Lecture 4
Efficiency of Markets and Market Failure

Macroeconomics (Quantitative)
Econ 101B

Jón Steinsson
University of California, Berkeley

Age of Capitalism

- What is the appropriate role of markets in society?
  - Question central to economics
  - Highly charged and frequently debated
- What are the intellectual justifications for free market capitalism?
  - Freedom: Free market capitalism is a system based on a great deal of individual freedom. Freedom is good in and of itself.
  - Material well-being: Free market capitalism generates more material well-being than other systems of organizing the economy

Designing Utopia

- Our goal: Design a government – laws, regulation and institutions – that is as good as possible in terms of generating material well-being
- Two challenges:
  - **Information challenge**: How do we figure out what to produce, who should produce it, and who should consume it?
  - **Incentive challenge**: Even if we know what needs to be done, how do we get people to do these things?

Different Ways to Organize Societies

- Families / Villages / Tribes
  - Kin-based altruism, tit-for-tat, loyalty to group
  - Respect for authority and existing hierarchies
- Larger societies:
  - Raw coercion, respect for authority and existing hierarchies
  - Society very rigid / No solution to information challenge
- Is there another way?
  - Central planning? Something else?

Adam Smith's Radical Idea

- How about if we simply:
  - Grant the individuals of society freedom to choose themselves what they produce and consume
  - Allow then to engage in free exchange of goods and labor to realize these choices
- Smith argued:
  - Such freedom might in many circumstances lead to better social outcomes than more directed, coercive, and centrally controlled economic management

Surprising Result

- Free-market capitalism can attain high level of material well-being without relying **at all** on:
  - Altruism, group loyalty, respect for existing hierarchies
  - Planning and centralized control
- Perhaps the most surprising and interesting idea in all of economics
- Economics is mostly “organized common sense”.
- But the idea of the laissez faire policy can do as well as an ominous/omnipotent/benevolent central planner is for from obvious

A Formal Model

- To grasp these ideas better, it is useful to write down a formal model
- We begin by describing only the physical environment
  - No assumptions about institutions such as markets, laws, property rights, etc.
- Derive what is efficient
- Then show that competitive markets deliver this outcome

Simplest Possible Setting

- Two consumers:
  - Robinson Crusoe (R) and Friday (F)
- Two inputs to production:
  - Labor (L) and land (N)
- Two outputs:
  - Coconuts (C) and shelter (S)
- Two technologies:
  - One produces coconuts, the other shelter

Endowments and Technology

- Robinson Crusoe and Friday start off with endowments of time (ω_T) and land (ω_N)
  - Time can be used either for labor or leisure
- They also have access to knowledge of the two technologies:
  - Production function for coconuts:

$$Y_C = F_C(L_C, N_C)$$

  - Production function for shelter:

$$Y_S = F_S(L_S, N_S)$$

Preferences

- We represent the preferences of Robinson Crusoe and Friday by utility functions
- Robinson Crusoe's utility function:

$$U_R\left(X_{C,R}, X_{S,R}, X_{Z,R}\right)$$

  - $X_{C,R}$ denotes the consumption of coconuts by R
  - $X_{S,R}$ denotes the consumption of shelter by R
  - $X_{Z,R}$ denotes the "consumption" of leisure by R
- Friday's utility function:

$$U_F\left(X_{C,F}, X_{S,F}, X_{Z,F}\right)$$

An Allocation

- We define an allocation as some particular outcome for all endogenous quantities:
  - Inputs used: L_C, L_S, N_C, N_S
  - Output produced: Y_C, Y_S
  - Consumption: $X_{C,R}, X_{C,F}, X_{S,R}, X_{S,F}, X_{Z,R}, X_{Z,F}$
- Notices that there are no prices yet since we have not introduced any markets
- Also, no-one owns anything at the moment.

