE BY RATTING. SO RATTING IS HIS DOMINANT STRATEGY.**



AND THE SAME IS TRUE FOR **PENNY**:

**NO MATTER WHAT BUCK DOES**, PENNY CAN MINIMIZE HER JAIL SENTENCE BY **RATTING ON HIM**.

SO **RATTING IS MY DOMINANT STRATEGY TOO!**

**THE SECOND THING THAT MAKES THE PRISONERS' DILEMMA SPECIAL IS THAT DOMINANT STRATEGIES LEAD TO AN OUTCOME THAT IS BAD FOR BOTH PRISONERS!**



I'M GOING TO FOLLOW MY **DOMINANT STRATEGY**, SO I CHOOSE TO **RAT ON HER!**

I'M GOING TO **RAT ON HIM TOO!**

HA HA! YOU EACH GET **TEN YEARS** IN JAIL!


THAT'S **TERRIBLE!**

IF WE'D BOTH **CLAMMED UP**, WE WOULD HAVE EACH GOTTEN ONLY **ONE YEAR** IN JAIL!

**IN THE LANGUAGE OF ECONOMICS, THE PRISONERS' DILEMMA FEATURES DOMINANT STRATEGIES THAT LEAD TO A PARETO INEFFICIENT OUTCOME...**

DOMINANT STRATEGIES LEAD BOTH PLAYERS TO **RAT ON EACH OTHER...**



		<b>RAT</b>	<b>CLAM UP</b>
<b>RAT</b>		Buck: -10 Penny: -10	Buck: 0 Penny: -20
<b>CLAM UP</b>		Buck: -20 Penny: 0	Buck: -1 Penny: -1

**PARETO IMPROVEMENT!**

... EVEN THOUGH IT WOULD BE A **PARETO IMPROVEMENT** IF THEY BOTH CLAMMED UP.

**... AND IN PLAIN ENGLISH, THE PRISONERS' DILEMMA MEANS:**



THAT WHEN WE EACH ACT IN OUR **INDIVIDUAL SELF-INTEREST...**

**THE OUTCOME IS BAD FOR BOTH OF US!**

ECONOMISTS USE THE PHRASE **PRISONERS' DILEMMA** TO REFER TO ANY SITUATION WITH A **SIMILAR INCENTIVE STRUCTURE**.

HERE'S A **GENERIC PRISONERS' DILEMMA MATRIX**:

		2nd Player	
		A	B
1st Player	A	1st Player: <b>BAD</b> 2nd Player: <b>BAD</b>	1st Player: <b>BEST</b> 2nd Player: <b>WORST</b>
	B	1st Player: <b>WORST</b> 2nd Player: <b>BEST</b>	1st Player: <b>GOOD</b> 2nd Player: <b>GOOD</b>

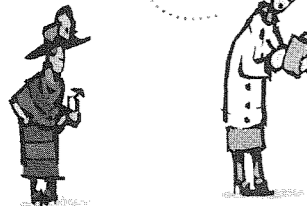
IN THE STORY ABOUT THE PRISONERS, **CHOICE A** WAS TO **RAT** AND **CHOICE B** WAS TO **CLAM UP**.



WHAT THESE SITUATIONS HAVE IN COMMON IS THAT THEY ALL HAVE **DOMINANT STRATEGIES**...

IF SHE CHOOSES **A**, WHAT'S YOUR BEST CHOICE?

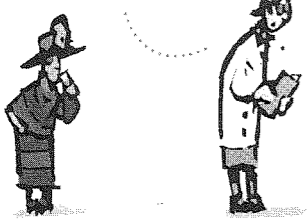
**CHOICE A**, BECAUSE A **BAD** OUTCOME IS BETTER FOR ME THAN THE **WORST** OUTCOME.



		2nd Player	
		A	B
1st Player	A	1st Player: <b>BAD</b> 2nd Player: <b>BAD</b>	1st Player: <b>BEST</b> 2nd Player: <b>WORST</b>
	B	1st Player: <b>WORST</b> 2nd Player: <b>BEST</b>	1st Player: <b>GOOD</b> 2nd Player: <b>GOOD</b>

AND IF SHE CHOOSES **B**, WHAT'S YOUR BEST CHOICE?

