THE UNIVERSITY OF CHICAGO

THREE ESSAYS ON DELEGATION

A DISSERTATION SUBMITTED TO
THE FACULTY OF THE IRVING B. HARRIS
GRADAUTE SCHOOL OF PUBLIC POLICY STUDIES
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

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CHICAGO, ILLINOIS
JUNE 2017

This dissertation is dedicated to my wife Jackie for her unwavering support through this long process and to my parents for affording me the opportunities to pursue my academic dreams.

Politics means striving to share power

Max Weber

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ACKNOWLEDGMENTS

I'd like to thank my committee of Scott Ashworth, Peter Buisseret, Ethan Bueno de Mesquita and Pablo Montagnes for their invaluable help during this project. I could not have completed it without their guidance. I'd also like to thank my fellow Harris School classmates, participants at the Harris School PhD workshop, the Harris School Political Economy Lunch and the MPSA annual meeting for helpful advice and suggestions along the way.

ABSTRACT

In this dissertation I analyze three different models of delegation. First, I explore how delegation incentives change when the principal may lose power in the future in "Delegation and Political Turnover". One principal, called a legislator has policy making authority in the first stage. He can implement a policy location himself or he can develop to an expert. This expert can then implement both a policy location and location-specific quality. An election occurs, and the first legislator may be replaced by a second legislator with different policy preferences. The legislator in power then again decides whether to implement policy himself or delegate to an agent. I show that the first legislator can use delegation as insurance against possible future loss of power. The agent chooses a policy designed to be retained by both legislators in the second stage. Without delegation, the second legislator can always get his own ideal point, a terrible outcome for the first legislator. I then extend the model to show how political turnover influences the first legislator to invest in the agent's capacity. I also show that when the first legislator has a choice of agents, he prefers an agent opposed to the second legislator.

The second chapter, "Delegation to an Overconfident Expert"(with Scott Ashworth) is concerned with expert overconfidence. Policymakers often delegate partial decision-making authority to experts. Although monetary transfers can be useful in aligning the decision maker's and expert's policy choices, they are typically not observed in practice. We analyze a principal-agent model where the policymaker and agent have identical preferences over state-contingent policy, but disagree over the accuracy of the expert's information. The policymaker believes the expert to be overconfident in the precision of the signal he receives about the state of the world. In this case, the optimal mechanism is a delegation interval, without transfers.

Finally, in "Delegation, Information, and Federalism" I study a principal-agent model of federalism. One central government can delegate to two districts or make policy herself. The districts however have a monopoly on local information. There are coordination ex-

ternalities between all levels of government that reward policy closeness regardless of local characteristics. The central government prefers to delegate when its specific conditions are moderate and externalities are low. When conditions are extreme and externalities are high, the central government prefers to implement a uniform policy across all levels government. This contrasts to local government decision making. While local governments also prefer a uniform policy when externalities are large, the uniform policy is most beneficial when local conditions are moderate.

CHAPTER 1

DELEGATION AND ROTATING PRINCIPALS

1.1 Introduction

Politicians create policies intended to outlast their time in office. However, future politicians may move or reverse policy once the previous office holder is out of power. Therefore, politicians must create ways for their policies to withstand the uncertainty of political turnover.

One oft-suggested solution to this problem is to delegate to an independent agent. However, there are two reasons this may not work. First, delegation of authority to an agent may itself be revoked by a future politician. Second, the agent can anticipate the chances of future turnover as well as the principal, and modify his behavior accordingly.

We see real world examples of principals and agents anticipating this possibility of turnover all the time. In 2014, Washington and Colorado became to the first two states two implement a fully legal marijuana program. In effect, the federal government delegated marijuana policy to the states. The states could only be certain they would have a Democrat controlled justice department for two years however. Therefore they would have to either be prepared to have their policies possibly overturned after the election, or create policies that both parties would accept. Both states touted the large increase in tax revenue they expected to receive from legalizing marijuana. By stressing the revenue creation, they were hoping to appeal to people who were not drug legalization proponents.

I seek to understand how delegation can help protect policy in the face of turnover. This turnover threat is complicated by both the principal's policy misalignment with his successor and policy misalignment with the agent. To do so, I consider a two date setting with two legislative principals and one agent. The agent could be thought of as state (as in the preceding example), a bureaucratic agency or a private firm.

Policies have two components: a location and a quality. All players have an ideal policy location. Everyone values quality regardless of the location but disagree on the most preferred location. However, only the agent can develop quality. Crucially, quality is policy specific. That is, any quality developed is applicable only to the single policy for which it was developed. Within our context of marijuana legalization, the policy could be criminal punishment, while the quality could tax revenue. For example, a more efficient tax system would cost the state more to set up and would be useless under a different punishment scheme.

The timing of the game proceeds as follows. At date one, an incumbent legislator decides whether to delegate policy making authority to an agent or to retain authority for himself. If he retains authority, the legislator chooses any policy location he wishes with zero policy quality. If he delegate authority, the agent chooses both a policy location and a policy quality.

In between periods, there is an exogenous probability the incumbent legislator will be replaced by a second legislator. The first period policy, both the location and quality, remains in place at the beginning of date two.

The date two legislator again makes his between delegating policy making authority to an agent or retaining it for himself. If the legislator retains authority, he could again choose any policy location with zero quality or retain the first date policy location *quality.* If he delegates authority, the agent can again choose any policy location and policy quality.

Crucially, if the second date legislator moves the first period policy, the new policy choice will have zero quality. However, if he retains the first stage policy location, he can keep the corresponding quality. Which policies would he retain? The second stage legislator can always choose his own ideal point. Therefore any combination of location and quality he retains must make him at least as well off as his ideal policy location with zero quality.

This creates a problem for the first stage legislator; he lacks the ability to create quality. Therefore the second legislator's ideal point is the only retainable policy location he can choose. This provides no incentive to compromise today when tomorrow's policy will be unaffected. This makes the first stage policy choice a static problem. There are no dynamic linkages to consider even though the two legislators may be severely opposed to each other.

Unlike the legislators, the agent can develop policy quality that appeals to all players. The agent can pick a location and quality that is sufficient for neither principal to value reversing the policy. That is, the agent can use policy quality to get legislators to compromise on policy location. This then creates a dynamic linkage between the two periods. Delegation today affects the tomorrow's policy because of the agent's monopoly on quality generation. If legislators abandon the agent's policy in the second stage, the associated quality vanishes. Therefore, an increase in quality increases the cost of policy abandonment to the legislators. It also gives the agent a degree of *real authority* over the second stage policy even when the legislator still has the *formal authority* in the sense of Aghion and Tirole (1997) (need to expand?).

This bring us to the major result of the paper. Delegation acts as *insurance* in the face of turnover. Delegation helps mitigate the conflict between the first and second legislators. The agent's policy choice constrains the second period legislator. The first stage legislator can then use the agent's monopoly on quality generation to his advantage. By divesting himself of formal first stage policy authority, the first stage can rely on the agent's ability to produce a compromise policy. This compromise policy helps the first stage legislator hedge his bets in case he does not win the election and stay in power in the second stage.

This insurance benefit occurs in two separate ways. First, the agent could choose compromise policy such that both legislators will accept in the second period. This removes the possibility of the second principal choosing his own extreme position upon winning the election. A stable policy such as this one must have enough quality that both principals are willing to compromise on the policy location. This then guarantees the first stage legislator a payoff at least as good as his own ideal point regardless of who wins the election.

If the agent is allied with the first legislator (that is, the agent's ideal policy location is closer to the first legislator's ideal policy location than to the second legislator's ideal location), this compromise policy will, perhaps surprisingly, make the first principal better off than if there was no possibility of turnover. This combination of policy location and policy quality will be *better* for the first principal than guaranteeing him his own ideal point in both stages. The agent must worry about both possible future legislators, and this creates surplus value for this allied legislator to exploit.

Second, the agent could choose a compromise policy only the second principal would accept. This would necessarily be worse for the first stage legislator than his own ideal point. However, this trade off may be worthwhile due to the dynamic incentives. If the first stage legislator loses the election, then his successor will have full reign to implement his own ideal point in the second stage. By compromising in the first stage, the first legislator ties the hands of the potential second stage legislator.

Delegation becomes more attractive as the first stage legislator becomes more likely to lose power. Perhaps more surprisingly, increasing polarization may also improves the chances of delegation. Consider that as the two legislators move farther apart, the second legislator's ideal point becomes increasingly unattractive for the first legislator. Avoiding this more extreme position becomes relatively more important than getting one's own ideal point. Therefore a compromise policy through delegation becomes more appealing with greater polarization.

That principals and agents should be forward looking is not a new concern and has been much discussed for decades. McCubbins et al. (1987), McCubbins et al. (1989), Calvert et al. (1989), all talk about how politicians try to insulate their policies from future bureaucratic drift. To insulate policies, principals often restrict the actions of the bureaucratic agent at the expense of policy efficiency. Horn and Shepsle (1989), Moe (1989), and Moe (2012) are concerned political turnover of the principal or legislative drift. By delegating and implementing inefficient insulation mechanisms, the principals can often tie the hands of the future legislators and secure policy even when the current legislators lose power. This paper shows how policies themselves can insure the legislator against political turnover.The agent's ability to produce compromise policies acts as policy insulation without the addition of inefficiencies. In essence, bureaucratic drift helps counteract legislative drift.

A paper by de Figueiredo (De Figueiredo, 2002) provides a canonical model for dynamic bureaucratic politics. In his framework, cooperation between competing parties increases as election get more competitive. However, when one party is likely to lose power, they often choose to insulate their policies against repeal even though this is inefficient. However, de Figueiredo does not model the delegation problem explicitly. Instead, the politicians can simply choose an insulated or non-insulated policy, leaving the delegation problem as a black box. These are interpreted to be insulated agencies, but are not modeled as such. Agencies have their own policy preferences (Clinton and Lewis (2008), Clinton et al. (2012)), and principals cannot always freely implement their preferred policy. By explicitly modeling the agent's problem, I can show how the agent's distance from the first legislator affects the benefits of delegation. I can also extend the analysis to different areas. In the extensions, I analyze when the first stage legislator would like to invest in the agent's capacity, and also the first legislator's optimal agent policy location.