A Feasible Allocation

- We define a feasible allocation as an allocation that satisfies all constraints imposed by the physical environment
  - Land use: $N_C + N_S = \omega_N$
  - Time use: $L_C + L_S + X_{Z,R} + X_{Z,F} = \omega_T$
  - Consumption of coconuts: $X_{C,R} + X_{C,F} = Y_C$
  - Consumption of shelter: $X_{S,R} + X_{S,F} = Y_S$
  - Production functions: $Y_C = F_C(L_C, N_C)$ and $Y_S = F_S(L_S, N_S)$

Efficient Allocation

- Our goal is to describe the efficient feasible allocation (efficient allocation for short)
- How do we define what is efficient?
- Efficiency refers to lack of waste
- Since our ultimate aim is utility of people, we define efficiency in terms of whether we are squandering opportunities to make someone better off without making anyone else worse off

Pareto Efficiency

- Informally: An allocation is Pareto Efficient (or Pareto Optimal) if no one can be made better off without making someone else worse off.

- Formally: Allocation A is Pareto Efficient (or Pareto Optimal) if no other feasible allocation B exists such that $U_{i,B} \geq U_{i,A}$ for all i and $U_{i,B} > U_{i,A}$ for at least one i.

Pareto Improvement

- An allocation A is said to be a Pareto improvement over allocation B if someone is better of under allocation A but no one is worse off
- In this case, allocation B is said to be Pareto inefficient.

Pareto Efficiency: Example

- Government builds a bridge
  - People pay tolls. Tolls pay for bridge
  - Potential Pareto improvement
  - Why only potential?
  - Perhaps bridge diverts traffic and business away from some stores. Owners worse off.
  - Perhaps noise or shadow from bridge adversely affects neighbors of bridge
  - How can this be fixed? (in principle)

The “Weakness” of Pareto Efficiency

- Pareto efficiency is a rather “weak” concept
- Many Pareto efficient allocations:
  - Consider an allocation where one agent gets all the resources.
  - This is Pareto efficient since all other allocations make them worse off
- Many allocations that cannot be Pareto ranked
- Pareto efficiency does not concern itself at all with distributional issues

Utilitarian Optimal Outcome

- Add up everyone's utility (weighted sum):

$$\theta_R U_R\left(X_{C,R}, X_{S,R}, X_{Z,R}\right) + \theta_F U_F\left(X_{C,F}, X_{S,F}, X_{Z,F}\right)$$

- Rank allocations by this weighted sum
- Allocation that maximizes this weighted sum is utilitarian optimal outcome
- Can taking from the rich and giving to the poor improve welfare from this perspective?
  - Yes. Since poor have higher marginal utility
  - But if you start systematically doing this, you may weaken incentives to work ("reduce the size of the pie")
- This is **NOT** our definition of efficiency

Conditions for Pareto Efficiency

1. Exchange Efficiency
   - There cannot be any scope for mutually advantageous trade in final goods
2. Production Efficiency
   - There cannot be any scope for Pareto improving reallocation of factors of production between their different uses.

Exchange Efficiency

- Say we start with a candidate efficient allocation, which we denote by * (e.g., $X^*_{C,R}$)
- Let's consider variations on this allocation to test whether we can find another allocation that does better
- How about taking some shelter from Friday and giving it to Robinson Crusoe?
- Could this be a Pareto improvement?
- No!! (Friday would never agree to this)

Exchange Efficiency

- Suppose, instead, that we:
  - Take ε units of shelter from F and give to R and in exchange take $\eta\varepsilon$ coconuts from R and give to F
  - Here η is the number of coconuts per unit of shelter in this "exchange"
- If the initial allocation is Pareto efficient, this variation cannot make one of them better off without making the other worse off

Exchange Efficiency

- Useful notation:

$$U^*_{R,C} = \frac{\partial}{\partial X_{R,C}} U_R\left(X^*_{C,R}, X^*_{S,R}, X^*_{Z,R}\right)$$

  - I.e. $U^*_{R,C}$ denotes the partial derivative of U_R with respect to $X_{C,R}$ at the point $\left(X^*_{C,R}, X^*_{S,R}, X^*_{Z,R}\right)$
- We will use the same type of notation for other partial derivatives of both the utility functions and the production functions

Exchange Efficiency

- Robinson Crusoe‘s utility:
  $U_R\left(X^*_{C,R} - \eta\varepsilon, X^*_{S,R} + \varepsilon, X^*_{Z,R}\right)$
- Let’s differentiate Robinson Crusoe’s utility with respect to ε and evaluate at $\varepsilon = 0$:
  $$\frac{dU_R}{d\varepsilon} = -U^*_{R,C}\eta + U^*_{R,S}$$

