Nash Equilibrium II

Do Better People Make a Better Society?

"If we were all better people the world would be a better place."

- seem self-evidently true
- as a matter of logic involves the fallacy of composition: just because a statement applies to each individual person it need not apply to the group

- one possible meaning of "being a better person"
- obey the biblical injunction to "love your neighbor as yourself"
- that is: be altruistic

Love thy Neighbor as Thyself

if I truly value you – my neighbor – as myself I should place the same value on your utility as on my own

just add the two together

my selfish utility 20 yours is -9

my “altruistic utility” is sum of the two: 11

Excessive Altruism

Adaption from Martin Osborne's [2003] textbook *Bus Seating Game*.

one vacant bench on a bus and two passengers

	Sit	Stand
Sit	2*,2*	3*,0
Stand	0,3*	1,1

Unique Nash equilibrium; strategies are dominant, outcome is Pareto efficient

Politeness

Care only about the comfort of our fellow passengers

Polite Bus Seating Game the payoffs are

	Sit	Stand
Sit	2,2	0,3*
Stand	3*,0	1*,1*

Unique Nash equilibrium, strategies are dominant – the outcome is bad for everyone

Better not Perfect People

- assertion is not “If we were all perfect people the world would be a better place”
- It is “if we were all better people the world would be a better place.”
- central idea – changes in payoffs due to greater altruism can change incentives so as to lead to a less favorable equilibrium true more broadly

Pride Game

Repeated Prisoner's Dilemma with discount factor 9/10

	Grim	Not Confess	Confess
Grim	100*,100*	100,100*	9,38
Not Confess	100*,100	100,100	-90,200*
Confess	38,9	200*,-90	20*,20*

Pride game: instead of *Grim* there is *Tough* where you get a bonus of 15 at a cost to your opponent of 35

	Tough	Not confess	Confess
Tough	80*,80*	115,65	24*,3
Not confess	65,115	100,100	-90,200*
Confess	3,24*	200*,-90	20,20

Unique Nash equilibrium at tough-tough everyone gets 80

Better People

Weight of two on my selfish utility, weight of one on yours

for example, in Pride Game, if I get 65 and you get 15 then in the *Altruistic Pride Game* I get $2 \times 65 + 115 = 245$

payoffs in Altuistic Pride Game

	Alt-Grim	Not Confess	Confess
Alt-Grim	240,240	295,245*	51,30
Not Confess	245*,295	300,300	-20,310*
Confess	30,51	310*,-20	60*,60*

Unique Nash equilibrium at confess-confess: Everyone is unambiguously worse off

based Hwang and Bowles [2009]: more persuasive model and backed by experimental evidence

Voter Participation

- the “rational” view of voter participation is widely used in theory
- equally widely viewed as controversial
- “the 'paradox' of voter turnout”
- turnout in large election seems high relative to the probability of being pivotal

The Model

based on the Palfrey and Rosenthal (1985)

voters, divided into two groups, supporters of candidate A, supporters of candidate B

population sizes: 3, 9, 27, 51 (odd numbers divisible by 3)

drop the Palfrey and Rosenthal assumption that two groups are equal size

size of group A is N_A (minority, underdog)

the size of group B is $N_B > N_A$ (majority, frontrunner)

sizes common knowledge to voters

each electorate size: two subtreatments

landslide $N_B = 2N_A$; tossup $N_B = N_A + 1$

The Game

voting rule: simple plurality

voters decide simultaneously to vote for preferred candidate or abstain

candidate with votes wins election, ties broken randomly

incentives

if A wins all members of group A receive reward of H; all members of group B receive reward L<H

if B wins all members of group B receive reward of H; all members of group A receive reward L

rewards are common knowledge: L=5, H=105

voting is costly, and the voting cost is private information

distribution from which costs are drawn are integers drawn uniformly on [0, 55]; this is common knowledge

Protocol

get to play each game 50 times, randomly assigned to a group

instructions read aloud so everyone could hear, and Powerpoint slides were projected in front of the room to help explain the rules and to make all the common knowledge to the extent possible