The separation of policy quality and policy location has been used in other models in a wide variety of settings. Open rules produce more committee specialization in legislatures than closed rules in Hirsch and Shotts (2012). Hirsch and Shotts (2015) shows how competition between two agents produces better policies for a single principal. Ting (2011) shows how the level of quality specificity affects investments in bureaucratic capacity. In contrast to my paper, these papers assume the principal stays constant. Without turnover, the agent can always tell ex-ante whether the principal will accept the agent's proposal.

Policy specific quality has also been used in a dynamic setting. Callander and Raiha (2014) models infrastructure investments over time by an elected government. However, the legislator in this case can choose both the policy location and the policy quality. He is also beholden to voters, and must calibrate policy decisions to best win election. This is in contrast to this paper, where the the legislator must give up formal authority to the agent in order to see any level of positive quality and the probability of turnover is exogenous.[1]

There is another rich literature on delegation which assumes the agent's expertise is more general in nature. Usually this involves the agent being able to resolve some underlying uncertainty over the state of the world as opposed to adding policy specific valence. In this setting, the principal will often set a discretion interval under which the agent has full policy making authority. This constraint allows the principal to expropriate some of the agent's expertise investment for himself. Epstein and O'halloran (1994), Gailmard and Patty (2007), and Huber and Shipan (2002) provide some classic approaches to delegation under policy uncertainty. Callander et al. (2008) provides a middle ground between entirely general expertise and entirely policy specific expertise. In this model, the principal can never completely learn the state of the world from the agent's policy choice, but can learn something about the mapping from policy to outcomes. [2]

This paper is also related to the literature about dynamic policy making. Generally, this literature has focused on three possible channels for dynamic linkages. One, an endogenous status quo where today's policy choice becomes tomorrow's status quo. This has been explored frequently in a legislative bargaining setup in such papers as Baron (1996), Duggan and Kalandrakis (2012), and Penn (2009). While this paper does make use of a persistent policy related to the endogenous status quo, I use explore a separate mechanism that produces dynamic linkages: delegation. To do this, I also use a principal-agent model that is different from the traditional bargaining model framework.

Two, information from today's outcome informs players about the mapping from policy to outcomes tomorrow. Callander and Krehbiel (2014) explores how drift over time in policy outcomes provides an incentive for delegation. Crucially, this result relies on a changing state of the world with static policy preferences to induce delegation. In this paper, I rely on certainty about the state of the world but uncertainty about future policy preferences.

1. citation about exogenous turnover probability being reasonable for most policy areas

2. Gailmard and Patty (2012) and provides a further overview and Bendor and Meirowitz (2004) provides a good overview of the technical details.

Callander and Hummel (2014) shows how policy experimentation can be useful in dynamic settings even when it is not optimal in static settings. Three, investment has longterm impacts which affect the policy outcomes of tomorrow. This is explored in Callander and Raiha (2014) where investments in infrastructure today persist into the future. Montagnes and Bektemirov (2016) shows they dynamic trade off between government investment and with government investment more likely when politicians have a high probability of winning reelection.

1.2 Model

This is a two date game with three players. There is one agent, and two legislative principals. To fix ideas, we will often refer to the principals as legislators. This is a game of full information will fully observable actions; there is no uncertainty in the mapping between policies and outcomes.

Policies have two components, a location $p \in \mathbb{R}$ and a quality $q \in \mathbb{R}^+$. We will denote a single policy as a pair of location and quality: $(p,\ q)$. Players are entirely outcome motivated; there are no rents to office in this model. Players have quadratic loss utility over policy location, with location utility maximized at their ideal points. Legislators 1 and 2 have ideal points L_1 and L_2 respectively and I normalize the agent's ideal point to 0. Without loss of generality, I assume $L_1 = 1$. Policy quality and policy location are additively separable, with all players valuing quality regardless of the policy location.

Agents must exert effort to develop quality. This effort cost is proportional to the amount of quality developed, costing κq for quality level q. However, policy quality is persistent. If the agent develops policy quality q in period 1 and the legislator does not move the policy location in period 2, no effort is needed to keep quality at q. For example, once the the administrative apparatus is set up to collect taxes in the first period, we assume there is no cost to continue using this system in the second period as long as tax policy remains the same.

Therefore the payoff legislators receive in stage j for a policy with location p and quality$q$ is

$$U_{L_i}^{j}(p,\ q) = -(p - L_i)^2 + q$$

Similarly, the payoff the agent receives in stage j for a policy with location p and quality$q$ is

$$U_A^{j}(p,\ q) = -(p - 0)^2 + q - I\kappa q$$

where $I = 1$ if the agent developed policy in period j, 0 otherwise.

We let all players weight the outcomes in both periods equally. Total utility for player i is simply

$$U_i = U_i^1\left(p^1,\ q^1\right) + U_i^2\left(p^2,\ q^2\right)$$

In the first stage, players inherit a status quo policy location with 0 quality. The incumbent legislator can choose another policy location himself, or he can delegate policy making authority to an agent. If he delegates, the agent can choose any policy location he wishes plus choose an associated level of quality for this location.[3] The first stage ends.

Before the second stage begins, there is an exogenous probability that the first legislator will be replaced by a second legislator. After the election, the legislator in power can again delegate policy making authority to the same agent, or choose policy himself. If he retains authority, he can again choose another policy location or he can retain the first stage policy with its associated quality. If he delegates, the agent can again choose any policy location he wishes plus choose an associated level of quality for this location. The second stage ends, and payoffs are realized.

For example, both legislators could choose a policy located at point p. However, only the agent could choose policy location p with quality $q > 0$. Any policy the legislators pick must have quality 0. If the agent chose p with quality q in period 1, either Legislator could keep $(p,\ q)$ in the second period. On the other hand, if they chose a new policy location p',

3. Shapiro (2002) convincingly argues that unconstrained delegation is quite frequent in many contexts.

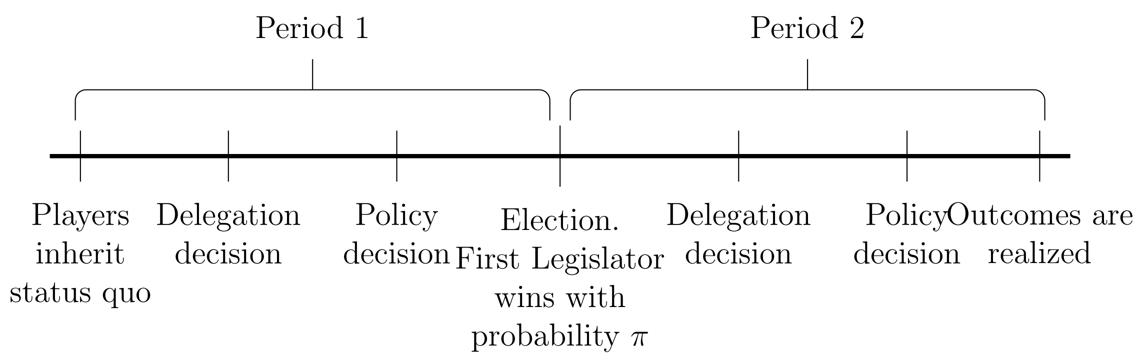


Figure 1.1. Game Timing

p' would have quality 0.

With this model, I study Subgame Perfect Equilibria, henceforth just called Equilibria. To avoid uninteresting cases where the agent chooses his own ideal point with infinite quality, we will place a restriction on κ.

Assumption: $\kappa > 2$

If $\kappa \leq 2$, the marginal benefit of increasing quality is always greater than the marginal cost of producing quality. The agent would therefore produce infinite quality for any policy. Imposing $\kappa > 2$ will allow us to restrict attention to cases where the agent uses quality as a costly tool to move policy closer to his ideal point, but does not invest in extra quality purely for quality's sake.

1.3 Analysis

1.3.1 Baseline

We will look at two different baseline scenarios that will make for helpful comparisons. First, I will analyze the case of principal turnover with no possibility of delegation. This will allow me to highlight the ideological conflict between the two legislators. Second, I will analyze the case of the reelection probability π equal to one, eliminating the possibility of turnover. We will then compare these cases to the the case of delegation under electoral turnover.

No Possibility of Delegation

With no possibility of delegation, no policy quality can be created. Therefore, legislators have incentive to compromise, as shown by the first baseline equilibrium:

Remark 1.1 (No possibility of delegation equilibrium)**.** *Let there be no possibility of delegation. Then there is a unique equilibrium. In the first stage, the first legislator always chooses his own ideal point. In the second stage, both legislators choose their own ideal points.*

To solve for the equilibrium, we start from the final stage. Let the second legislator win the election and take power for the second period. He inherits some first period policy $\left(p^1, q^1\right)$. Note, however, that any first period policy will have a quality of 0. He can choose any policy location he wishes, including retaining the first period policy. The legislator then has a simple maximization problem:

$$\max_{p}^{2} -\left(p^2 - L_2\right)^2$$

This is clearly maximized at $p^* = L_2$, or the second legislator's ideal point. Similarly, if the first legislator retained power in the second stage, he would have an identical maximization problem. Therefore the first legislator's ideal policy location is $p^* = L_1 1$.

