MBA 405B

Handout for Lecture 6

Cooperation and coordination

The topic of this lecture is cooperation and coordination. We will consider how agents organize themselves and how institutions affect this. We will pay special attention to whether these organizations are efficient or not.

Markets

Markets are one of the leading ways that we coordinate economic activity. Adam Smith remarked that:

"It is not from the benevolence of the butcher, the brewer or the baker that we expect our dinner, but from their regard to their own self-interest"

He proposed that markets were like an invisible hand that leads each individual to promote the common good through seeking his own welfare.

This is a very appealing idea that suggests that supply and demand adjust prices so that goods are produced in the cheapest possible way, and are allocated to their highest value uses.

Consider the problem of how to produce and use corn. A farmer has to decide what to plant on this land. How does he decide? He looks at the price he can get for corn, and counts the costs of the resources (gas, fertilizer, pesticide, time, machinery) needed to produce it. He then makes the same calculation for soybeans, wheat, shopping malls and so on and chooses the most profitable crop. Which farmers choose to produce corn at the end of the day? Only those who can do it most cheaply. That is, only those whose land it most suited for corn given the alternatives uses.

Suppose we want more corn; then raising the price gets the next most efficient farmers to switch out of their intended crop to corn.

Does a farmer have to worry that the fuel he uses to grow corn cannot be used for long haul trucking? No! The price of fuel is a summery of the social value of fuel in its next best use.

If it generates more value to the farmer than to the long haul trucker, the market, through the price, automatically allocates the fuel to the farmer.

What about the demand side? Corn can be used to make tortillas, ethanol, sugar, cattle feed, and so on. The price of corn causes people to consider alternative foods, fuels, sources of sugar, and cattle feed and only use corn if it is the cheapest option. Thus, the price allocates the corn to its best use in consumption.

How would you solve these problems as a central planer? Clearly this would be extremely difficult. You would have to collect a great deal of information, issue many orders, and depend on agents in the economy to comply with your commands.

At a slightly more formal level, what economists mean when the say markets are efficient is that the resulting market allocation is *Pareto efficient.*

Pareto efficiency: A feasible allocation is said to be Pareto efficient if there is no other feasible allocation that is preferred by all agents.

That is, if we choose a different allocation, at least some agents **must** be made worse off.

Example: how may Pareto efficient ways are there to divide a dollar?

One of the big results from theoretical economics is the so-called "first welfare theorem". This is a kind of formal version of Adam Smith's insight.

First Welfare Theorem: If the market is competitive, then the market allocates goods in a Pareto efficient way.

The key here is the assumption here is that markets are competitive. Among other things, this means:

- No externalities (formally, markets are complete).
- Production and preferences are convex (in particular, no increasing returns).
- Markets are thick (many consumers and producers in each market).
- Full information.

Externalities and market failures

We now turn to the problem of what happens when markets are not competitive. First, suppose that there are externalities.

Externalities: an externality exists when the actions of one agent affect the welfare another agent outside of the price system.

Often, externalities exist because markets are incomplete.

The leading example of an externality is air pollution. Clear air is an important input for many goods, such as electricity production. A coal-fired power plant uses coal, transmission lines, labor, air (to burn the coal) and many other things to produce electricity. The key observation is that, although the plant pays for the coal and labor it uses, it does not pay for the clean air it uses up. Thus, although it uses coal and labor until the marginal cost equals the marginal benefit, the marginal cost to the power plant for air is zero. The plant therefore treats clean air as if it has no value. The problem is that is does have value, especially to agents living downwind.

How much pollution do we want? None? How much do we want to work? Not at all? The answer in each case is no. We want to work until the marginal cost of forgone leisure equals the value of what we produce. Similarly, we want to produce pollution to the point were the marginal social cost of more pollution equals the marginal social benefit of the resulting electricity.

Examples of negative externalities:	Examples of positive externalities:
Smoking cigarettes	Training your workers
Not taking a shower	Doing basic research
Driving a car in a polluted city	Volunteering your time to the needy
Driving a car on a congested highway	The nuclear umbrella
Dumping toxic waste	Fixing up you house

How do we solve this? Make agents privately realize the costs and benefits they impose or produce for others. This is called *internalizing* the externality.

Examples of how to do this are:

- Pollution taxes.
- Subsides to beneficial activities.
- Opening up markets in a nonpriced good.