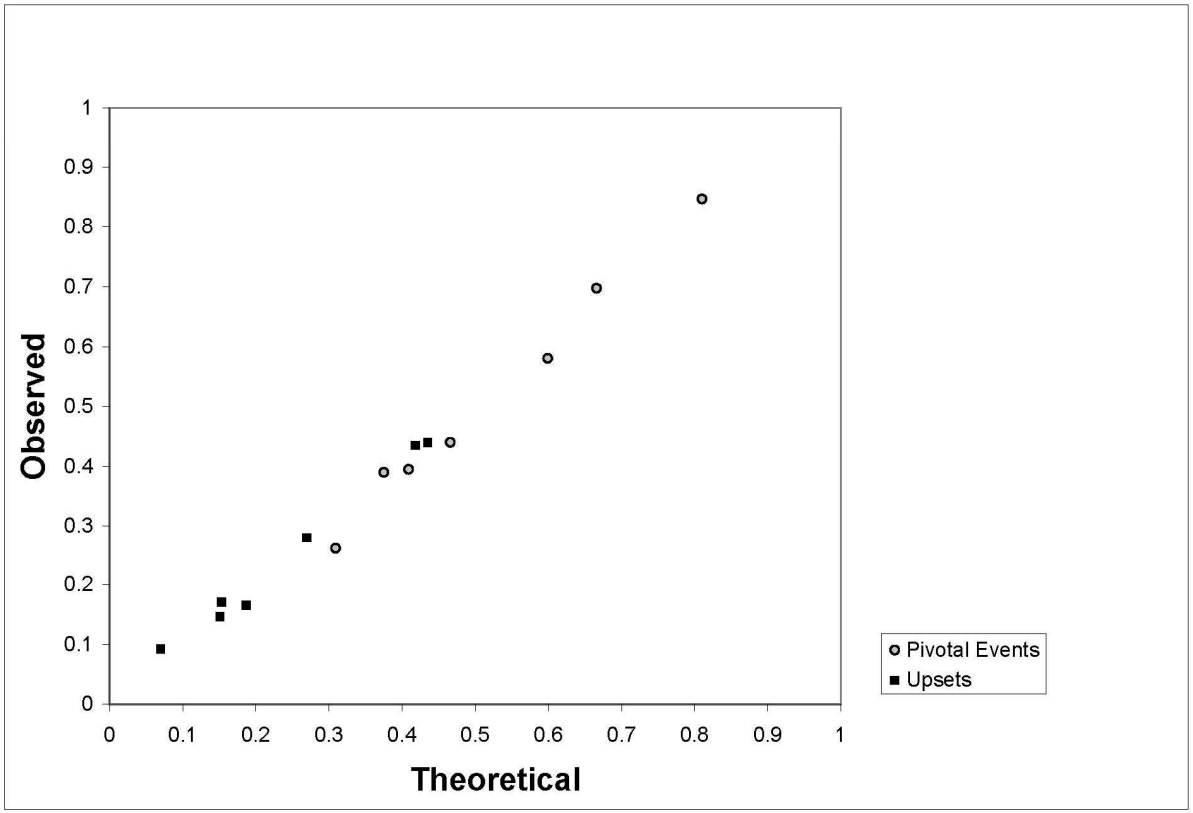
after instructions were read, subjects were walked through two practice rounds with randomly forced choices and required to correctly answer all questions on a computerized comprehension

after first 50 rounds, a short set of new instructions were read aloud, explaining that the sizes of group and group would be different for the next 50 rounds

wording written to induce as neutral an environment as possible

no mention of voting or winning or losing or costs

Results


Observed
Theoretical
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Pivotal Events
Upsets

Competitive Markets

economists generally study trade taking place in markets

former Presidential advisor, N. Gregory Mankiw writes

> New Keynesian economists, however, believe that market-clearing models cannot explain short-run economic fluctuations [2010]

experimental evidence: easy to identify what settings are competitive; in these settings we observe exactly the price that economists expect based on theory.

Roth et al 1991

simple market auction with nine identical buyers

each bids on object worth nothing to seller and worth $10.00 to a successful buyer

seller accepts earns the highest price offered

buyer selected from the winning bids by lottery earns difference between the object's value and the bid

10 different market rounds with a changing population of buyers

bids must be in increments of five cents.

Theory

highest bid x

you bid x a tie, you can earn at most $(\$10 - x)/2$

raise the bid by a nickel you can earn $\$9.95 - x$

if $x < \$9.90$ better to raise by a nickel

if $x < \$10$ you never want to bid less than x since a share of something is better than nothing

if everyone else bids $\$9.90$ better to bid $\$9.95$ and get five cents for yourself, rather than a 1/9th share of ten cents

So: at a Nash equilibrium winning bid has to be at least $\$9.95$ and cannot be more than $\$10.00$

Laboratory Results

After seven auctions the price was $9.95 or $10.00 in *every* case – and in most cases this happened long before the seventh try.