We can now solve the first legislator's first stage policy choice problem.

$$\max_{p} -\left(p^2 - 1\right)^2 - \pi\left(1-1\right)^2 - \left(1-\pi\right)\left(L_2 - 1\right)^2$$

which is again maximized at the first legislator's ideal point. This gives the first legislator an expected utility of

$$EU_{L_1} = -\left(1-\pi\right)\left(L_2 - 1\right)^2$$

Crucially, the first stage policy does not enter the second stage maximization problem; there is no linkage between the first and second stage policies. Both legislators will simply choose their own ideal points regardless of the first stage policy. This removes any incentive for the first legislator to compromise in the first stage. If he cannot induce his opponent to moderate in the second stage, why should the first legislator compromise in the first stage? We will see later that the agent will be critical for compromise policy and to create non-trivial dynamic incentives for the first legislator.

Definition: *Polarization* is defined as the distance between L_1 and L_2.

The first legislator's utility is decreasing in polarization and increasing in the reelection probability. However, his optimal policy choice is not affected by either of these parameters.

Definition: A path of play is considered *stable* if the first stage policy and the second stage policy are the same with probability 1. A first period policy that results in a stable path of play will be called a *stable policy.* An equilibrium path with a stable first period policy will be called a *stable equilibrium.*

Definition: A path of play is considered *unstable* if the first stage policy and the second stage policy are the same with probability less than 1. A first period policy that results in an unstable path of play will be called an *unstable policy.* An equilibrium path with an unstable first period policy will be called an *unstable equilibrium.*

With no possibility of delegation, the equilibrium first stage policy is always unstable.

No turnover

Now I turn to the other baseline case. Delegation is an option, but there is no chance of turnover (that is, $\pi = 1$). Again I start from the final stage. This time, however, I start with the agent's policy choice. Once the legislator delegates, he forfeits all policy making authority in the second stage. This means the agent can choose any policy he wishes without fear of reversal. Because of the assumption that $\kappa > 2$, it is never in the agent's interest to create quality purely for his own sake. As the second stage policy choice has no bearing on future legislator behavior, the agent will never create quality in the second stage. He may, however, retain the first period combination of location in quality. If the agent chooses a new policy location, he will choose his own ideal point. If he does not choose his own ideal point, he will retain the first stage policy location and quality.

Consider the legislator's second stage policy choice without delegation. The legislator will either choose his own ideal point, or retain the first stage policy. Because his policy location choice is unrestricted, the legislator can always guarantee himself at least his own ideal point. Therefore he will only retain the first period outcome if it guarantees him a utility of at least 0. The agent then must take this into account when deciding on the first period policy. This gives us the following lemma for the agent's outcome choice (all proofs are in the appendix).

Lemma 1.1 (Agent's No Turnover Choice)**.** *Let the principal delegate in the first period. Then there are two possible optimal policy choices for the agent. If* $2 < \kappa \leq 4$*, then the agent will choose the policy location and quality pair* $\left(L_1 - \frac{2L_1}{\kappa},\ (-\frac{2L_1}{\kappa})^2\right)$*. If* $\kappa > 4$*, the agent will choose the policy location and quality pair* $(0,\ 0)$*.*

When the legislator delegates, the agent's maximization problem when choosing a policy the legislator will retain in the second stage is

$$\max_{p,\, q} \ (2 - \kappa)\, q - 2(p - 0)^2$$

However, to assure the legislator a utility of at least his ideal point, the agent must set the quality to at least $(p - L_1)^2$. Therefore we can substitute this constraint into the maximization problem to get.

$$\max_{p} \ 2(p - L_1)^2 - 2(p - 0)^2 - \kappa(p - L_1)^2$$

If the agent does not choose his own ideal point, his policy choice is calibrated to give the legislator exactly the same utility as the legislator's ideal point. Importantly, $\left(L_1 - \frac{2L_1}{\kappa}\right)$

lies in between 0 and L_1. The agent uses his monopoly on quality development to get the legislator to compromise on policy location. However, if producing quality is too expensive, the agent would prefer not to compromise and simply get his own ideal point for one period. This leads directly to the no turnover equilibrium.

Remark 1.2 (No Turnover Equilibria). *Let $\pi = 1$. Then if $\kappa > 4$ there exists a unique SPNE such that the legislator will not delegate in either stage and will choose his own ideal point in both both stages.*

If $2 < \kappa \leq 4$, the equilibria takes this form: In the first stage, the legislator delegates. The agent chooses the location and quality given by Lemma 1.1. In the second stage, the first period policy is retained with probability 1.[4]

Notice that all delegation equilibria must retain the agent's first period policy in the second period; the legislator cannot put any positive probability on choosing his own ideal point in the second stage. However, it does not matter whether the legislator or the agent has actual policy making authority.

In all no turnover equilibria, policy is always stable between periods even without a between period commitment mechanism. The outcome is either the agent's stable policy choice in both periods or the legislator's ideal point in both periods. The legislator's second period decision problem exerts oversight on the agent's first period outcome choice. That is, the legislator's stage two formal authority acts as a constraint on the agent's first stage real authority.

Period by period, the agent has complete freedom to choose any policy he wishes. However, the legislator's second period policy choice acts as a constraint on first period behavior.

4. The policy can be retained in three ways:

- One, the legislator delegates and the agent retains the the first period policy
- Two, the legislator does not delegate and himself retains the first period policy
- Three, the legislator mixes between options one and two.

The legislator can always choose his own ideal location, and the agent must take this into account when choosing first period policy. This dynamic oversight will then become more complicated when the reelection probability is non-degenerate as the agent will not know with certainty which constraint he will actually face in the future. Policy stability will not always occur when principals can rotate.

When the quality cost is too high, the agent chooses his own ideal point in the first period; the threat of the legislator's ideal point in the second stage does not outweigh the cost quality production. The legislator, however, could always choose his own ideal point with 0 quality in both periods. This is clearly better for the legislator than getting the agent's ideal point in the first period. Again, note that no matter the cost of producing quality, policy is still stable.

As would be expected, quality is decreasing in the effort cost of quality production. As it becomes more expensive, the agent would like to produce less of it. Because a policy location farther away from L_1 requires a higher policy quality in order for the legislator to be indifferent, a higher quality cost will shift the agent's policy choice closer to the legislator's ideal point. The legislator, however, does not care about this quality decrease since it is offset with a more preferred policy location.

1.3.2 Policy Choice with Turnover

I will now consider the effects of an election on policy and delegation. In between the first and second periods, there is an exogenous probability of legislator turnover. The first legislator retain power in the second stage with probability π and the second legislator takes power in the second stage with complementary probability $1 - \pi$, .

A few definitions will make the rest of the discussion clearer. We say the first legislator is relatively *aligned* with the agent if $|L_2| > L_1$. Similarly, we say the first legislator is relatively *misaligned* with the agent if $|L_2| < L_1$. For example, if we consider the marijuana legalization example from the introduction, it seems reasonable to assume that Washington

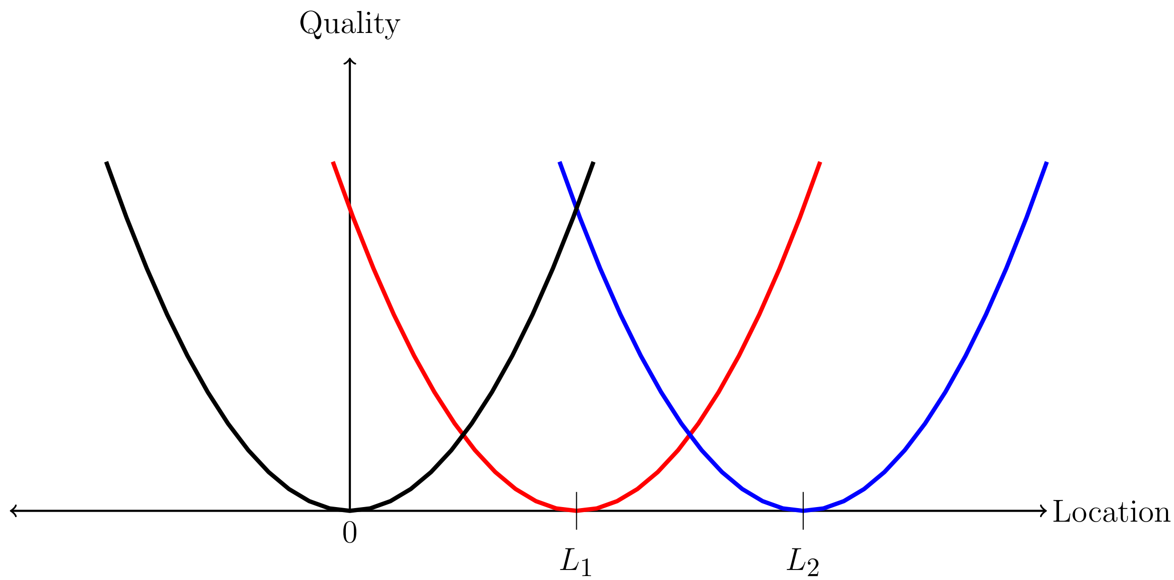


Figure 1.2. Zero Utility Indifference Curves

and Colorado are to the left of both national parties, but closer to the Democrats. The Democrats currently in power would then be aligned with the states. However, other states may in fact be in the middle, or to right of both parties.

Throughout this section, keep in mind the ideological conflict between the three players, not just the two legislators. In the baseline case, there was only one policy disagreement: the first legislator's and the agent's and ideal points were different. Now, there is ideological conflict between all three players as all three actors have different policy preferences. As we vary the ideal point of one player, these tensions will grow or shrink. For example, moving the second legislator's ideal point from L_2 to L_2' where $L_2' < L_2 < 0$ increase the policy disagreement between the two legislators and between the second legislator and the agent. While the ideological disagreement between the agent and the first legislator will stay the same, they will be relatively more aligned as with L_2' than L_2.