**CHOICE A**, BECAUSE THE **BEST** OUTCOME IS BETTER FOR ME THAN A **GOOD** OUTCOME.



		2nd Player	
		A	B
1st Player	A	1st Player: <b>BAD</b> 2nd Player: <b>BAD</b>	1st Player: <b>BEST</b> 2nd Player: <b>WORST</b>
	B	1st Player: <b>WORST</b> 2nd Player: <b>BEST</b>	1st Player: <b>GOOD</b> 2nd Player: <b>GOOD</b>

... THAT RESULT IN **PARETO INEFFICIENT OUTCOMES** FOR THE TWO PLAYERS!

**CHOICE A** IS MY **DOMINANT STRATEGY** TOO.

BUT WHEN WE **BOTH** CHOOSE **A** THE OUTCOME IS **BAD** FOR **BOTH** OF US!



THE PRISONERS' DILEMMA CAN HELP US BETTER UNDERSTAND LOTS OF **MUTUALLY DESTRUCTIVE BEHAVIOR**...

WHY'D YOU RAT ON ME, YOU RAT?



SAME REASON YOU RATTED ON ME, YOU RAT!



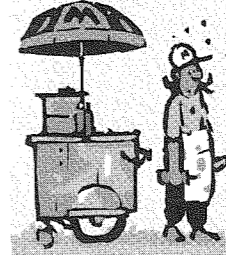
... LIKE **PRICE WARS** BETWEEN TWO **COMPETING BUSINESSES**...

CHARGING **LOW PRICES** HELPS ME ATTRACT MORE CUSTOMERS.

SAME FOR ME!

TOO **BAD** WE DON'T BOTH CHARGE **HIGH PRICES**, THOUGH...

... THEN WE'D BOTH MAKE **MORE MONEY!**



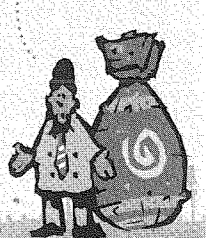
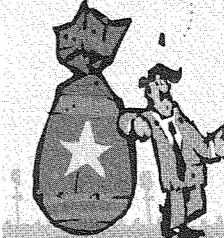
... AND **ARMS RACES** BETWEEN TWO **NATIONS**.

IT'S A **RACE**, SO IF WE BEHIND WE NEED TO **CATCH UP**, AND IF WE'RE **AHEAD** WE NEED TO **STAY AHEAD!**

SAME FOR US!

YOU KNOW, IF WE BOTH BUILT **FEWER WEAPONS**...

... WE COULD SPEND OUR MONEY ON **SOMETHING MORE USEFUL!**

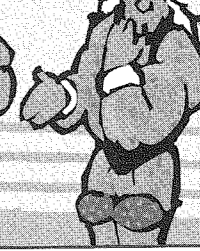


WE CAN EVEN **GENERALIZE** THE PRISONERS' DILEMMA TO SITUATIONS INVOLVING **MORE THAN TWO PLAYERS**, LIKE WHEN **PROFESSIONAL WRESTLERS** CHOOSE TO USE **STEROIDS**:

INJECTING **STEROIDS** IS MY **DOMINANT STRATEGY** BECAUSE I NEED TO HAVE THE **MOST POWERFUL ARMS!**

IT'S **EVERYBODY ELSE'S** **DOMINANT STRATEGY** TOO...

