Strategic Adjustment
Key Idea

Actions “up the tree” affect actions “down the tree”

If fail to account for strategic response to policy change, implement ineffective or incorrect policy

Have to anticipate adaptation when designing policy

This also makes it important to measure the right outcome
sometimes by a large margin. Overall, there are 150 models at whose rating ends in .5 and 99 whose rating ends in .4. The probability that, of 249 draws, 150 or more would be drawn from a binomial distribution with equal probability is just 0.0007. If we widen our window and compare the number of models at .3 and .4 to the number at .5 and .6, the story does not change: 200 are just below the notch, and 295 are just above.

The counterexamples to the preponderance of .5 decimals over .4 decimals are high-performance, high-price ultra-luxury automobiles with very low fuel efficiency. Manufacturers of these cars may perceive that their prospective buyers care little about a few hundred dollars because it is a small fraction of the total cost, or even perceive that a low mpg is a status symbol of high performance. These models also have relatively low sales volume, so that if modification involves a fixed cost, we would see less bunching among these vehicles. To capture this possibility,

Fig. 3 replicates Fig. 2 but weights the distribution by sales volume. Note that the total economic impact of manipulation depends on the sales-weighted distributions. In this figure, the predominance of .5 decimals is even more pronounced, and the integers where .5 does not predominate feature very low sales.

Fig. 4 aggregates across integers to show a histogram of mpg decimal values for all vehicles subject to the Gas Guzzler Tax. For example, if a vehicle had a 20.5 fuel economy rating, we put that vehicle into the .5 bar. For those reading in black and white, in each pair of shaded values, the blue bar is on the left and the red bar is on the right.

Fig. 2. Gas guzzler rating distribution, unweighted: 1991–2009. Note: IRS data, sample size is 1221. Higher fuel economy ratings correspond to lower taxes. Ratings ending in .4, all of which are just below a tax notch, are colored in blue, while ratings ending in .5 are colored in red. For those reading in black and white, in each pair of shaded values, the blue bar is on the left and the red bar is on the right.
Car Notches 2

Subject to Tax

Not Subject to Tax
Baby Notches U.S.

Tax benefits to having child in December instead of January in U.S.

Many more children born in final week of December than first week of January

A $500 increase in tax benefit of having a child increases the probability a child is born in the last week of December rather than the first week of January by over 25%
Evidence of Strategic Adjustment: Baby Notches Australia

In May 2004 Australia announced a $3,000 “baby bonus” for children born on or after July 1, 2004

More children born on July 1, 2004 in Australia than on any other single day in decades

Over 1000 births delayed, with over two hundred of them moved by a week or more

In the last week of June, 42% of births through pharmaceutical induction or Cesarean

In the first week of July, 52%
Efficacy and Adaptation

People adapt to avoid policy

This limits efficacy and requires careful policy design
  ▶ Remember our discussion of college affordability earlier this year

Sometimes adaptation also creates opportunities
Educational Reform

Hold students, teachers, and schools accountable by evaluating based on standardized test scores

- NCLB
- Race to the Top

Adaptation to improved measurement and heightened incentives

- Get scores just above test thresholds
- Shift effort to test-relevant tasks
- Shift attention to students close to the test threshold
These discontinuous jumps around the 55 and 65 thresholds are evidence that the system being gamed. It is hard to manipulate the score of a student who made, say, a 35 to get it up over the 55 or 65 point threshold. But it may be much easier to slightly shade things up over the threshold for a student who scored, say, in the low 50s or low 60s. Thus, the big jumps just at the thresholds suggests that scores are being manipulated in some way.