We can immediately see that agent's problem is now more complicated. In the no turnover case, the agent could choose pick a stable policy the single legislator would retain or an unstable policy he would not retain. Now, the agent can choose an unstable policy that only the first legislator would retain, an unstable policy only the second legislator would retain,

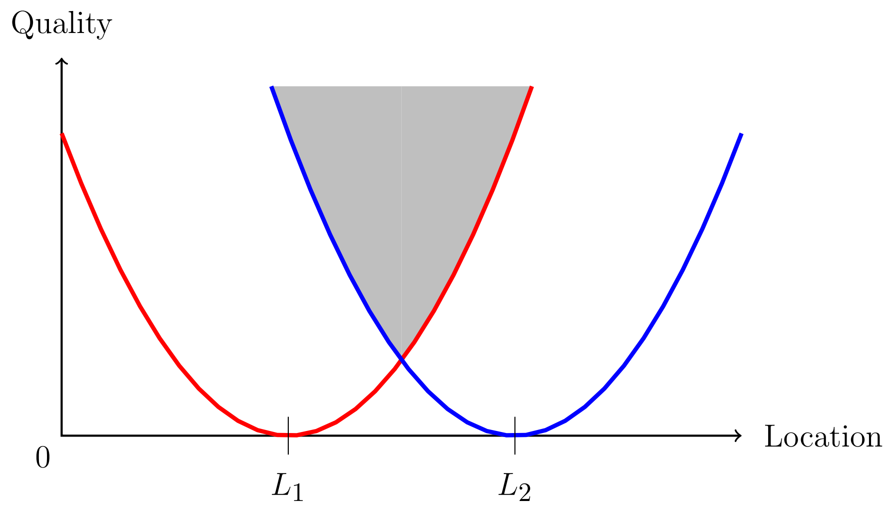


Figure 1.3. Shaded area includes all stable policies

an unstable policy neither legislator would retain, or a stable policy both legislators would retain. I will use these agent policy choices as the framework for characterizing equilibria.

To choose a policy both legislators would retain, and therefore remove any risk of a policy being moved in the second period, the agent needs to guarantee both legislators a payoff of at least zero. If he does not guarantee both legislators a payoff at least as good as their ideal points, at least one of the legislators will prefer his own ideal point with zero quality to the agent's policy choice.

Any stable policy must have a corresponding quality that gives both legislators weakly positive utility. Graphically, a stable outcome would need to lie on or above both 0 utility indifference curves. Unless the policy lies at the intersection point, one of the legislators must get a strictly positive utility. This next lemma makes this point formally.

All stable policy locations will lie in between 0 and $\frac{L_1+L_2}{2}$, the midpoint between the legislators' ideal points. If the first legislator and agent are aligned, a policy location within this interval will be closer to L_1 than to L_2. Therefore the second legislator requires a higher level of quality than the first legislator requires in order to retain the agent's policy in the second stage. The first legislator also gets to enjoy this high quality level coupled with a relatively closer policy location.

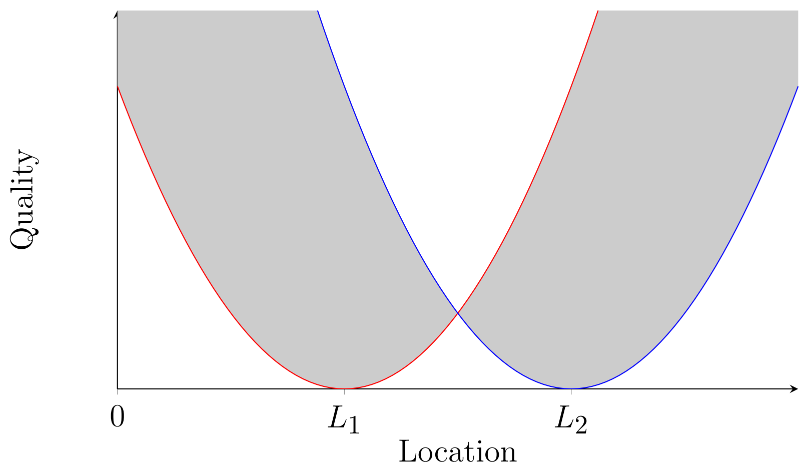


Figure 1.4. Shaded area includes all unstable policies

Now consider the exact same policy location, but a lower level of quality. This quality level still guarantees the first legislator a utility of at least 0, the same utility as his own ideal point. However, it gives the second legislator a negative utility. In the second stage, this unstable policy will only be retained by the first legislator; the second legislator will choose his own ideal point instead. The first class of equilibria shows exactly when the agent will choose a stable policy over an unstable policy.

Proposition 1.1 (Stable Policy Equilibria)**.** *Assume the cost of quality κ is low enough and the election probability $\pi(\kappa,\ L_2)$ of the misaligned legislator is high enough. Then there is a unique equilibrium policy and all equilibria*

- *The first legislator delegates in the first stage*
- *The agent chooses a stable policy that guarantees the both legislators a utility of at least* 0
- *Both legislators retain the agent's policy in the second stage.*

We will call the election probability cutoff for a stable policy equilibria $\bar{\pi}_1$ when the first legislator is aligned with the agent and $\bar{\pi}_2$ when the second legislator is aligned with the agent. For convenience, I will suppress the

Compare these stable equilibria to the equilibria without delegation. With no delegation, stable policies never occur in equilibrium; the first legislator always chooses his ideal point in the first stage. He can never prevent the second legislator from choosing his ideal point in the second stage. Adding the option of delegation is an immediate improvement, regardless of legislator alignment. Delegation acts as *insurance* against the second legislator's ideal point. All stable equilibria insure the first legislator against this extreme outcome.

Note that this stability occurs without a commitment mechanism. Once the legislator delegates, the agent has complete freedom to choose any policy he wishes. Indeed, in a one stage game the agent would simply choose his own ideal point. The dynamic incentive pushes the agent to invest in quality and to make sure this quality is not wasted. An unstable policy runs the risk of being moved in the second stage and therefore wasting some of the agent's effort. The first legislator benefits from the agent's dynamic incentives and avoid his rival's ideal policy.

The next lemma will show how alignment affects the legislator utility:

Lemma 1.2 (Stable Utility)**.** *If the agent chooses a policy both legislators will accept, the policy will always give the aligned legislator a (weakly) higher utility than it gives the opposing legislator. If the policy does not equal* $p = \frac{L_1+L_2}{2}$*, the inequality is strict.*

Lemma 1.2 shows that in equilibrium, a stable policy will be more beneficial to the aligned legislator than to the misaligned legislator. The agent chooses a combination of policy location and policy to quality to give the misaligned legislator a utility of exactly 0. The aligned legislator still gets to benefit from this quality level however, and therefore is even better for him than for the misaligned legislator.

Lemma 1.2 combined with Proposition 1.1 shows how the combination of turnover and delegation works in the first legislator's favor:

Proposition 1.2 (Delegation Benefits)**.** *The first legislator is always strictly better off with any Stable Equilibria than No Possibility of Delegation and and always weakly better off with*

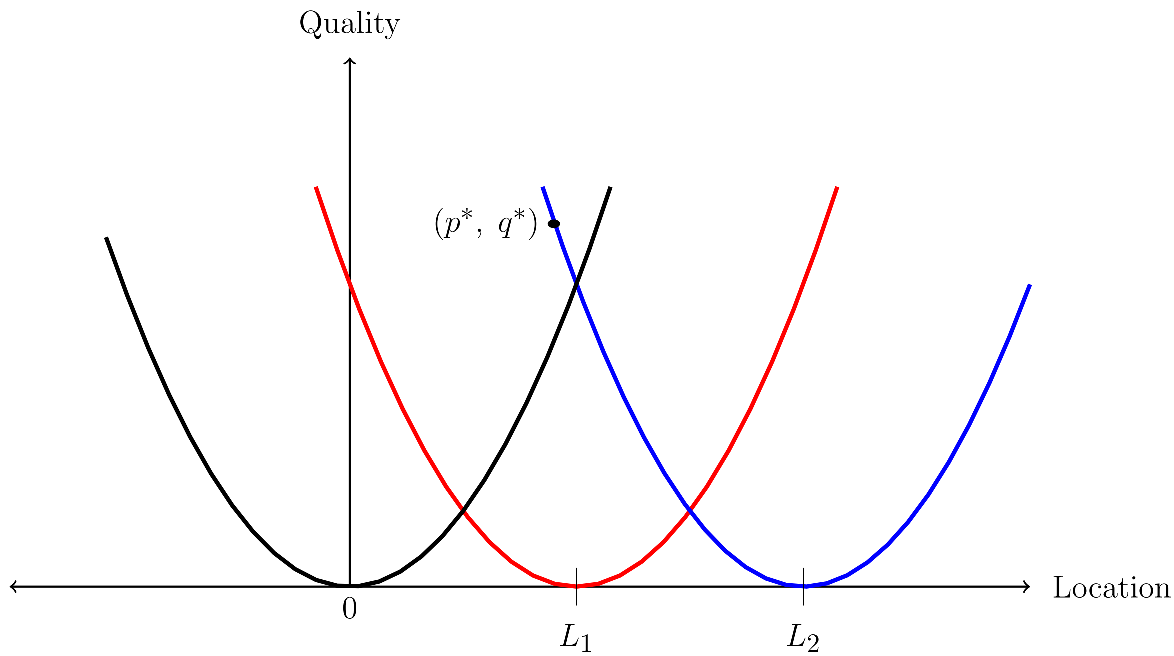


Figure 1.5. Stable Policy for Aligned First Legislator

any Stable Equilibria than No Possibility of Turnover.

An aligned first legislator benefits in two separate ways from the possible turnover in the second period. One, there is the *direct* policy benefit. The first legislator's utility from the agent's aligned stable policy choice is greater than his utility from his own ideal point. The agent's greater ideological conflict with the second legislator works directly to the first legislator's advantage.

