Introduction to International Relations
Lecture 5: Domestic Politics and Social Choice

Professor Branislav L. Slantchev
Department of Political Science, University of California – San Diego

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Overview.   We are now almost ready to begin studying international security. We have defined our methods (scientific method of theorizing and hypothesis testing), we have settled on an abstract theoretical construct (the rational actor model), and now we discuss some exceedingly important constraints that world actors have to operate under: domestic politics. We try to define what the "national interest" is, and in the process we find out that it is crucial to figure out how groups reach decisions. To our distress, we will discover that groups can often behave irrationally, and may make choices that are completely unpredictable from an analyst's point of view. We briefly look at implications of this finding, and ways of alleviating the problem.

Outline of Lecture 5: Domestic Politics and Social Choice

1. Constraints

    a) physical
    b) technological
    c) international
    d) domestic

2. National interest

    a) preferences and best way to achieve goals
    b) defined by objective factors, elites, populace

3. Collective choice

    a) preference aggregation
    b) Condorcet Paradox
    c) cycling and group irrationality
    d) agenda-setting and manipulation
    e) Arrow's Impossibility Theorem
        - universal domain
        - Pareto optimality
        - independence of irrelevant alternatives
        - non-dictatorship
    f) McKelvey's Chaos Theorem (multi-dimensional policies)
    g) real-world stability

4. Troubling implications for democracy

    a) populism
    b) liberalism
    c) deliberative democracy

The environment is among the most important components in our analyses. Recall that we define the environment in terms of the options available to decision makers, and the distribution of information among the participating actors. When we talk about options, we mean actions that one can take and actions that one may not take. In other words, we talk not only about what is possible but also about what is not, that is, we want possibilities and **constraints**.

On one hand, any actor in the international arena is going to be constrained by what is feasible physically and technologically. A leader of a poor Third World country with no access to weapons-grade radioactive material is unlikely to be able to afford to build (or purchase) a nuclear weapon. As far as this leader is concerned, possession of a nuclear device is not an option, it is unavailable for physical and financial reasons. Similarly, before 1945, the technology for nuclear weapons did not exist in a form proven to be able to deliver an explosion. Hence, prior to July 16, 1945, no country in the world possessed the ability to nuke things. This was a technological constraint that made this option unavailable to everyone. Hence, you do not hear many historians who write about World War I discussing the effect of nuclear weapons on this war. As you can easily see, the constraint can come from an option being unavailable or unattainable.

The **international constraints** that actors have to deal with have multiple sources and features, and we shall discuss many of these as we go along. For example, one's ability to win a war is constrained by the opponent's ability not to lose it. The ability of a state to engage in a sneak attack on another is limited both by possible international sanctions and the opponent's ability to detect, and perhaps prevent, such an attack. As you can see from American experience in Iraq, the international opinion demanding a role for the U.N. in the reconstruction of the country is proving to be a major constraint on the ability of the Bush administration to secure funds, pledges for debt forgiveness, and other help in rebuilding Iraq.

Today we shall concentrate on another set of constraints, this time coming from the actor's own domestic environment: public opinion, government structure, pressure groups (including NGOs), and even attitudes of important bureaucracies, to which we shall collectively refer to as **domestic constraints**. We are usually a bit more familiar with the interaction of these other actors when it comes to domestic politics (e.g. tax law, or economic policies), but far less certain about their role in formulating **foreign policy**.

Foreign policy (that is, decisions about what to do internationally, usually in places where the state has no sovereignty over) is shaped by an extremely large number of very complex factors. Many scholars spend quite a bit of time studying how foreign policy is made in various countries: who is involved, how people analyze the possibilities, what they think or believe about the goals and the consequences, and how they interact with each other. For example, recently I've been reading a book who author argues that contrary to popular opinion, our three major national security agencies (the CIA, the Joint Chiefs of Staff (JCS), and the National Security Council (NSC)) do not work even reasonably

well, and that the problem lies in the way they were organized from the get-go.[1] Others compare how policy is made across different countries and they try to infer particular characteristics of such policy that derive from the varying modes of organization of the policy-making process.

At the most fundamental level (and in keeping with the rational actor model), leaders are thought to pursue foreign policy goals (objectives) on behalf of the nation, or, as usually called, in the **national interest**. There are two things here that we should be careful about:

1. How is the national interest determined, and

2. How is the most appropriate action chosen given that national interest?

That is, as a society we probably need to agree on what our common interests are, and once we agree on that, what the best ways to achieve these interests would be.