Commuting, an example:

Consider the problem of a commuter deciding between taking the bus and driving his car to get to work on the New Jersey Turnpike. If the Turnpike is at capacity, then each new vehicle imposes delays on the other commuters. This is a negative externality. The book suggests a method of calculating the delay associated which each new vehicle, but let's just assume the following:

Total delay imposed by one additional car on other commuters: 30 minutes
Total delay imposed by one additional bus on other commuters: 60 minutes
Social cost of delay: $10 per hour

How do we get agents to internalize this externally? Simple: we impose a toll of $5 per car and $10 per bus.

- Would this induce all agents to get on buses?
- Is this what we want?
- Who gets on buses?
- Is this efficient?
- Is this better or worse than having a lottery to determine who has the right to use a car and who has to ride a bus?

Network externalities and Nonconvexities.

Now we consider a special kind of externality which results from increasing returns to scale, a kind of nonconvexity

Let's think about why people use Windows. It seems widely agreed that almost every well-known operating system, MacOS, and Unix in particular, are better than windows. Yet we all use windows. Why?

I like to use Windows because

- Lots of software exists.
- It is easy to transfer my files to my friends and coworkers.
- Lots of people are around who can help me if I have problems with my Windows based software.
- My students and secretaries are using Windows applications.

The driving force behind this is a very strong *Network Externality*

Network Externality: The value to each individual of being on a network (or more generally, to making a given decision) increases as the number of individuals on the network (or making the same decision) increases,

In other words, there is an increasing return (nonconvexity) in usage to a network.

Examples:

Windows
Telephones
Airlines
Keyboard systems (QWERTY vs. DSK)
VHS vs. Beta
CD players
Language
Scientific journals

The problem is that there is a kind of "lock in" effect. Once a network takes off and achieves critical mass, it is very hard to overturn it. Even if Unix is a better OS, it is not worth it for any individual to switch. Thus, bad standards that are widely used can persist under their own momentum. The market fails. Inventing a better mousetrap does no good.

We would be better off in we made a once and for all simultaneous move to better network. The problem is: how do we coordinate this?

This provides a role for regulation, government intervention, and industry wide open-standard committees.

Coordination in Politics

Suppose we have a beach that is one mile long with people uniformly distributed on its length and consider the problem facing a pair of ice cream vendors. Where should the ice cream vendors put their carts on the assumption that agents go to the closest vendor?

The problem is that they will both locate next to each other in the middle of the beach. Why? Is this the most efficient?

Now what if the beach is really the political spectrum from right to left and sunbathers are really voters? What does this imply?

A complication: suppose the beach was on an island with one-mile circumference (with a volcano in the middle)? This would be as if the right and left (Nazis and communists) met in the middle. That is, the far right and far left are essentially the same. What is the equilibrium now?

The core and stable allocations

The final topic we consider is what are the limits of cooperation. To explore this we ask what is the least that agents would be willing to accept in any given situation without deciding to strike out on their own. The fundamental concept here is called the *Core*.

In the games we have explored so far, we have treated each player as if they behaved unilaterally in seeking their best interests. In particular, we have not allowed for the possibility that agents may join together in *coalitions* to improve their power against other players.

The intuitive notion of the core is that it consists of all allocations (of money, utility, goods, or anything of value that is gained by playing the game in question) that are "proof against coalitional deviation". That is, an allocation is in the core if no group of agents can defect from the grand coalition, and using only their own resources, make each of its members better off.

To say this formally, we will need to define a *game in characteristic function form*.

Players:
$i \in (1, 2, \ldots, I) \equiv \mathbf{I}$

Coalitions:
$C \subseteq \mathbf{I}$
Coalitions are collections of agents, formally, subsets of **I**, which is the set of all agents called the *grand coalition.*

Allocations:
X_C is called an allocation for the coalition C. This is a list payoffs $(x_i, x_j, x_k, \ldots) \equiv X_C$ where i, j, k, etc. $\in$ C. Thus, this gives the payoff to each agent in C. We will denote an allocation for the grand coalition as Y_I

Characteristic Function (defines coalition values)
F : Coalitions $\rightarrow \Re$.
For example, $F(C) = 120$ means that the total payoff available to coalition C to distribute over its members is 120.