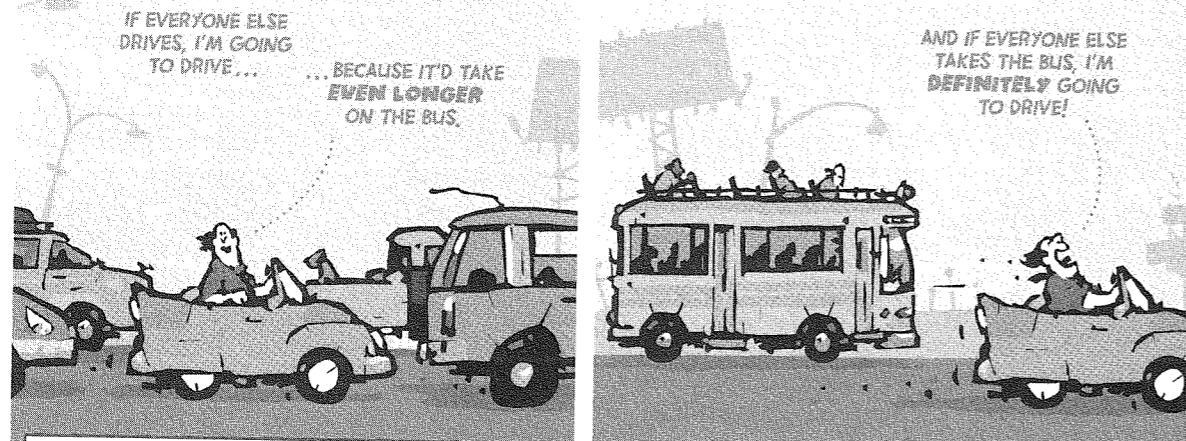
... EVEN IF **STEROIDS** MIGHT MAKE US ALL **BALD** AND **IMPOTENT**.



THIS **GENERALIZED PRISONERS' DILEMMA** IS CALLED THE **TRAGEDY OF THE COMMONS**.

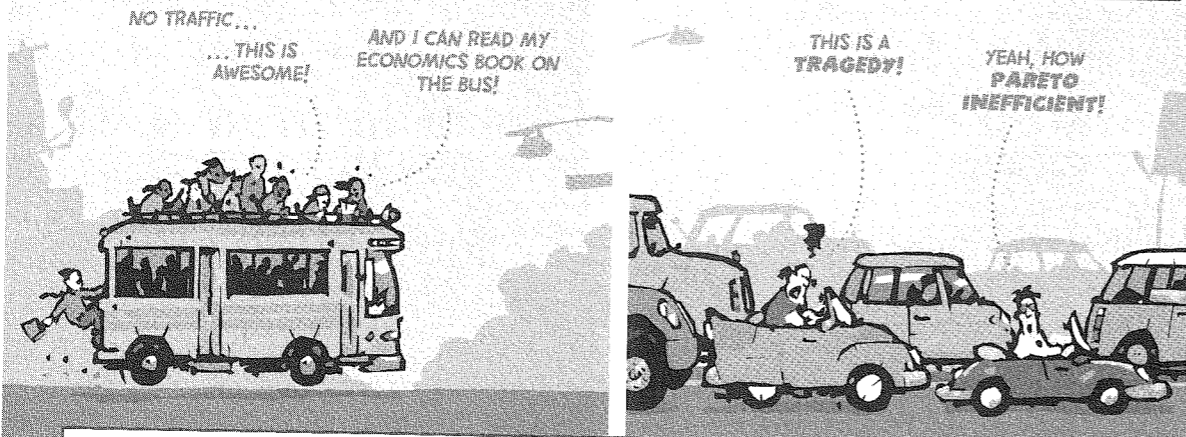
**AS WE SAW ON PAGE 11, ANOTHER EXAMPLE OF THE TRAGEDY OF THE COMMONS IS TRAFFIC CONGESTION.**

IN CITIES WHERE COMMUTERS CAN CHOOSE BETWEEN DRIVING AND TAKING THE BUS, DRIVING IS OFTEN A **DOMINANT STRATEGY**.



SO EVEN THOUGH THE COMMUTE WOULD BE MUCH SHORTER IF EVERYONE TOOK THE BUS...

... WE GET TERRIBLE TRAFFIC BECAUSE **EVERYONE** FOLLOWS THEIR **DOMINANT STRATEGY**.