1   The National Interest

You have all read history books and are aware of stuff you see on TV. Not a single day goes by without some pundit pontificating on air or in print about the current crises in Iraq and with North Korea, not to mention the perennial Arab-Israeli conflict in the Middle East, the economic difficulties of Latin America, the AIDS epidemic devastating Africa, or the corruption scandals rocking Europe.

All of these discussions are invariably framed in terms of preferences of the participating actors. Historians, journalists, economists, and political scientists are all intensely interested in these preferences because we all look for explanations of behavior by assuming some consistent pursuit of self-interest by these actors. Whether in trying to divine Saddam Hussein's preferences or those of the United States, we all resort to an appeal of instrumentally rational behavior to explain what goes on. ("Instrumentally rational" refers to the assumption that people pursue actions consistent with their goals. That is, people will not willingly hurt their own interests.)

For simplicity, many analysts take the state as the unit of analysis when it comes to important international events. So we talk about a Second Persian Gulf War between America and Iraq, or a crisis between the U.S. and North Korea, or bargaining for more money between Turkey and the U.S. In other words, we often take the state to be the important actor whose behavior we want to explain. It is in this context that you frequently hear the much abused and maligned term "the national interest." But what is it?

There are several possible ways we can approach the problem, and all of them have been used in international relations theory:

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[1]Amy B. Zegart, *Flawed by Design: The Evolution of the CIA, JCS, and NSC.* Stanford University Press, 1999.

- Objective interest, which overrides all other concerns whether states realize that or not. For example, realism postulates that state survival is the most important national interest and all other goals are subordinated to this one. Liberals tend to argue that the world is not such a dreadful place and that economic well-being is the most important national interest.

- Expression of elite choice. In this view, elites have specific interests that they pursue through the state apparatus, to which they have better access than ordinary people. Elites then "sell" these policies to the rest of us, inducing our choices to conform to their preferences. This works both for democracies and non-democracies (authoritarian or totalitarian regimes).

- Expression of people's choice. Proponents of democracy argue that the national interest is simply an aggregation of individual preferences. That is, each and every one of us has his or her own preferences. In a democracy, we would then use some aggregation mechanism, usually voting, to arrive at the social preference.

Of course, there is no such entity as a state when it comes to preferences. States do not have preferences, people do. The "objective" interest is really a simplifying assumption in the tradition that treats states as actors in their own right. It is also fairly narrow because it only specifies what it takes to be the most important objective and therefore may not provide much of a guidance when we want to deal with less apocalyptic issues.

The other two ways of looking at the national interest may be more helpful. Instead of postulating an objective to an abstract entity (the state), we take the national interest to be really an expression of individual preferences, whether they are elite decision-making groups or voters. In these views, a state implements the "best" policy consistent with either elite or voter preferences. The approaches tend to disagree as to who gets to decide what's "best" and whose preferences the policies will tend to reflect: those of the majority voters, of the few powerful members of the elite? However, they agree that somehow some relevant group of people has to agree on what the national interest is and how to get at it.

People have disagreements, usually vehement, on both of these issues. For example, you and I may disagree whether maintaining stable international markets is ultimately in our national interest. I, being internationally minded, may strongly believe that of America fails to keep the economy stable, it will eventually cause enormous problems domestically as well. You, being a firm agnostic about the value of globalization, may maintain that this is nonsense, and America should rely on its huge internal market and perhaps insulate itself as much as possible. There are many contentious issues in foreign policy, and what constitutes the national interest is a question that is seldom answered, although many talking heads seem to assume that it is self-evident. Quickly: is preventing the spread of Islamic fundamentalism in the national interest? Or plugging the ozone hole? Or saving hundreds of thousands AIDS victims in Africa? Or

assisting Israel against the Palestinians? Or the Palestinians against Israel? Or championing women's rights in Afghanistan? Which is more important? What about making sure Pakistan doesn't sell nuclear technology to other unsavory characters beside Lybia's Muammar Qaddafi? Or that Russia keeps its precocious bio warfare specialists from selling their services for hard currency? The list is potentially endless.