I can think of two ways this might be happening. Amazingly, given the high stakes for students and schools, Regents Exams are graded by the teachers at the school administering the exam. Moreover, the exams are not purely multiple choice, so there is plenty of room for subjective grading. Teachers might have personal loyalties to their students and, thus, be inclined to shade grades higher for students just on the verge of making a score that would allow them to graduate. Further, the number of students making scores above 55 and 65 points directly affects a school’s ratings under No Child Left Behind. Consequently, it affects the resources the school has and the welfare of that school’s teachers. So the teachers might also have a direct personal reason to manipulate grading so as to push as many scores as possible up above the 55 point and 65 point thresholds.
Fig. 3. Achievement trends in Chicago vs. other large, urban school districts in the Midwest, 1990–2000. The achievement series for large Midwestern cities includes data for all tested elementary grades in Cincinnati, Gary, Indianapolis, St. Louis and Milwaukee. The sample includes all grades from 3 to 8 for which test score data was available, and only includes students whose test scores were reported. Test scores are standardized separately by grade*subject*district, using the student-level mean and standard deviation for the earliest available year.
Teaching to the Marginal Student

A. Change in fifth-grade reading scores, 2002 versus 2001

B. Change in fifth-grade math scores, 2002 versus 2001
4 Targets

Defender has 100 units to allocate across targets

- Call allocation to target $i$, $x_i$

Attacker observes allocations and chooses a target to attack

Probability of successful attack on target $i$ is

$$100 - x_i$$
A Model of Optimal Counterterrorism

Two potential targets: $A$ and $B$

$\alpha \in [0, 1]$ is government resources devoted to protecting $A$ and $\beta \in [0, 1]$ is government resources devoted to defending $B$

$\alpha + \beta = 1$

Terrorists choose to attack one or the other target.

If resources $x$ spent protecting a given target, then the probability of an attack on that target succeeding is $1 - x$

Terrorists value two targets equally
**Terrorist Best Response**

If the government chose $\alpha > \frac{1}{2}$, terrorists’ best response is to attack target $B$.

If government chose $\alpha < \frac{1}{2}$, terrorists’ best response is to attack target $A$.

If government chose $\alpha = \frac{1}{2}$, terrorists are indifferent between attacking $A$ or $B$. 
If the government expends more resources protecting one target than another, those resources are entirely wasted because the terrorists adjust, attacking the other target.

The best the government can do is divide its resources evenly between two targets.

Strategic adjustment by terrorists forces the government to spread resources thin.
Implications 1

Optimal counterterrorism policy is not responsive to how much the government cares about the two targets.

It is a mistake to particularly defend targets that are of high value to the government.
Optimal counterterrorism policy is responsive to how much the terrorists care about the two targets.

Suppose the value to the terrorists of the two targets is $v_A$ and $v_B$. The terrorists strictly prefer to attack $A$ if:

$$(1 - \alpha)v_A > (1 - \beta)v_B$$

$$\alpha < \frac{v_A}{v_A + v_B}.$$ 

Government again spreads resources thin, but weighted by how much the terrorists care about each target to equalize expected value of attacking each target.
Implications 3

If there are lots of targets, the problem is even starker

Algorithm for optimal counterterrorism policy:

- Start by spending on the target considered most valuable by the terrorists
- Keep spending until its expected value as a target is equal to the second most valuable target
- Then spend on both of those until they are both equal to the third most valuable target
- Then spend on all three of those until they are all equal to the fourth most valuable target
- Continue this process until you are out of money
Worldwide Skyjackings per Quarter, 1968-1977

Horizontal line is average incidents per quarter before and after 1973:Q1

Incidents per quarter
Worldwide Hostage Takings per Quarter, 1968-1977

Horizontal line is average incidents per quarter before and after 1973:Q1

Year and quarter
Incidents per quarter

25 / 29
General Lessons

You have to think about the behavior of the people your policy is targeted at

Adaptation limits efficacy
War on Drugs

Caribbean share
- 1985: 75%
- 1992: 10%

Mexican Share
- 1989: 33%
- 1992: 50%
- 1998: 80%
A Proposal for Ending Drug Violence in Mexico

6 major drug trafficking organizations

Mexican government crafts a public measure of how violent each organizations is

United States and Mexican governments target all drug enforcement resources on the single most violent organization

Only way to avoid being targeted is to not be most violent
  ▶ Creates a race to the bottom

Could eliminate violence, but would not disrupt drug trafficking
People adapt in response to policy changes

In order to anticipate the effect of a policy change, one must take into account how behavior will change

Nonetheless, adaptation limits the efficacy of policy

Try to find policies that target the broadest category of behavior your policy is aimed at

- Tax on carbon rather than implement CAFE standards
- Increase intelligence rather than airport security