In the no turnover equilibrium, there was no extra surplus for the first legislator to extract; the agent could always calibrate the pair of policy location and quality to make the first legislator indifferent. Here an aligned first legislator is able to exploit the agent's desire to please both legislators. The influence of a misaligned second legislator pushes the agent to increase quality past the level it would be with no electoral competition. This benefit is independent of winning the election, as both legislators will retain the stable policy.

Two, the first legislator also receives an *insurance* benefit from delegation. The agent's policy choice leaves the second legislator indifferent between retaining the agent's policy and choosing his own ideal point. In equilibrium, the second legislator always retains the agent's policy. By delegating, the first legislator avoids the second legislator's ideal point. Avoiding L_2 with certainty was impossible when delegation was not an option. Stable equilibria are strictly better for an aligned first legislator than either baseline case.

When the first legislator and agent are misaligned, he no longer receives the direct policy benefit of delegation; the agent chooses policy to leave the first legislator exactly as well off as he would be with his ideal point. However, he still receives the insurance benefit. The second legislator will again retain the agent's policy, and not choose his own ideal point. While a misaligned first legislator is not made strictly better off with electoral competition, delegation and turnover is clearly better than turnover without delegation.

Equilibria Comparisons and Comparative Statics

In general a stable policy is good news for the first legislator, even if he is misaligned with the agent. He always receives the insurance benefit from a stable equilibrium even if there is no direct benefit. However, the agent will not always chooses a stable policy. Instead, he may choose a policy only one of the legislators will retain. These unstable policies do not always offer the first legislator any protection from a loss of power in the future. Therefore we would like to compare across different equilibrium outcomes and different parameter values to see when the first legislator benefits from delegation and political turnover and when he does not.

First, I will describe and give some intuition about the different classes of equilibria. In general, these other equilibria will be share similarities with baseline equilibria. Then I can explore how changing polarization changes the incentives for delegation by showing how it affects which equilibria arises from different polarization levels.

Consider a situation where the first legislator is very likely to win reelection with an election probability very close to 1. The agent then has little to fear from the second legislator coming into power, and therefore does not need to worry much about the second legislator moving policy in the second stage. The agent can tailor his policy choice purely for the first legislator.

I have already shown that when the first legislator and agent are misaligned, this results in a stable equilibrium; the first legislator is insured against the the second legislator taking power. However, if the first legislator and agent are aligned, the agent chooses an unstable policy that would be moved by the second legislator in the unlikely event the second legislator wins the election. The Unstable Equilibria are essentially analogous to the no turnover case; the first legislator receives no insurance benefit and no direct benefit. He runs the same risk of the second legislator's ideal point whether or not he delegates. This policy, however, still gives the first legislator a utility equal to the utility he would receive from choosing his own ideal point.

Now let the election be more competitive with a lower election probability. Choosing an unstable policy becomes riskier for the agent. This has two possible effects. One, an unstable policy is still attractive, but the threat of turnover is more salient. The agent still chooses an unstable policy, but does not invest quite as much in quality. The policy location lies closer to the first legislator's ideal point but has a lower level of quality than when the first legislator was more likely to retain power. The agent does not invest in as much quality when there is a greater chance the quality will be worthless in the second stage. The first legislator would be strictly better off without electoral competition; the presence of an agent does not help mitigate the conflict of interest between the first and second legislators as it does in the Stable Equilibria.

As the election gets more competitive, however, this unstable policy becomes more and more likely to be overturned by the second legislator. The agent would bear the cost of developing quality for two periods, yet only receive the benefit for one. At some point this becomes untenable, and the agent would prefer to just get his ideal point in the first period and ignore the second period consequences. Therefore, the agent may choose a police neither legislator would retain. If neither legislator would retain this policy in the second stage, there is no incentive for the first legislator to delegate. He receives no insurance benefit and receives

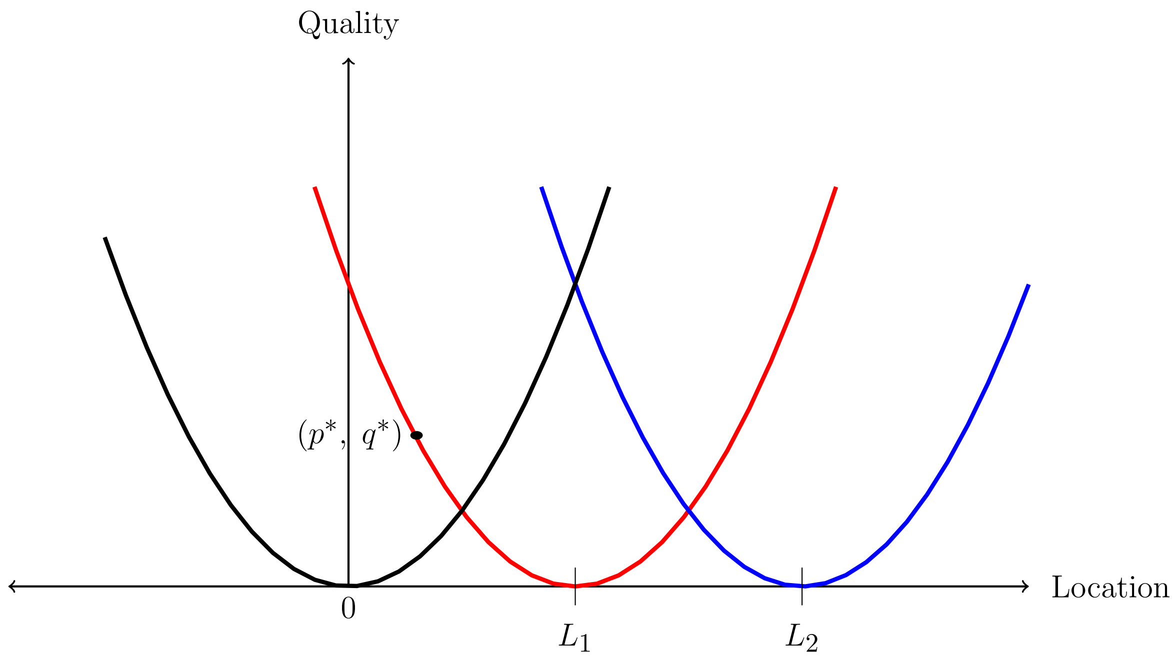


Figure 1.6. Unstable Policy for Aligned First Legislator

a negative direct benefit from the agent's ideal point. This results in an equilibrium with no delegation.

If the first legislator and agent are aligned, the Unstable Equilibria are analogous to the no turnover case. The agent's policy choice does not stop the second legislator from choosing his own ideal point in the second period. In addition, the first legislator receives the exact same utility from the agent's policy choice as from his own ideal point. Therefore there is no direct benefit and no insurance benefit.

If the first legislator is misaligned with the agent, the Unstable Equilibria becomes more interesting, and is worth describing formally.[5]

Proposition 1.3 (Unstable Equilibria for a Misaligned First Legislator)**.** *Let the first legislator be misaligned with the agent, $L_2 < 0$, and κ low enough. Then if $\pi(\kappa,\ L_2)$ is low enough, all SPNE must be of the form:*

- *The first legislator delegates in the first stage*

5. I leave the formal definitions of the other equilibria to the appendix.

- *The agent chooses the unstable policy retained by the second legislator*
- *The second legislator retains the agent's policy in the second stage, but the first legislator chooses his own ideal point the second stage.*

We will call the cutoff for the unstable equilibria $\hat{\pi}_2$.

The first legislator can now use the agent to keep the second legislator from choosing his ideal point in the second period. The agent's second legislator unstable policy choice gives the first legislator negative utility in the first period, a negative direct benefit. However, it is also gives the second legislator a utility of 0. That is, it the second legislator will retain this policy in the second stage. By retaining this policy, the second legislator does not choose his own ideal point, the first legislator's worst possible outcome. The first legislator still receives an insurance benefit.

There is a dynamic trade off between the negative direct benefit and insurance benefit; the first legislator cannot receive the insurance benefit without also inuring the policy cost. If the first legislator is very likely to lose power, this dynamic trade off between giving up policy benefits today for stability tomorrow is worth it. As the first legislator becomes more likely to remain in power, he prefers to gamble by choosing his ideal point in the first period.

This is another instance of the first legislator uses the agent's presence to help mitigate his ideological conflict with the second legislator.The agent provides a link between the first and second stages. With no possibility of delegation, there is no way to choose policy today and tie the hands of the second legislator tomorrow. It is worth emphasizing that this requires no second period commitment device. The first legislator does not commit to keeping the agent's policy choice or delegating again in the future, yet he is still able to use the agent to moderate the second legislator's policy choice.

Finally, delegation does not always occur. With a large enough cost of quality ($\kappa > 4$), the agent will simply choose his own ideal point in the first period regardless of the election probability. Therefore the first legislator will not delegate, and choose L_1. Mitigating the ideological conflict between the two legislators becomes impossible when the quality cost is too high.

For a moderately large effort cost and an aligned first legislator, delegation occurs only when the election is relatively *uncompetitive*. 1.7 shows this clearly; there is a no delegation wedge in between the Unstable and Stable Equilibria. As it becomes more expensive to create quality, both stable and unstable policies become less appealing to the agent. This happens both directly (the policies are simply more expensive) and indirectly through the election probability.

For a given quality level, a high probability of reelection for the first legislator makes the unstable policy appealing to the agent. The agent does not have to worry much about the second legislator being in power in the second stage, and therefore tailors his policy choice specifically to the first legislator.

Similarly, a low probability of reelection for the first legislator (conversely, a high probability of election for the second legislator) makes the stable policy more attractive. The agent wants avoid the second legislator's ideal point, the worst possible outcome. Because the second legislator is misaligned with the agent, it makes more sense to implement a stable policy over an unstable policy. However, this stable policy is expensive. Therefore the benefit of avoiding the second legislator's ideal point becomes less important as the second legislator becomes less likely to hold power in the second stage. This again leads the agent to prefer his own ideal point over investing in quality. If the agent will choose his own ideal point, the first legislator never delegates. Therefore, we should expect to see less delegation, and therefore less policy stability, with more competitive elections.