Suppose, however, that somehow we, as society, agree on what constitutes the national interest. For example, we all agree that America should strive to keep the global economy stable. We then fall into the next pit: what is the best way to do this? Should we maintain close links with repugnant regimes like the Saudi Arabia's autocrats just because they sit on the world's largest oil reserves that our European and Asian friends need so badly? Should we pursue a more hard-line policy in the Middle East to secure our ability to react to potential problems when the unpopular regimes eventually fall apart, as they must inevitably do? Or maybe we should hike up gas prices domestically so people don't drive needlessly? Or maybe we should invest heavily in fossil fuel-efficient technologies or even totally new hydrogen-based ones? Or perhaps tax the hell out of gas-guzzling SUVs that no sane person should be driving anyway? Or maybe everyone who thinks that Americans should be limited in their ability to drive tanks on highways is a goddamn Commie bastard that we should get rid of? New Yorkers and Bostonians with their nice public transportation and city lives that involve walking from place to place may be inclined to support policies that make driving costlier. But Californians and Texans who are rather spread out and who commute long distances may be much less enthusiastic. Anyway, even if we agree on the ultimate goal, we may still disagree ferociously on the methods we should use to get there.

Given all these disagreements that are bound to result from the simple fact that people are different, hold disparate beliefs, perceive the world in various ways, and have differential access to the levers of government, we should either appoint a dictator who simply implements the choices she wants (and hopefully these would be the ones she believes are for the good of the many) or else we must find a way to aggregate our disparate opinions into some sort of a **collective choice**. (Note that even if we are ruled by a small elite, an oligarchy of sorts, then the members of this ruling elite must still find a way to aggregate *their* preferences into choices that the smaller collective body will make.) Today we look at the problem of group decision-making. Whether it is the elites or the voters who get to define the national interest or the means of achieving it, each group has to arrive at some ranking of alternatives and pick the one it likes best. So how do they do that?

2 Group Decisions: Preference Aggregation

Both voters and members of the elite are individuals who have individual preferences. We shall continue to assume that individual preferences are rational. When these groups must make decisions, they have to find ways of aggregat-

ing these individual preferences into a group preference and then decide on an action consistent with this group preference.

How do groups make decisions? Well, they can certainly flip coins but there is something not quite satisfying about making important decisions randomly. Should groups depend on unanimity (consensus)? That is, should a group only make a decision when all its members agree on what it is to be? This would be best, of course, but people have different preferences and most often disagree about great many things. If we take consensus to be the necessary condition for a decision, groups will seldom do anything. So, what do we do?

We can relax the unanimity requirement and agree that we only need some fraction of the group members to concur for the decision to be made by the group. (Note that we are finessing the all-important issue as to who gets to decide membership in the group.) We can set a certain threshold that must be crossed for a decision to be made legitimately by the group. A super-majority requirement would be something like needing 80% or 60% of the members to agree. These sorts of super majorities are usually reserved for crucially important issues where one wants to make sure that if there's a dissatisfied dissident minority, it will not be too big.

We are all familiar with the simple majority rule where an alternative that garners 50% of the votes plus 1 wins. But what about deciding among more than two alternatives? Do we still require majority? No, we usually require some sort of plurality. That is, we pick the alternative that receives the largest number of votes, even though it may fall short of a simple majority.

There are other, more complicated rules, that take into account the specific composition of the group. For example, we may agree that wealthy people get more votes than poor uninformed fellow members. Or that educated people's votes weigh more heavily in the counting. Or we can give a subset of the group the right to veto the decisions.

For example, the U.N. Security Council has 5 permanent members and 10 elected members who serve on a rotational basis. Each of the 5 permanent members (U.S., Russia, China, Britain, and France) has the power to veto any decision of the Council. That is, unless all five of them agree, the Council cannot adopt any measure (well, technically, abstentions are not counted as "no" votes, so some may abstain, as Russia and China frequently do). However, for a decision to be made, the five votes are not sufficient because the rules require that at least nine of the current members of the Council vote for it. That is, for a substantive decision to be made in the SC, at least nine of the members must vote for it, and none of the five permanent members must vote against it.

To select an alternative, a group would use some sort of aggregation rule to order the group preferences according to the individual preferences of its members. Each member of the group has an **individual** preference, which we assume to be rational. The group then uses an **aggregation rule** to take all individual preferences into account and create a **social** preference. If this social ordering is rational, then it is well-defined and the group can make a logically consistent

social choice. If, however, we find out that the social preference is irrational (that is, logically contradictory), then we'd be in trouble: as with irrational individuals, we would have little idea about what the group can possibly select from the range of alternatives.