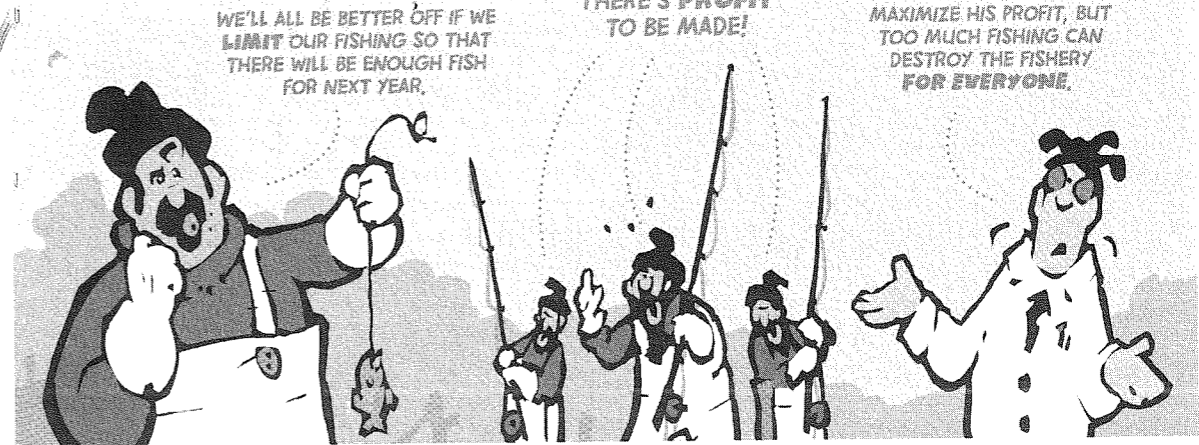


IN THIS KIND OF SITUATION, INDIVIDUAL SELF-INTEREST ACTS IN **OPPOSITION** TO OUR COLLECTIVE GOALS.

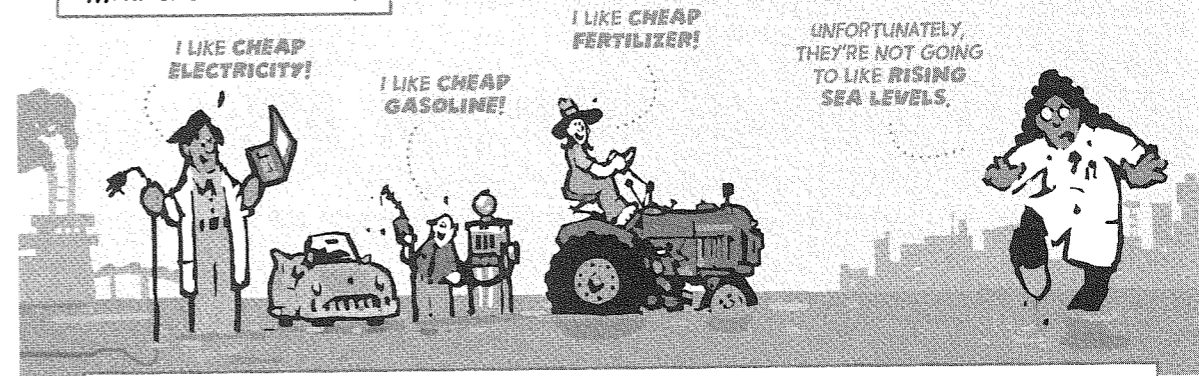


THE TRAGEDY OF THE COMMONS IDEA ALSO DESCRIBES MANY **ENVIRONMENTAL PROBLEMS...**

... LIKE **OVERFISHING** ...



... AND **CLIMATE CHANGE**.



IT MIGHT EVEN HELP US UNDERSTAND WHY **ENTIRE ECONOMIES** SOMETIMES CRASH.