The No Delegation Equilibrium is fundamentally similar to the baseline No Possibility of Delegation Equilibria. The first legislator chooses his own ideal point in the first stage, and then the legislator in power in the second stage also chooses his own ideal point.

The differences between equilibria are summarized in Tables 1 and 2.

Returning to the marijuana legalization example, states are incentivized to create a high

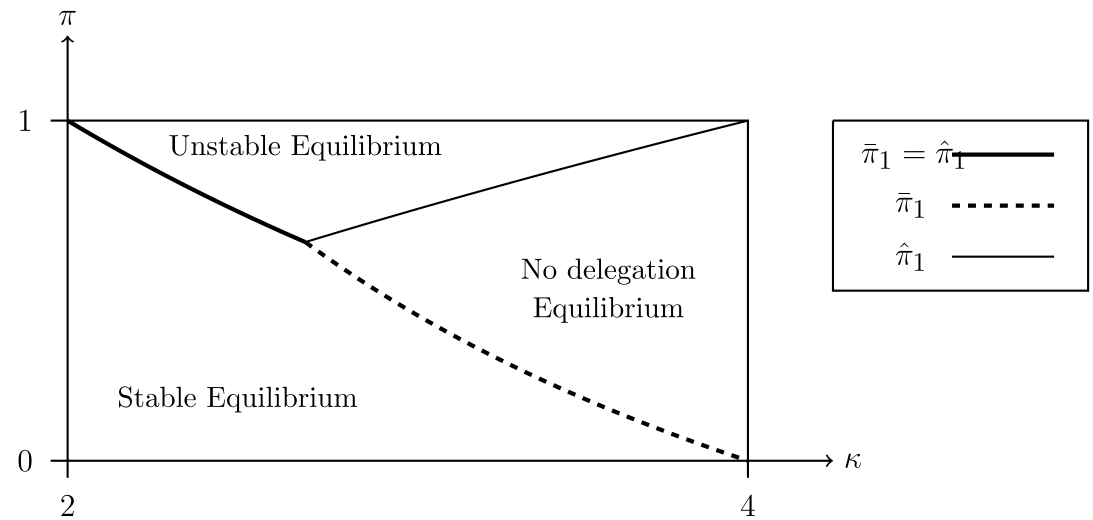


Figure 1.7. Equilibria for an Aligned First Legislator and $L_1 = 1$ and $L_2 = 2$

Table 1.1. Equilibria Comparisons for Aligned First Legislator

	Direct Benefit	Insurance
Stable	Positive	Full
Unstable	Zero	None
No Delegation	Zero	None

quality policy in order to placate both legislators. Colorado has constantly stated how revenue has exceeded expectations, a signal of policy quality separate from criminal penalties. This would help convince Republicans not to overturn the state policy if they won the White House. If Colorado and Washington knew for sure the Democrats would stay in power, there would be less incentive to make as efficient a policy since the Democrats were more inclined to support the criminal penalty decrease in the first place. This suggests the federal government and states are playing a Stable Equilibria.

Now that we have characterized all possible equilibria, we can analyze how delegation responds to changes in parameters. Most importantly, how does the polarization level between the two legislators impact the first legislator's delegation decision? Does polarization make delegation and policy stability more or less likely? The next set of remarks answers this question.

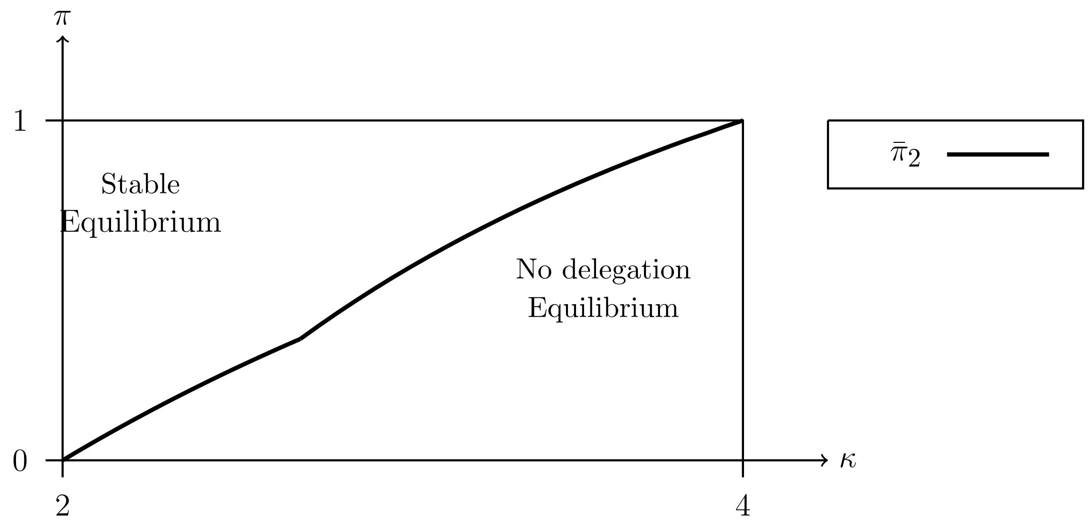


Figure 1.8. Equilibria for a Misaligned First Legislator and $L_1 = 1$ and $L_2 = .5$

Table 1.2. Equilibria Comparisons for Misaligned First Legislator

	Direct Benefit	Insurance
Stable	Zero	Full
Unstable	Negative	Partial
No Delegation	Zero	None

Proposition 1.4 (Polarization and Delegation)**.** *Let the first legislator and agent be aligned. Then $\bar{\pi}_1$ is increasing in polarization.*

Let the first legislator and agent be misaligned. Then $\bar{\pi}_2$ is decreasing in polarization and $\hat{\pi}_2$ is increasing in polarization.

Polarization (weakly) increases the set of parameter values resulting in delegation, regardless of legislator alignment with the agent. The shows that the first legislator can benefit from more polarized environment. The set of stable equilibrium election probabilities grows with greater polarization. For example, for a given level of relatively moderate polarization, the reelection probability of the first legislator could be too high for the agent to choose the stable policy. However, as the two legislators move farther apart, the agent finds it more advantageous to choose the stable policy. At this new level of higher polarization, the same

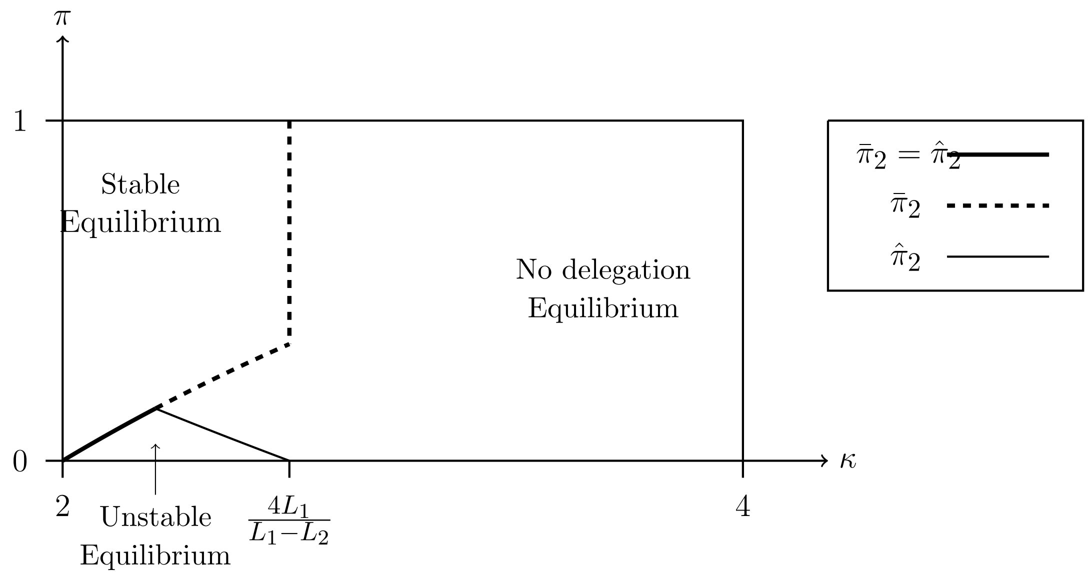


Figure 1.9. Equilibria for a Misaligned First Legislator and $L_1 = 1$ and $L_2 = -.5$

reelection probability may now result in a stable policy instead of an unstable policy.[6]

For example, if L_2 shifts from 2 to 3 in 1.7, both segments of $\bar{\pi}_1$ increase. Therefore for every value of κ, more election probabilities result in delegation and a Stable Equilibrium. Similarly, moving L_2 from -1 to -1.5 in 1.9 would increase both the size of the Stable Equilibria partition and the Unstable Equilibria partition.

Polarization does not only make all stable equilibria more likely, it also makes the misaligned unstable equilibrium more likely. Increased extremism from the second legislator makes delegation more attractive. As the legislators' ideal points move farther away, the second legislator's ideal point makes a less and less attractive second period possibility for both the first legislator and the agent. The agent is more willing to.

The comparative statics together suggest we should see two related facts in a more polarized world. One, there should be more overall delegation as polarization increases. Two, we should see more stable policies and less policy movement after elections. In particular, we should not always expect incoming legislators to change delegated policy because many

6. Note that this is not a statement an increase in the Stable Equilibrium Utility; rather it's statement on which equilibrium will occur given certain parameter values. More polarization shifts the cutoff such that there are more reelection probabilities where the Stable Allied Equilibrium occurs.

policies will already have been calibrated to appeal to the new legislator. This provides an explanation for policy stability that does not rely on institutional barriers or commitment mechanisms.