2.1 The Condorcet Paradox

Let me give you a very simple example to illustrate these things. Suppose the group consists of three people who have to decide among three alternatives. Let's go to the Cuban Missile Crisis of 1962 and suppose that President Kennedy has asked the special executive committee on national security to make a recommendation about what the U.S. should do to get the Soviets to remove the missiles from Cuba.

Simplifying things a bit, we are to consider three possibilities: a naval blockade (B), a military option (M), or a diplomatic solution (D). Let's say that the relevant people are Robert Kennedy (RFK), the Chairman of the JCS, and Adlai Stevenson (AS). We can compactly represent the situation with a table that lists each individual and his ranking of the three alternatives:

		Person		
		RFK	JCS	AS
	Best	B	M	D
Preference	*So-so*	M	D	B
	Worst	D	B	M

Clearly, a rule that requires unanimity would paralyze this group because the three members cannot agree on any of the three alternatives. Another possibility is to use majority rule in paired comparisons. That is, the group votes on every pair of alternatives and selects a winner using majority rule, which then constructs the social ordering. Let's apply this to our example:

B v. M

$$
\left.
\begin{array}{lll}
\text{RFK} & : & B \succ M \\
\text{JCS} & : & M \succ B \\
\text{AS} & : & B \succ M
\end{array}
\right\} \quad B \succ M
$$

B v. D

$$
\left.
\begin{array}{lll}
\text{RFK} & : & B \succ D \\
\text{JCS} & : & D \succ B \\
\text{AS} & : & D \succ B
\end{array}
\right\} \quad D \succ B
$$

M v. D

$$
\left.
\begin{array}{lll}
\text{RFK} & : & M \succ D \\
\text{JCS} & : & M \succ D \\
\text{AS} & : & D \succ M
\end{array}
\right\} \quad M \succ D
$$

$$\left. \right\} \quad B \succ M \succ D \succ B \succ M \succ D \ldots$$

We are in trouble now! The majority rule in binary comparisons produced the following group preference ordering: $B \succ M \succ D \succ B$. That is, the aggregation rule produced an irrational (because intransitive) preference ordering. The group seems to prefer blockade to the military option to diplomacy, and so it must prefer blockade to diplomacy. However, our result show that it also prefers diplomacy to blockade! As you can see in the ordering above, you get cycling between alternatives, which is why the phenomenon is often called **cycling**.

Why is this a problem? Because an actor with an irrational preference ordering can do anything and whatever he does will be consistent with his preferences! For example, suppose the group has to select one of the three alternatives. It selects the military option with the argument: A majority prefers the military option to diplomacy, and a majority also prefers diplomacy to blockade; therefore, the group prefers the military option to everything else.

Unfortunately, the group could recommend the blockade just as easily with the argument: A majority prefers the blockade to the military option, and a majority prefers the military option to diplomacy; therefore, the group prefers the blockade to everything else. As you can see, an analogous argument can easily produce a recommendation for diplomacy.

Individually rational preferences can lead to irrational social preferences. This has been known from quite some time and is sometimes referred to as the Condorcet's Paradox in honor of the guy who wrote about it first way back when (18th century, if you're curious). In general, as the number of group members increases and/or the number of alternatives increases, the more possibilities for irrational social preferences.

2.2 Agenda Setting

To make this clear and to illustrate an extremely troubling corollary to this result, suppose an agenda setter is selected to decide the order in which alternatives come up for vote. That is, the agenda setter would pick two alternatives and each member would then vote for its most preferred alternative of the two. The alternative that receives the majority votes wins and the losing alternative is discarded. The winning alternative is then pitted against the third remaining alternative and each member votes for the one it likes best between these two. After the second round, the alternative with the most votes wins.