Competitive Equilibrium

- key feature of this auction: no individual buyer can have much impact on the price – everyone else is bidding $9.95 or $10.00 question for a buyer is not about changing the price, but rather willingness to buy given that price
- the idea market participants can have little impact on prices is central to the economic theory of competitive markets
- an important variation on Nash equilibrium: competitive equilibrium
- traders in markets choose their trades ignoring whatever small impact they may have on market prices
- competive equilibrium occurs at prices that reconcile the desire of suppliers to sell with consumers to buy
- modern economic theory recognizes the particular way in which prices are adjusted is not so important

Mechanism Design Theory

game theory takes the game as given

mechanism design theory asks: how might we design a game to achieve some desired social goal?

from mechanism design perspective an auction is one of many price setting mechanisms

an auction is a mechanism that acts to reconcile demand with supply – to clear the market

many mechanisms do this: electronically as done by the Chicago Board of Trade, or by shouting out orders as on the New York Stock Exchange

all these mechanisms are equivalent in that they perform the same function of clearing markets, and the exact details are of no great importance

A Producer Game

a simple market with five suppliers

each supplier faces a cost of producing output given by the following table

Units produced	Cost
0	0
20	905
40	1900
60	3000
240	17000

Profit Maximization

profit of a firm is revenue from sales minus cost

using calculus for any price we can work out the profit maximizing output

Price	Profit Maximizing Output	Corresponding Industry Output
100	240	1200
90	198	990
60	72	360
30	0	0
10	0	0

A Remark on Computation

business people do not generally choose their production plans by using calculus.

they weight the cost of hiring a few more workers against the additional revenue from a few more sales and decide whether or not to expand – or shrink – their operation

in the end they get exactly the same result as we do using calculus.

Demand

price consumers are willing to pay depends on number of units for sale, given by:

Units for sale	Price
0	100
180	80
360	60
630	30
900	0

Competitive Equilibrium

to decide how much to produce firms must guess what price they will face

competitive market clearing equilibrium (rational expectations or perfect foresight equilibrium) means they guess correctly

inspecting table for profit maximization – the supply

and table for consumer willingness to pay – the demand

when price is 60 consumers wish to purchase 360 units, and firms wish to provide this same number

60 is the price that “clears the market” or the “competitive equilibrium price”

the corresponding output of firms is 72 each

Strategic Naivety

in competitive equilibrium firms are strategically naïve

they ignore the fact that by producing less there will be less supply and consumers will be willing to pay more resulting in a higher profit

each firm is only 20% of the market: ability of each firm to manipulate prices is not large, but not zero

apply theory of Nash equilibrium so that each firm correctly anticipates the choices of their rival firms

Nash: firms produce less – 63 instead of 72

price is higher: 65 rather than 60

not a huge difference, so competitive equilibrium is a reasonable approximation even with as few as five firms

A Behavioral Model

real people are not unboundedly rational

can't be expected to rationally forecast "equilibrium" prices

suppose instead that firms forecast prices next period to be whatever prices were last period

a widely used "modern" behavioral model of "adaptive expectations"

not a new model to economists: commonly used by economists before the rational expectations revolution

Behavioral Predictions

If starting price is 90 firms will wish to produce 990 units of output

consumers not willing to buy so many units, so price falls to 0

at a price of 0 firms aren't willing to produce anything

now price rises to 100

following period the industry produces 1200

cycle continues with market alternating between overproduction leading to a zero price, then underproducing leading to a price of 100

the "cobweb" model

we might also call it the "business cycle"

or we could say as Karl Marx does that this is the self-destructive nature of the capitalist system: flooding the market with cheap goods and then falling into recession

Which Theory is Correct?