1.4 Extensions

1.4.1 Capacity Investment

Scholars have long shown that agency capacity is a key determinant in policy quality (eg, Huber and McCarty (2004)). Therefore it seems reasonable to see how optimal policy outcomes change when the principal has an opportunity to affect the agent's capacity prior to the first delegation decision. Now suppose the principal can make an investment in the agent's quality capacity before the first period. For some cost, the principal can lower the agent's capacity cost. When would the legislator invest in the agent's capacity and how much would he invest?

To incorporate capacity investment into the model, we introduce a linear cost function to the legislator's decision problem. The agent has some default internal capacity which we denote as κ_0. The principal can invest in the agent's capacity by lowering the agent's quality cost. The new quality cost will be denoted κ with $2 + \epsilon \leq \kappa \leq \kappa_0$.[7] The principal pays $\gamma * (\kappa_0 - \kappa)$.

It should be clear that investing in capacity for a payoff-equivalent policy is never optimal. For example, any unstable aligned policy assures the first legislator of a utility of exactly 0. Increasing the agent's capacity for another unstable aligned policy would be costly without producing any benefit for the first legislator. Therefore the principal would incur a cost for no benefit. This also removes any possibility of capacity investment in a no turnover case.

This leaves two broad classes of equilibria where investment may be beneficial: stable equilibria for an aligned first legislator and unstable equilibria for a misaligned first legislator.

7. κ must still be greater than 2 to avoid creating quality for its own sake.

The cheaper the agent's quality cost, the better both of these equilibrium policies are for the first legislator.

However, lowering an agent's quality cost could also shift the agent's policy from an unstable policy location to a stable location. In other words, the legislator can use capacity investment to not not only improve policies within classes of equilibria but also to switch classes of equilibria.

For every value of κ, we already know the equilibrium policy. Therefore, we can let the legislator maximize over κ to find his optimal agent capacity cost. We find that if investment occurs, it always changes equilibria:

Proposition 1.5 (Capacity Investment)**.** *Let the the cost of investment γ and the original quality cost κ_0 be low enough. Then the first legislator always invests in capacity and always invests enough such that the agent chooses a stable policy.*

As long as the cost is not too large, the first legislator is willing to invest in the agent's capacity. If he's willing to invest, he makes sure to invest enough to end up in a stable equilibria. The first legislator can change from an unstable equilibrium to a stable equilibrium through the mechanism of capacity investment. This helps him in two ways. First, it improves the agent's policy, the direct benefit. It also improves the second legislator's second stage policy, the insurance benefit.

We can also show that increasing polarization increases the cutoffs for γ and κ_0. With higher cutoffs, there are more parameter values such that the legislator will invest in capacity and move from a unstable equilibrium to a stable equilibrium. This should be unsurprising, given that polarization already increases the incentive to delegate. Higher polarization increases the value of stability. Increasing polarization provides a greater incentive to invest in capacity. Therefore, if we allow for capacity investment, we should see less policy movement after an election as there will be fewer unstable equilibria policies.

This extension gives a novel reason for state capacity investment. We should not expect

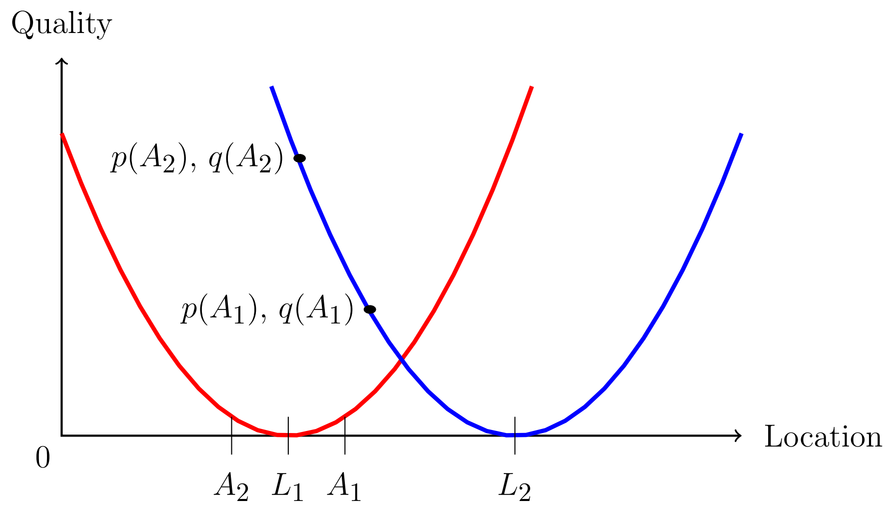


Figure 1.10. Optimal Agent Policy Choice for A_1 and A_2

to see capacity investment in regimes highly resistant to turnover as the ruling party will not see a benefit from the increased capacity. Instead, political competition incentivizes capacity investment, particularly when the agent is allied with the investing principal. The agent is worried about the transient nature of political power, and the legislator can exploit this worry by investing in the agent's capacity. With investment, the the first legislator may strictly prefer delegation to no delegation instead of simply being indifferent. However, this preference change is a direct result of the agent choosing to make the *second* legislator indifferent. This incentive only exists with a possibility of electoral turnover.

1.4.2 Choice of Agent

So far, we have assumed the first legislator has no control over his alignment with the agent. In reality, the principal often has the ability to appoint an agent. The optimal agent ideal point is not immediately clear. Does the legislator want an agent that perfectly shares his view? Or instead, does he prefer an agent with some amount of policy conflict. To analyze this question, we will let the first legislator choose the agent's ideal point before the first period. Instead of assuming the agent's ideal point is 0, we will let A vary.[8]

This choice may be constrained by outside factors, such as the available talent pool or probability of confirmation. For this reason, we will limit the legislator's choice to two agents. The agents have ideal points $A_1 \geq A_2$.

Proposition 1.6 (Legislator's Agent Choice)**.** *Let the first legislator have the choice of two possible agents.* [9] *Then, if at least one agent would choose a Stable Equilibrium, the legislator will choose the agent the farthest distance from L_2 that would choose a Stable Equilibrium.*

We can understand the intuition by looking at 1.10. Notice that the difference between the first and second legislators' indifference curves increases as the policy quality pair moves farther away from L_2. Since the gap between the curves represents the first legislator's surplus and the stable policy moves farther from L_2 as the distance between A and L_2 grows, the first legislator clearly wants A as far from L_2 as possible. Therefore he sets A a the farthest point that still results in the stable equilibrium.

As the agent's ideal point moves farther away from L_2, it becomes more important to avoid the second legislator's ideal point in the future. Therefore, increasing the distance between A and L_2 does not push the agent to avoid choosing the stable policy even though said policy is becoming more expensive. This is the same logic that leads the first legislator to delegate more often and invest in capacity more often as polarization increases.

It's worth emphasizing that, if possible, the optimal aligned agent ideal point lies on the other side of L_1 from L_2. The legislator wants to push the agent as far from L_2 as possible. He does not want a perfectly aligned agent (that is, $A = L_1$); a relatively extreme agent is more beneficial than a perfect ally. The first legislator can exploit the ideological conflict between the other two players and indeed the more the agent and second legislator are in conflict, the better.

8. Under very basic conditions this is equivalent to the principal choosing the policy location, and the 0 ideal point agent choosing quality.

9. Allowing the principal from an unbounded set of agents results in no equilibrium. The principal would choose an agent an infinite distance away from L_2.

1.5 Conclusion

Political turnover enriches the strategic implications of delegation to experts. It provides the principal with a way to mitigate the ideological conflict with his political rival, a conflict that does not exist without electoral competition. This allows us to see delegation as a form of political insurance, protecting the first legislator from an election loss.

This paper also shows how including the agent as a strategic actor instead of as a black box reveals important insights. As a player with his own preferences, the agent must balance the interests of both legislators. This then allows the delegating legislator to benefit from the conflict between the agent and the second legislator.

Traditional accounts of policy stability often rely on repeated interactions or stickiness built into the institutions. In this model, we see stability arise purely from the policy location and quality. The agent values stability, and is able to create a policy accepted by both legislators. This then removes any incentive for either legislators to implement a new policy in the future.

We should be cautious when observing stability in the real world however. For example, the The Unstable Equilibria looks like cooperation in the first period. The first legislator willingly delegates to an agent who choose a policy closer to the second legislator. It also looks like cooperation if the second legislator wins the election, as he will happily keep the agent's policy, an action that looks like policy stability. However, the first legislator retains the option to choose policy if he is reelected and he delegates with full knowledge that he can possibly overturn the agent's policy in the future.

There are still more avenues for further research. We have assumed throughout this paper that the election probability is exogenous. In many, if not most policy areas, this is a reasonable assumption. However, this need not be the case. It may be worthwhile to think about the reelection probability also being a function of the first period policy. The agent's incentives may change if he could influence the election outcome with his policy choice. Perhaps a simple version of this model could be embedded within an electoral accountability framework.

We should also think about extending the idea of turnover to other models. For example, delegation to the states may also run into possible turnover on the agent side. Governors can lose elections just and it would be illuminating to see how and when delegation occurs when the agent implementing policy may be different halfway through the project.