Suppose in our example, President Kennedy really wanted to get the group to recommend the blockade. Without revealing his preferences, he (as the President) is picked to set the agenda for the group's voting sequence. JFK sets the following agenda: the group will first vote on M and D, and the winner of this round will be pitched against B in the second round. Since a majority prefers $M \succ D$, the winning alternative from the first round is M, and because a majority prefers $B \succ M$, the winning alternative is the blockade. So Kennedy can get

his way simply by structuring the voting sequence (agenda) for the group.[2]

Well, suppose that JFK was hawkish, and so he really wanted a military showdown with the Russians. He needs the group to recommend the military option without overtly coercing or influencing the group's members (plausible deniability). He sets the agenda as follows: the group will first vote on D and B, and the winner of this round would then be pitched against M in the second round. Since a majority prefers $D \succ B$, the winner of the first round is D; and because a majority prefers $M \succ D$, the winning alternative is the military option. So JFK can get his way again.

We are not done yet. Suppose JFK wanted to go the diplomatic route all the way and basically do nothing. He sets the agenda as follows: in the first round, alternatives B and M, and the winner goes against D in the second round. Because a majority prefers $B \succ M$, the winner of the first round is B, which is then defeated by D in the second round because a majority prefers $D \succ B$. The winning alternative is diplomacy, just like JFK wanted it to be.

We conclude that depending on the *preferences of the agenda-setter*, the group can arrive at *any of the possible alternatives* as its choice. Very troubling indeed: after all, the group is using a democratic method for making decisions; nobody was forcing individuals to vote in a way inconsistent with their preferences; and the President did not even reveal his own preference so that not to influence the voting by his prestige. Everything looks hunky-dory... but, of course, it is not. The group was manipulated just the same. And it gets worse.

3   Impossibility and Chaos

You might be tempted to discard this example as irrelevant or rare. In particular, you might wonder whether this was not an artifact of the extreme differences in player individual preferences. Or you might wonder whether another aggregation rule could have been used to guarantee rationality of the social preference.

You will be right if you thought that the problem has to do with the extreme differences among the group members. However, there is a general result that demonstrates that without restricting these preferences in some way (e.g. excluding members with "inconvenient" preferences), there exists no aggregation rule that will guarantee a rational social preference ordering unless the group simply selects a dictator and implements his rational preference ordering (recall that all individual preferences are rational).

This result is due to economist Kenneth Arrow, who won the Nobel Prize for it among other things, and is known as *Arrow's Impossibility Theorem*. The theorem asserts that given a minimal set of reasonable conditions for aggregating individual preferences, there exists no aggregation rule except dictatorship that can guarantee rational social preferences.

ARROW'S IMPOSSIBILITY THEOREM. *There exists no mechanism for ag-*

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[2]Is this power? Or manipulation? Or even coercion?

*gregating rational individual preferences into a rational social prefer-
ence ordering that satisfies the following four conditions:*

Universal Domain *The group does not exclude any preference order-
ings. (Every logically possible combination of individual orderings
is allowed.)*

Pareto Optimality *If everyone prefers an outcome, then the group
should select it.*[3]

Independence of Irrelevant Alternatives *All that is relevant for the
social ordering of any two alternatives x and y are the individual
orderings of x and y, and is independent of the individual order-
ings of x and z, for example. (For example, if Bush is preferred
to Gore, then Bush must always be preferred to Gore whether or
not we consider Nader.)*

Non-dictatorship *There is no individual whose preferences dictate
the group's preferences independent of the other members.*

The proof of the theorem proceeds by showing that if the first three condi-
tions are satisfied, then there exists a dictator in the group. That is, there exists
some individual who can change the group's preference ordering by changing
his preference ordering unilaterally.

To put it simply, any group choice mechanism (aggregation rule) that satis-
fies Universal Domain, Pareto Efficiency, and IIA is either dictatorial or does not
guarantee rationality. Note that the theorem does *not* say that the social pref-
erence ordering will *always* be irrational, just that we cannot guarantee group
rationality in all situations.

What does this imply for our study of international relations?

- Assuming rational actors at any level of aggregation is extremely problem-
atic. Not only states, but bureaucracies, international organizations, sub-
state associations, every possible group you can think of may be subject
to irrationality.

- Even if we assume that states are rational actors (e.g. a monarchy or an-
other type of absolutist regime, like dictatorship), groups of states still
face social choice problems (U.N., NATO, IMF).

- National interest (especially in a democracy) may not be definable because
states usually have a large number of individuals with heterogeneous pref-
erences and they have to deal with a large number of options. All of these
combine to make group irrationality very likely.

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[3]Technically, if at least one member prefers x to y and everyone else either prefers x to y
also or is indifferent between them, then the group preference must reflect a preference for x
over y as well.