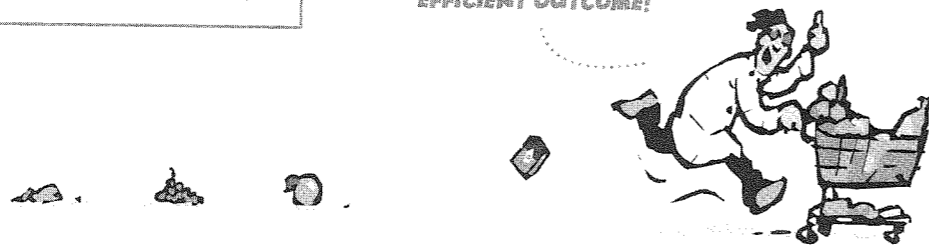
I'M WORRIED I MIGHT GET LAID OFF, SO I'M GOING TO STOP SPENDING MONEY!  
**ME TOO!**  
**ME THREE!**  
 IT'S THE **PARADOX OF THRIFT**:  
 IF EVERYBODY STOPS SPENDING MONEY, MORE PEOPLE WILL **DEFINITELY** GET LAID OFF!



FORTUNATELY, THE NEWS IS NOT **ALL BAD**...

**ONE PIECE OF GOOD NEWS COMES FROM THE COASE THEOREM.**

IF THERE'S NOTHING TO STOP PEOPLE FROM TRADING, THEY WILL CONTINUE TRADING UNTIL THEY REACH A PARETO EFFICIENT OUTCOME!

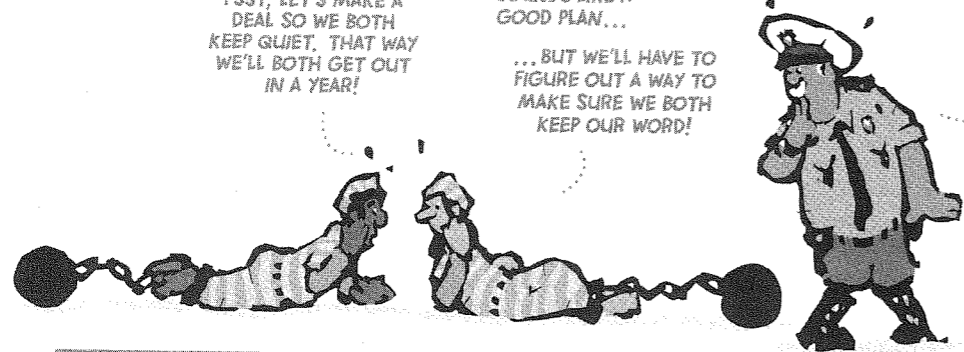


**THE COASE THEOREM CAN SOLVE THE PRISONERS' DILEMMA IF THE PRISONERS CAN TALK TO EACH OTHER AND NEGOTIATE AN AGREEMENT.**

PSST, LET'S MAKE A DEAL SO WE BOTH KEEP QUIET, THAT WAY WE'LL BOTH GET OUT IN A YEAR!

SOUNDS LIKE A GOOD PLAN...  
... BUT WE'LL HAVE TO FIGURE OUT A WAY TO MAKE SURE WE BOTH KEEP OUR WORD!

DARN, I SHOULD HAVE KEPT THEM IN SEPARATE CELLS.



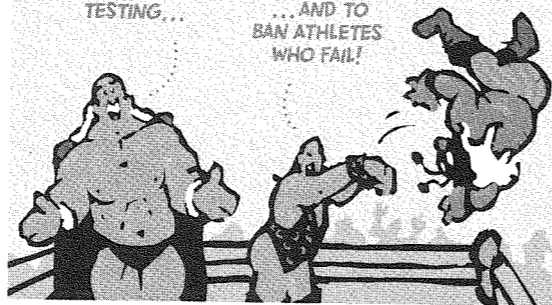
**NEGOTIATED AGREEMENTS CAN ALSO SOLVE THE TRAGEDY OF THE COMMONS!**

THE PLAYERS JUST NEED TO FIND A WAY TO ALIGN THEIR INDIVIDUAL INCENTIVES WITH THE GOALS OF THE GROUP AS A WHOLE:



WE ALL AGREE TO SUBMIT TO STEROID TESTING...