- Friday‘s utility:
  $U_F\left(X^*_{C,F} + \eta\varepsilon, X^*_{S,F} - \varepsilon, X^*_{Z,F}\right)$
- Let’s differentiate Friday’s utility with respect to ε and evaluate at $\varepsilon = 0$:
  $$\frac{dU_F}{d\varepsilon} = U^*_{F,C}\eta - U^*_{F,S}$$

Exchange Efficiency

- How should be choose η?
  - Very big or very small won't work
  - One of them worse off
- Let's choose it so as to make Robinson Crusoe indifferent to the change
- Why is this a good choice?
  - In that case, the change is a Pareto improvement if (and only if) it makes Friday better off!

$$\frac{dU_R}{d\varepsilon} = -U^*_{R,C}\eta + U^*_{R,S} = 0$$

$$\eta = \frac{U^*_{R,S}}{U^*_{R,C}}$$

Exchange Efficiency

- Let's now plug this value for η into the marginal change in Friday's utility

$$\frac{dU_F}{d\varepsilon} = U^*_{F,C}\frac{U^*_{R,S}}{U^*_{R,C}} - U^*_{F,S}$$

- What must be true about this expression if the initial allocation is Pareto efficient?
  - It must be equal to zero (i.e. the derivative of Friday's utility with respect to ε must be zero at the optimum)
  - Otherwise beneficial to do either a positive or negative amount of the proposed "exchange"

Exchange Efficiency

- Exchange efficiency therefore implies:

$$\frac{dU_F}{d\varepsilon} = U_{F,C}^* \frac{U_{R,S}^*}{U_{R,C}^*} - U_{F,S}^* = 0$$

$$\frac{U_{F,S}^*}{U_{F,C}^*} = \frac{U_{R,S}^*}{U_{R,C}^*}$$

Exchange Efficiency

$$\frac{U^*_{F,S}}{U^*_{F,C}} = \frac{U^*_{R,S}}{U^*_{R,C}}$$

- $U^*_{F,C}$ is utility F gets from one extra coconut
- $U^*_{F,S}$ is utility F gets from one extra unit of shelter
- $1/U^*_{F,C}$ coconuts give F one “util”
- $U^*_{F,S}/\ U^*_{F,C}$ coconuts give F $U^*_{F,S}$ “utils”
- $U^*_{F,S}/\ U^*_{F,C}$ is # of coconuts that F is willing to give up to get 1 extra unit of shelter (marginal rate of substitution)

Exchange Efficiency

$$\frac{U^*_{F,S}}{U^*_{F,C}} = \frac{U^*_{R,S}}{U^*_{R,C}}$$

- Intuition: # of coconuts R would be willing to give up for an extra unit of shelter must be same as for F. Why?
- Otherwise there is scope for mutually advantageous trade
- Suppose $U^*_{F,S}/U^*_{F,C}$ = 4, while $U^*_{R,S}/U^*_{R,C}$ = 2. Why is this not an efficient outcome?
- If F offers R 3 coconuts in exchange for 1 unit of shelter, both are made better off.

Production Efficiency

- Variation: Robinson Crusoe works ε more hours on gathering coconuts and gets to keep the proceeds
- Marginal Benefit? $U^*_{R,C}F^*_{C,L}$
  - Here $F^*_{C,L}$ denotes the partial derivative of F_C with respect to L at the allocation *
- Marginal Cost? $U^*_{R,Z}$
- Optimality necessitates? $U^*_{R,C}F^*_{C,L} = U^*_{R,Z}$ or $\frac{U^*_{R,Z}}{U^*_{R,C}} = F^*_{C,L}$

Production Efficiency Intuition

$$\frac{U_{R,Z}^*}{U_{R,C}^*} = F_{C,L}^*$$

- Intuition: # of coconuts R is willing to give up for an extra hour of leisure must equal # of coconuts one can produce using an extra hour of labor
- Otherwise R can be made better off by working either more or less
- Suppose $\frac{U_{R,Z}^*}{U_{R,C}^*} > F_{C,L}^*$. Why is this not efficient?
- This means that R is working too much since the last hour he worked only yields $F_{C,L}^*$ coconuts but costs him as much utility as giving up $U_{R,Z}^*/U_{R,C}^*$ coconuts