As an important aside, you should ponder what this implies for the concept of democracy as an expression of the popular will in general. Democracy's claim to legitimacy is based on the notion that a democratic polity somehow reflects the individual preferences of most of its members. Philosophers are fond of speaking of the "general will" and policy-makers frequently refer to the "will of the people". But we just saw that these may be meaningless concepts. There exists no such thing as the will of the people because we cannot aggregate each individual's will and guarantee a logical result.

Where do we go from here? We can tinker with any one of the three fundamental assumptions. In practice, most work has been done on restricting the domain of admissible preference orderings.

It is possible to demonstrate that if we exclude certain "inconvenient" preference orderings, then we can guarantee group rationality. In a way, by eliminating people with opinions that are too contrary to what most people hold, we can get a group that is homogenous enough so that its majorities would produce consistent social preference orderings. You should already see some normative problems with this approach: who gets to exclude whom? How? Before you even attempt to answer these questions, let me point out that whatever answers we give may be moot and irrelevant. Here's why.

The above result depends crucially on the assumption that people were ordering their preferences along a single dimension (for example, in our Cuban Missile Crisis case, it was the increasing military hostility of the option). Most policies, however, are not about a single issue. Rather, they are packages that deal with multiple issues simultaneously. For example, a government spending policy would include welfare spending in addition to a budget allocation for the military, among many other things. So one's preferences would be defined over many dimensions.

The big bad result came in 1976 when Richard McKelvey proved the *Chaos Theorem* that showed that a winning alternative will rarely exist when multi-dimensional policies are concerned.

> THE CHAOS THEOREM. *In multi-dimensional policy spaces, using paired comparisons and majority rule, winning alternatives will rarely exist, and if they do not exist, any policy can be chosen with the appropriate agenda.*

Recall that an **agenda** is a rule that determines the order in which options should be considered. We already saw a simple example of the power of the agenda setter who could guarantee that the group would implement his most preferred outcome by simply manipulating the order in which alternatives come up for a vote.

McKelvey's theorem asserts that (a) when there are more than one dimensions to a policy, the social preference ordering is likely to be irrational, and (b) by manipulating the agenda, the polity can choose anything! That is, group choice becomes completely unpredictable almost for sure and, what's perhaps worse, subject to strategic manipulation by a smart agenda-setter.

Because individually rational preferences can lead to irrational social preferences, strategy can be used to control the group's decisions by manipulating the agenda. That is, a member of the group is powerful if he can get the group to implement his particular preferences. To understand state preferences, we must look at individual preferences, institutions that determine voting rules, and the power of players within these institutions.

4 Summary

What do we conclude from all this? Group choice may be subject to a host of problems, the worst of which is the cycling problem caused by intransitivity of the social preference ordering. If policies can be reduced to a single dimension and certain preference orderings excluded, then we can predict group choice, which will be rational. If neither of these requirements hold, the social preference ordering will be irrational and the polity can choose just about anything. It also becomes subject to strategic manipulation of agenda-setters.

It is interesting that the world does not exhibit wild cycling and instability as predicted by the Chaos Theorem. Studies have shown that in many cases policies can, in fact, be reduced to a single dimension and that often there are not enough "inconvenient" preferences to generate cycling problems. People can also design institutions to help overcome some of the instability by restricting either the number of alternatives under consideration or the admissible preference orderings. (The committee system, by the way, is one such structural method of restricting these.) In addition, relatively homogenous groups — that is, groups whose members do not differ too much — may be less prone to cycling.

- To define important concepts such as the **national interest**, we must understand how groups make decisions.

- All members of a group have **rational individual preference orderings**. The group uses a **preference aggregation rule**, like majority vote, to construct the **social preference ordering**. The alternative that is most preferred by the group wins.

- ARROW'S IMPOSSIBILITY THEOREM shows that if the social ordering satisfies Universal Domain, Pareto Optimality, and Independence of Irrelevant Alternatives, then there exists no non-dictatorial aggregation rule that can guarantee a rational social preference ordering.

- MCKELVEY'S CHAOS THEOREM shows that in multi-dimensional settings under majority rule social preference orderings will generally be intransitive, in which case any policy can be chosen by using the appropriate **agenda**.

- Empirically it appears that many policies can be reduced to a single dimension, in which case we can often avoid cycling problems.