... AND TO BAN ATHLETES WHO FAIL!



WE ALL AGREE TO KEEP THE FISHERY SUSTAINABLE...

... BY USING A TRADABLE PERMIT SYSTEM!



WE ALL AGREE TO IMPOSE A CARBON TAX ON FOSSIL FUELS...

... WE DON'T LIKE IT, BUT IT'S BETTER THAN RISING SEA LEVELS!

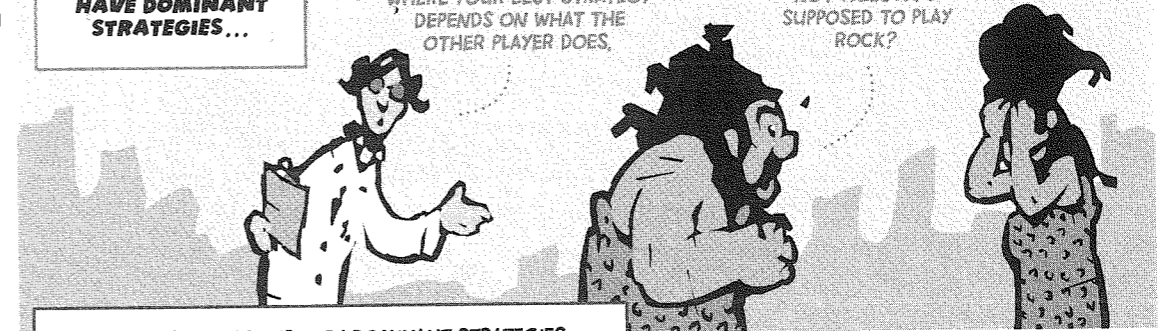


**ANOTHER PIECE OF GOOD NEWS IS THAT LOTS OF SIMULTANEOUS-MOVE GAMES AREN'T LIKE THE PRISONERS' DILEMMA.**

MANY GAMES DON'T HAVE DOMINANT STRATEGIES...

LIKE ROCK PAPER SCISSORS, WHERE YOUR BEST STRATEGY DEPENDS ON WHAT THE OTHER PLAYER DOES.

YOU MEAN MOG NOT ALWAYS SUPPOSED TO PLAY ROCK?



**... AND SOME GAMES WITH DOMINANT STRATEGIES DON'T HAVE PARETO INEFFICIENT OUTCOMES.**

LIKE THIS GAME, WHICH MIGHT BE CALLED THE PRISONERS' DELIGHT.

IN THIS PAYOFF MATRIX OUR INCENTIVE IS TO COOPERATE BY CHOOSING A!

	A	B
A	1st Player: GOOD 2nd Player: GOOD	1st Player: BEST 2nd Player: WORST
B	1st Player: WORST 2nd Player: BEST	1st Player: BAD 2nd Player: BAD