Production Efficiency

- Similar arguments yield similar conditions for
  - Robinson Crusoe working more/less on shelter
  - Friday working more/less on coconuts
  - Friday working more/less on shelter
- These conditions are listed in draft chapter

Efficient Use of Land

- What about land use? How much land is it efficient to use?
- We assumed (for simplicity) that land has no alternative use. So, they might as well use all the land for coconut and shelter production.
- Only question is how to divide up the land between coconut and shelter production
- What condition must hold for the division of land between coconut and shelter production to be efficient?

Efficient Use of Land

- Variation: Suppose R transfer ε acres of land away from coconut production towards shelter production
- Marginal benefit: $U^*_{R,S}F^*_{S,N}$
- Marginal cost: $U^*_{R,C}F^*_{C,N}$
- Efficiency necessitates?

$$U^*_{R,S}F^*_{S,N} = U^*_{R,C}F^*_{C,N} \quad \text{or} \quad \frac{U^*_{R,C}}{U^*_{R,S}} = \frac{F^*_{S,N}}{F^*_{C,N}}$$

Pareto Efficiency

- Exchange efficiency
- Production efficiency
- Efficient land use (part of production efficiency)

- These are all the conditions that need to hold for an allocation to be Pareto efficient

Conditions for Efficiency

- Exchange Efficiency:

$$\frac{U^*_{F,S}}{U^*_{F,C}} = \frac{U^*_{R,S}}{U^*_{R,C}}$$

- Efficient use of land:

$$\frac{U^*_{R,C}}{U^*_{R,S}} = \frac{F^*_{S,N}}{F^*_{C,N}}$$

- Production efficiency:

$$\frac{U^*_{R,Z}}{U^*_{R,C}} = F^*_{C,L}$$

(and analogous conditions for F and S)

Pareto Efficient Allocation

- How can we bring about this outcome?

1. Central Planning
   - A benevolent, omniscient, omnipotent central authority could achieve this allocation by directive
   - I.e, they would calculate what the optimum was and tell everyone they have to do that or else they will be shot
     (less extreme measures might work)

- Is there an alternative?

Markets

- Suppose there is a competitive market where R and F can exchange coconuts for shelter
  - Competitive means that all agents in the economy take prices as given (and markets clear at those prices)
- Let's denote the price in this market as p coconuts per unit shelter (so coconuts are the numeraire)

Product Market

- What will Robinson Crusoe do in this market?
  - $U_{R,S}/U_{R,C}$ is marginal benefit of buying shelter (in units of coconuts)
  - p is marginal cost of buying shelter (in units of coconuts)
  - Robinson Crusoe will set these equal to each other. I.e., trade shelter for coconuts until:

$$\frac{U_{R,S}}{U_{R,C}} = p$$

Product Market

- What will Friday do in this market?
  - Also trade shelter for coconuts until:

$$\frac{U_{F,S}}{U_{F,C}} = p$$

- What does this imply about exchange efficiency?

$$\frac{U_{F,S}}{U_{F,C}} = p = \frac{U_{R,S}}{U_{R,C}}$$

- A competitive market for trading shelter for coconuts, thus, yields exchange efficiency in shelter versus coconuts!

Labor Market

- Suppose there is a competitive labor market with a wage denoted by w (coconuts per hour worked)
- What will Robinson Crusoe do?
  - Marginal benefit of work: w (in units of coconuts)
  - Margin cost of work: $\frac{U_{R,Z}}{U_{R,C}}$ (in units of coconuts)
- Robinson Crusoe will:
  - Supply labor until $\frac{U_{R,Z}}{U_{R,C}} = w$
- Friday will do the same
- What will owner of coconut technology do?
  - Marginal benefit: $F_{C,L}$
  - Marginal cost: w
  - Owner will demand labor until $w = F_{C,L}$