An allocation for the grand coalition Y_I is ***blocked*** by an allocation X_C for coalition C if

1. $\Sigma_{i \in C}\, x_i \leq F(C)$ (X_C is feasible for C)
2. For all $i \in C$, $x_i \geq y_i$ (all agents in the blocking coalition are at least as well off)
3. For some $j \in C$, $x_j > y_j$ (some agents in the coalition C are strictly better off)

Core: Y_I is a core allocation if it cannot be blocked.

This is all quite formal. Let's consider two examples:

Example 1:

$(1, 2, 3) \equiv \mathbf{I}$
$F(1) = F(2) = F(3) = 0$
$F(1, 2) = F(2, 3) = F(1, 3) = 1$
$F(1, 2, 3) = 2$

Observe the following:

- No agent will accept a negative payoff or else he will defect by himself.
- Every combination of two agents must get total allocation of 1 or else they should form a two-person blocking coalition and divide the surplus in a way that makes them each better off.
- The grand coalition must divide the whole surplus (thus, the any allocation in the core in Pareto optimal).

Thus:
$(y_1, y_2, y_3) = (2/3, 2/3, 2/3)$ is in core
$(y_1, y_2, y_3) = (1, 1, 0)$ is in core
$(y_1, y_2, y_3) = (1/2, 1/2, 1)$ is in core
$(y_1, y_2, y_3) = (0, 0, 2)$ is not in core
$(y_1, y_2, y_3) = (1/4, 1/2, 1\ 1/4)$ is not in core
$(y_1, y_2, y_3) = (1/2, 1/2, 1/2)$ is not in core

Example 2:

$(1, 2, 3) \equiv \mathbf{I}$
$F(1) = F(2) = F(3) = 1/2$
$F(1, 2) = F(2, 3) = F(1, 3) = 4$
$F(1, 2, 3) = 5$

Observe the following:

- No agent will accept less than 1/2 or else he will defect by himself.
- Every combination of two agents must get total allocation of 4 or else they should form a two-person blocking coalition and divide the surplus in a way that makes them each better off.
- The grand coalition must divide the whole surplus.

What is in the core? Equal division? But if each agent gets 1 2/3 as a payoff, it would be in the best interests of some pair to defect and divide the 4 they would get jointly between them. This blocks equal division. Can you propose any other allocation that can't be blocked? No! The core is empty in this case

It is even worse, it turns out. What if 1 and 2 form a coalition and divide 4 equally. Then 3 only gets a payoff of 1/2 by himself. He can offer agent 1 a payoff of 2 1/3 to defect and join him a two-person coalition, take the remaining 1 2/3 for himself and leave agent 2 out in the cold. Is this stable? No! Agent 3 can now make an offer to either of the agents in the two-person coalition that make him better off while also improving agent 3's allocation. The upshot is that nothing is stable in this case.

What is going on here? When are there stable allocations and when is the core empty? This has a technical answer, but to be less formal, the core exists if the game is *super-additive.*

Super-additivity: If the potential average payoff to each agent increases as the size of the coalition increases, then the game is supper-additive.

Moreover, the more strongly supper-additive the game, the larger the core. If a game is linearly-additive them the core is unique.

What do we learn from this?

Should I form a partnership? Only if you can propose a division of the profits that cannot be blocked. Suppose you have contacts and your two partners have technical skills. Then two years from now, your contacts will all be known your partners and they could form their own company and take all the business for themselves. You can't ask for a large share of profits as your partners will certainly defect from you in the future. Thus, maybe you should not form a partnership.

How should I pay employees? It is not simply a matter of looking at the salary each employee can make on this own. If your best engineer understands your technology and you best marketing guy knows all your customers, they could form a competitive company with high value. They had better each be paid well (or at least one of them) or else they may be tempted to strike out on their own.

- This is one motivation for stock options. If the company is valuable, the knowledge of your employees is valuable, thus, you automatically compensate them better through stock options to prevent their defection.
- You don't want any employee or group of employees from getting too valuable. If knowledge and skills are widely spread, it takes a lot of people defecting together to generate significant value as a coalition above their individual market value. Getting together large coalitions is hard.
- You also want to hold key valuable knowledge yourself to whatever degree possible. It increases your value to every coalition

Should you want your significant other to start going to the gym? The more beautiful or otherwise desirable your partner is, the better are his or her outside options. You may find yourself having to do more dishes or risk your partner leaving you. On the other hand, if you love each other, the core is large, and provided you are sharing the surplus, you are still better off as couple.

Final exam:
Wednesday, May 8, 1:30-4:30p 241 WH and 243 WH