**BUT THE BEST NEWS OF ALL IS THAT SOME PRISONERS' DILEMMA SITUATIONS HAVE UNEXPECTED BENEFITS!**

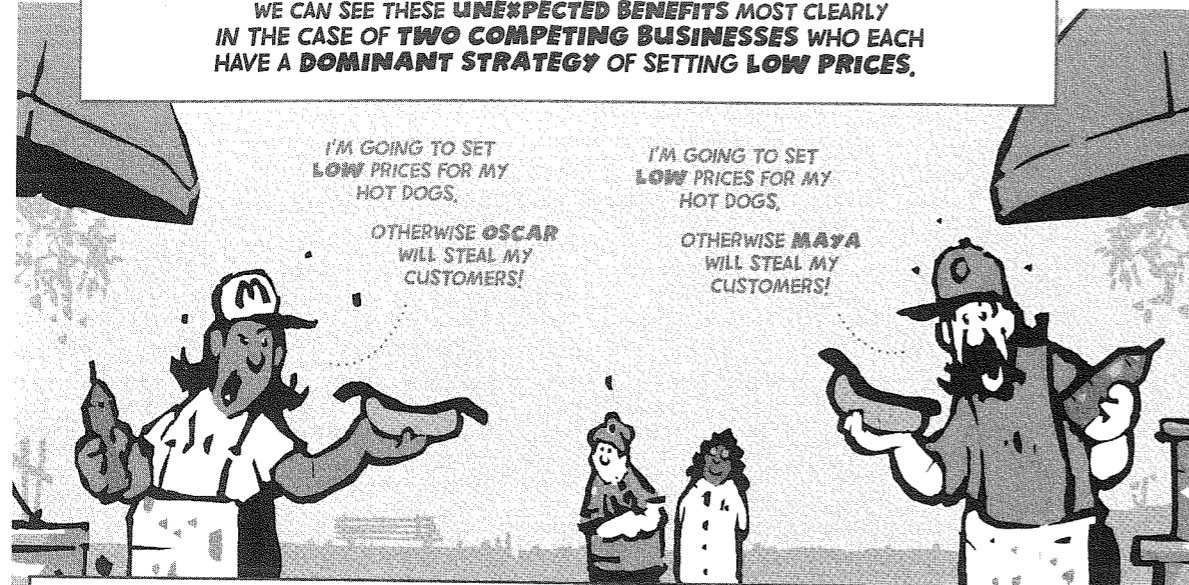
ESPECIALLY IF WE TAKE A BROADER PERSPECTIVE ON SITUATIONS LIKE THIS ONE...

CHARGING LOW PRICES HELPS ME ATTRACT MORE CUSTOMERS.

SAME FOR ME!




WE CAN SEE THESE **UNEXPECTED BENEFITS** MOST CLEARLY IN THE CASE OF **TWO COMPETING BUSINESSES** WHO EACH HAVE A **DOMINANT STRATEGY** OF SETTING **LOW PRICES**.



FROM THE **NARROW PERSPECTIVE** OF THE BUSINESSES, THIS IS A **CLASSIC PRISONERS' DILEMMA** SITUATION...

BOTH PLAYERS HAVE A **DOMINANT STRATEGY** THAT LEADS TO A **PARETO INEFFICIENT** OUTCOME FOR THEM.



	 <b>SET LOW PRICE</b>	<b>SET HIGHER PRICE</b>
<b>SET LOW PRICE</b>	Oscar: \$2m Maya: \$2m	Oscar: \$5m Maya: \$0m
<b>SET HIGHER PRICE</b>	Oscar: \$0m Maya: \$5m	Oscar: \$4m Maya: \$4m

**PARETO IMPROVEMENT!** (Arrow from top-left to bottom-right)

IF THEY **BOTH** SET HIGHER PRICES, THEY'D **BOTH** MAKE MORE MONEY!



... BUT FOR CONSUMERS THE RESULT IS **FANTASTIC!**

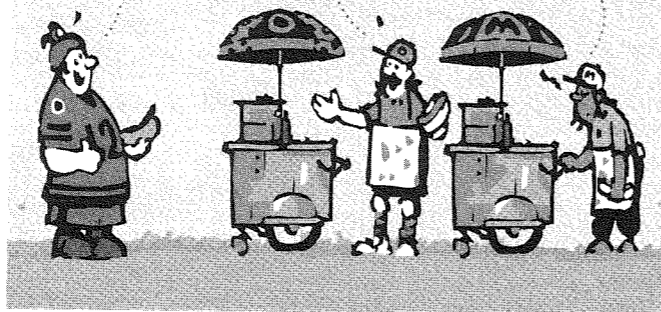
IT'S AS IF AN **INVISIBLE HAND** WERE GUIDING THEM TO PROVIDE ME WITH HOT DOGS AT **LOW PRICES!**



GEE, THANKS FOR THE **LOW PRICES!**

DON'T THANK ME— I'M JUST TRYING TO **MAXIMIZE MY PROFIT!**

**SELFISH JERK!**



## CHAPTER 9 AUCTIONS