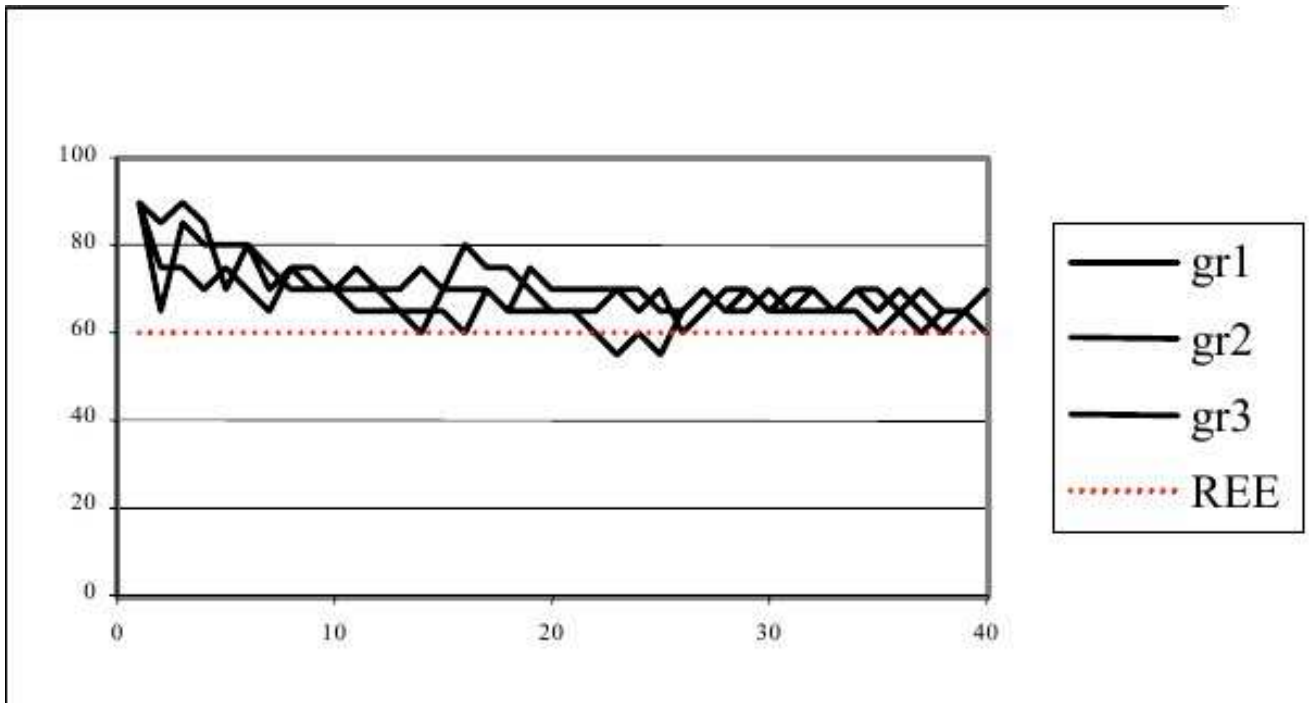
Sutan and Willinger [2004] implemented this game in the laboratory with real subjects playing for real money

participants had an opportunity to play 40 times

this was done with three different groups of participants

Experimental Results

Price in the experimental market plotted against time



REE = competitive/rational expectations equilibrium

Summary

- after about the first ten periods prices fluctuate within relatively narrow band
- “equilibrium” price is generally higher than the rational expectations competitive price of 60
- Sutan and Willinger view this as a minor contradiction of economic theory
- subjects are cleverer here than the experimenters: the price is essentially the Nash equilibrium price of 65
- behavioral theory does about as badly as a theory can. The average price according to the behavioral theory is 50 – much lower than the actual market price which is always above 60 – and prices do not cycle from one period to the next – let alone cycle from 0 to 100.

Bounded Rationality?

- no doubt true that people do not have unbounded rationality
- unfortunately we have only very simple and naïve models of bounded rationality
- people are very good at learning
- even very sophisticated computer programs produced over many years by very skilled computer scientists working on artificial intelligence are much less capable of learning than even small children
- “behavioral” models of “bounded rationality” such as expecting next period to price to equal this period price are extremely simplistic
- the quantitative question: is a model of unbounded rationality or an extremely primitive model of learning a better approximation to reality?
- in this experiment the model of unbounded rationality is vastly better

Market Experiments

- results by no means atypical
- experiments on competitive equilibrium have been conducted many times
- earliest go back to Vernon Smith in 1962
- not obscure work: he won a Nobel prize for it
- most experiments involve real paid subjects in the role of both buyer and seller
- results are highly robust
- competitive equilibrium predicts the outcome of market experiments with a high degree of accuracy, with experimental markets converging quickly to approximately the competitive price

Beauty Contest

- John Maynard Keynes: hero to critics of economics
- nobody believed more strongly that economics was governed by forces of irrationality
- stock markets, in particular, Keynes believed were driven by mysterious animal spirits of investors
- Keynes theory of stock markets in Chapter 12 of his 1936 *General Theory*
- investors want to buy stocks because they think that other investors like those stocks
- analogy to his *beauty contest* game