Labor Market

- A competitive labor market will therefore yield production efficiency

$$\frac{U_{R,Z}}{U_{R,C}} = w = F_{C,L}$$

- Same logic for other production efficiency conditions

Land Market

- Suppose there is a competitive rental market for land with a rental rate r (in terms of coconuts per acre of land)
- What will coconut producers do?
  - Demand land until $F_{C,N} = r$
- What will shelter producers do?
  - Demand land until $pF_{S,N} = r$

$$pF_{S,N} = F_{C,N}$$

$$\Rightarrow \frac{U_{R,S}}{U_{R,C}} F_{S,N} = F_{C,N}$$

$$\Rightarrow \frac{U_{R,S}}{U_{R,C}} = \frac{F_{C,N}}{F_{S,N}}$$

- A competitive land market will therefore yield efficient allocation of land

Competitive Markets Can Achieve Efficiency

- Goods market yields exchange efficiency:

$$\frac{U_{F,S}}{U_{F,C}} = p = \frac{U_{R,S}}{U_{R,C}}$$

- Labor market yields production efficiency:

$$\frac{U_{R,Z}}{U_{R,C}} = w = F_{C,L}$$

- Land market yields efficient use of land:

$$pF_{S,N} = r = F_{C,N} \Rightarrow \frac{U_{R,S}}{U_{R,C}} = \frac{F_{C,N}}{F_{S,N}}$$

First Welfare Theorem

- If:
  - Everyone is able to choose what is best for themselves among the set of options they have
  - Competitive markets for all goods and services (both inputs and output) exist
  - Property rights over all goods and services are well defined and costlessly enforceable
- Equilibrium will be Pareto efficient
- This result is called the First Welfare Theorem

First Welfare Theorem

- We have derived FWT for a simple example
- Can be generalize to economies with:
  - Any number of goods
  - Multiple periods (if all people exist at all times)
  - Uncertainty (as long as information is “symmetric”)

Remarkable Results

- Milton and Rose Friedman:
  “Adam Smith’s flash of genius was his recognition that the prices that emerged from voluntary transactions between buyers and sellers … could coordinate the activity of millions of people, each seeking his [or her] own interest, in such a way as to make everyone better off. It was a startling idea then, and it remains one today.”

Ideal Free Market Capitalism

- With competitive markets and well defined property rights: No one can rip off anyone else!!
- Competition keeps everyone in check
  - Everyone is paid their marginal product
  - All goods are priced at marginal cost
- E.g., labor market:
  - Competition between firms bids wage up to marginal product
  - Competition between workers bids wage down to marginal product

Implications for Role of Government?

- If markets are “complete” and “perfect”, and property rights are well defined and costlessly enforceable, *laissez faire* government policy yields a Pareto efficient outcome

- Even if we are concerned with redistribution, the *only* necessary government policy is an initial redistribution of wealth. (Second Welfare Theorem discussed in chapter)

“Only”

- Low cost enforcement of property rights and contracts and maintenance of institutions needed for competitive markets NOT easy
- “Let the market take care of things” is an illusion.
- Need to work hard to create maintain competitive markets

Conditions for Efficiency

1. "Complete" and "perfect" markets for all goods (First Welfare Theorem)
   - In our simple setting, market for labor, land, coconuts and shelter
   - In real world, markets for every conceivable thing
   - Huge "institutional" requirement

Or:

2. No impediments to private contracts (Coase theorem)
   - Even with no "markets" if Crusoe and Friday could costlessly negotiate and enforce private contracts they should arrive at an efficient outcome
   - Also large institutional requirement (enforcement of contracts)

- In both cases: Government must exist to enforce property rights and contracts. "Perfect courts" needed.

Flip Side of the Coin

- If conditions of “First Welfare Theorem” or “Coase Theorem” are not satisfied, markets / voluntary exchange will not yield an efficient outcome
- We will refer to deviations from the conditions needed for the First Welfare Theorem as market failures
- Main sources of market failures:
  - Monopoly, public goods, transactions costs, asymmetric information, imperfect rationality, commitment problems, price and wage rigidity, missing market

Typical Argument about Economic Policy

- Issue: Should government do X?
- Free market advocate:
  - Markets can take care of X
  - Voluntary exchange can take care of X
- Very powerful argument rhetorically
- One way a skeptic of laissez faire can potentially win argument is by pointing out a market failure and explaining how government can resolve the market failure