Keynes Beauty Contest Game

- players must choose the most beautiful woman from six photographs
- players who pick the most popular face win
- a rather boring coordination game: every face is a Nash equilibrium
- doubtful that this is really how stock markets work
- Keynes made a fortune for King's College Cambridge through his stock market investments
- at various times he also lost a fortune
- if he had stepped down as Bursar at a different time his name would be as infamous there as it is today famous

Rosemarie Nagel's Beauty Contest

In 1995 Rosemarie a simple variation of Keynes beauty contest examined experimentally

players choose a number between 0 and 100

players getting the closest to half the average value of the choices win

what you want to do depends on what you think average opinion is

if you think that people choose randomly, the average should be 50, so you would win by guessing 25

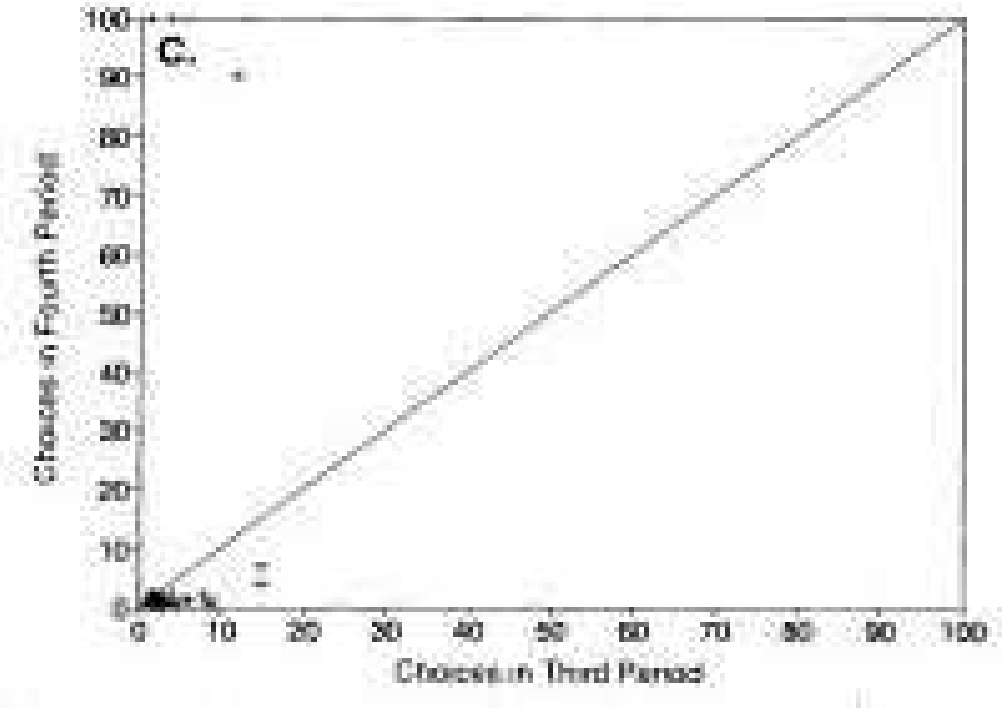
Unlike Keynes beauty contest, this game has (almost) a unique Nash equilibrium

any average greater than 0 can't be an equilibrium since everyone would want to guess less

the equilibrium is either for everyone to guess 0 or to all guess 1

Experimental Results

choices the third (horizontal) and fourth time (vertical) the game was played.



How Long Does it Take to Adjust to Rule Changes?

The Hijacking Game (from Wikipedia)

Before September 11, 2001 pilots and flight attendants were trained in the FAA approved "Common Strategy"

- comply with hijackers' demands, land safely, let security forces handle situation
- advise passengers to sit quietly in order to increase chances of survival
- do not be a hero and endanger the passengers

the longer a hijacking persisted of a peaceful ending

1988-1997 an average of 18 hijackings per year, the vast majority ending peacefully

well-established, successful procedure, well validated by experience

The Rule Change:September 11, 2001

8:46 am: American Airlines Flight 11 crashes into the North Tower of the World Trade Center

9:03 am: United Flight 175 crashes into the South Tower of the World Trade Center

9:28 am: United Airlines Flight 83 is hijacked

9:37 am: American Airlines Flight 77 crashes into the West side of the Pentagon

9:57 am: passengers on United Airlines Flight 93 assault hijackers

So: an hour and 11 minutes

Since that time passengers have resisted essentially all hijackings