1.6 Appendix

Proof: Remark 1.1. The second legislator's second stage maximization problem is

$$\max_{p^2} -\left(p^2 - L_2\right)^2$$

which gives

$$p^2_{L_2} = L_2$$

Similarly, the first legislator's second stage maximization problem is

$$\max_{p^2} -\left(p^2 - L_1\right)^2$$

which gives

$$p^2_{L_1} = L_1$$

Finally, the first legislator's second stage maximization problem is

$$\max_{p^1} -\left(p^1 - L_1\right)^2$$

which gives

$$p^1_{L_1} = L_1$$

□

Proof: Lemma 1.1. Any policy, quality pair the legislator will accept must satisfy the incentive compatibility constraint of

$$q - (p - L_1)^2 \geq 0$$

Optimality requires the agent make this an equality. Therefore we can substitute

$$q = (p - L_1)^2$$

and the agent's maximization problem becomes

$$\max_p \; 2(p - L_1)^2 - 2(p - 0)^2 - \kappa(p - L_1)^2$$

Taking the derivative and then solving for p^* gives

$$p^* = L_1 - \frac{2L_1}{\kappa}$$

q^* is then

$$q^* = (-\frac{2L_1}{\kappa})^2$$

$\square$

Proof: Remark 1.2. From Lemma 0.1, if the agent chooses an outcome the legislator will accept, he will chooses $\left(L_1 - \frac{2L_1}{\kappa}, \, (-\frac{2L_1}{\kappa})^2\right)$. This gives him a utility of

$$U_A(L_1 - \frac{2L_1}{\kappa}) = \frac{4\,(L_1)^2}{\kappa} - 2\,(L_1)^2$$

If the agent chooses his own ideal point in the first period, he will choose (0, 0) and get a utility of

$$U_A(0) = 0 - (L_1)^2$$

$U_A(L_1 - \frac{2L_1}{\kappa}) \geq -(L_1)^2$ if $\kappa \leq 4$. If the agent chooses $(L_1 - \frac{2L_1}{\kappa})$, $(-\frac{2L_1}{\kappa})^2$, in the first period, his second period utility of keeping this policy is

$$\frac{(4 - \kappa)\,(L_1)^2}{\kappa}$$

which is weakly greater than 0 if $\kappa \leq 4$.

If the agent chooses $(0,\ 0)$ in the first stage, $U_{L_1}(0) < 0$ so the legislator will not delegate. Therefore delegation only occurs in the first stage if $\kappa \leq 4$.

Consider a strategy profile for the legislator where he delegates in the first stage, but puts positive probability on choosing his ideal point in the second stage and let the agent choose $\left(L_1 - \frac{2L_1}{\kappa},\ (-\frac{2L_1}{\kappa})^2\right)$ in the first stage.

The agent could deviate by choosing $\left(L_1 - \frac{2L_1}{\kappa},\ (-\frac{2L_1}{\kappa})^2 + \epsilon\right)$ in the first stage. Then retaining the agent's policy strictly dominates the first legislator's ideal point. Therefore putting positive probability on the legislator choosing his own ideal point cannot be an equilibrium.

Because both the agent and legislator will retain $\left(L_1 - \frac{2L_1}{\kappa},\ (-\frac{2L_1}{\kappa})^2\right)$ in the second stage, any mixed strategy putting positive probability only on delegation and non-delegation with policy retainment can be supported in equilibrium. □

Proof: Lemma 1.2. Any policy accepted by both legislators must give both a utility of at least 0. For any q, $U_{L_1} = U_{L_2}$ only at $p = \frac{L_1+L_2}{2}$. Therefore for any stable $(p,\ q) \neq \frac{L_1+L_2}{2}$, any $(p,\ q)$ such that $U_{L_i}(p,\ q) = 0$ and $U_{L_j}(p,\ q) \geq 0 \implies U_{L_j}(p,\ q) > 0$.

Assume $p \neq \frac{L_1+L_2}{2}$. Then for any q, there are exactly two policy locations such that a) both legislator receive weakly positive utility and b) one legislator receives a utility of exactly 0. These two policies cost the agent the same amount of effort because their quality is the same. Therefore the agent will always choose the policy location closer to his own ideal point. Because of the quadratic utility, this policy location must be in between $\frac{L_1+L_2}{2}$ and 0. This policy location gives the misaligned legislator a utility of exactly 0.[10] □

10. Let $L_j < |L_i|$ and $U_{L_j}(p,\ q) = U_{L_i}(p',\ q)$ and $U_{L_j}(p',\ q),\ U_{L_i}(p,\ q) > 0$. Then due to the quadratic utility, $|p| < p'$ and $U_A(p,\ q) > U_A(p',\ q)$.

Lemma 1.6.1 (Stable Policy Choice)**.** *The optimal stable policy location for an aligned first legislator is* $p^* = L_2 - \frac{2L_2}{\kappa}$*. The optimal stable policy location for a misaligned first legislator is* $p^* = L_1 - \frac{2L_1}{\kappa}$*.*

Proof: Lemma 1.6.1. From Lemma 1.1, we know the agent's policy choice that gives the first legislator a utility of exactly zero is $p^* = L_1 - \frac{2L_1}{\kappa}$. Similarly, the agent's policy choice that gives the second legislator of exactly zero is $p^* = L_2 - \frac{2L_2}{\kappa}$. From Lemma 1.2, we know that the agent will always give the misaligned legislator a utility of exactly 0 when choosing a stable policy. Therefore the optimal stable policy location for an aligned first legislator is $p^* = L_2 - \frac{2L_2}{\kappa}$ and the optimal stable policy location for a misaligned first legislator is $p^* = L_1 - \frac{2L_1}{\kappa}$. □

Lemma 1.6.2 (Stable feasibility)**.** *The stable policy location for an aligned first legislator is feasible if* $\kappa \leq \frac{4L_2}{L_2 - L_1}$*. The stable policy location for a misaligned first legislator is feasible if* $\kappa \leq \frac{4L_1}{L_1 - L_2}$*.*

Proof: Lemma 1.6.2. From Lemma 1.2, we know that that a stable policy must be in between $\frac{L_1+L_2}{2}$ and 0. $L_2 - \frac{2L_2}{\kappa}$ lies in between $\frac{L_1+L_2}{2}$ if $\kappa \leq \frac{4L_2}{L_2-L_1}$. $L_1 - \frac{2L_1}{\kappa}$ lies in between $\frac{L_1+L_2}{2}$ if $\kappa \leq \frac{4L_1}{L_1-L_2}$. □

Lemma 1.6.3 (Agent unstable outcome choice)**.** *When choosing an unstable policy accepted by one legislator, the agent will chose* $L_1 - \frac{(1+\pi)L_1}{k}$ *or* $L_2 - \frac{(2-\pi)L_2}{k}$

Proof Lemma 1.6.3. Choosing a policy only the first principal accepts results in this maximization problem for the agent:

$$\max_p (1 + \pi - \kappa)(p - L_1)^2 - (1 + \pi)(p)^2 - (1 - \pi)(L_2)^2$$

which gives an optimal policy of

$$p_1^* = L_1 - \frac{(1+\pi)L_1}{\kappa}$$

Similarly, the maximization problem for a policy only the second principal accepts is

$$\max_p (1 + (1-\pi) - \kappa)(p - L_2)^2 - (1 + (1-\pi))(p)^2 - \pi(L_1)^2$$

which gives an optimal policy of

$$p_2^* = L_2 - \frac{(2-\pi)L_2}{\kappa}$$

□

Lemma 1.6.4 (Misaligned Unstable Choice)**.** *The unstable policy choice favoring the misaligned legislator is never optimal.*

Proof: Lemma 1.6.4. I will show this holds for $L_1 < |L_2|$, the other case is similar. For the opposing, unstable outcome to be optimal, we need

$$U_A(L_2 - \frac{(2-\pi)L_2}{\kappa}) \geq U_A(L_1 - \frac{(1+\pi)L_1}{\kappa})$$

and

$$U_A(L_2 - \frac{(2-\pi)L_2}{\kappa}) \geq U_A(L_2 - \frac{2L_2}{\kappa})$$

which is false □

Lemma 1.6.5 (Upper bound on κ)**.** *The first legislator will never delegate when $\kappa > 4$.*

Proof: Lemma 1.6.5. If $\kappa > 4$, the agent's utility from choosing his own ideal point dominates both the optimal stable policy and optimal unstable policy policy regardless of alignment or election probability. The first legislator never delegates when the agent's chooses his own ideal point and therefore will never delegate when $\kappa > 4$. □

Proof: Proposition 1.1. Assume all players are playing a stable equilibrium as defined in Proposition 1.1. By the definition of a stable policy choice, both legislators would receive a utility of at least 0 from the agent's stable policy choice. The greatest utility a legislator can receive when moving policy himself is 0. Therefore there is no profitable deviation for either legislator to move the agent's policy choice.

We need to show that it is optimal for the agent to choose the stable policy. From Lemma 1.6.2 and Proposition 1.6.5, we know the upper bounds on κ for stable policies. If either of these bounds are violated, there is no stable equilibria. We will show specifically for aligned first legislator; a misaligned first legislator is similar.

The agent prefers the stable policy to his own ideal point if

$$U_A\left(L_2 - \frac{2L_2}{\kappa}\right) \geq U_A\left(0\right)$$

This inequality holds if

$$\pi \leq \frac{L_2^2\left(4-\kappa\right)}{\kappa\left(L_2^2 - L_1^2\right)}$$

Similarly, the agent prefers the stable policy to the unstable policy if

$$U_A\left(L_2 - \frac{2L_2}{\kappa}\right) \geq U_A\left(L_1 - \frac{(1+\pi)L_1}{k}\right)$$

this inequality holds if

$$\pi \leq \frac{k(L_1^2 - L_2^2) - 2L_1^2 + \sqrt{16L_1^2L_2^2 + k^2(L_1^2 - L_2^2)^2}}{2L_1^2}$$

Therefore the agent will choose the stable policy if

$$\pi \leq min\left[\frac{L_2^2\,(4-\kappa)}{\kappa\left(L_2^2-L_1^2\right)},\ \frac{k(L_1^2-L_2^2)-2L_1^2+\sqrt{16L_1^2L_2^2+k^2(L_1^2-L_2^2)^2}}{2L_1^2}\right]$$

□

Proof: Proposition 1.2. Straight consequence of Lemma 1.2 and Proposition 1.1. If the first principal is aligned with the agent, then he gets a positive surplus in a stable equilibrium. □

Remark 1.3 (Unstable Equilibria for an Aligned First Legislator)**.** *Let the first legislator be aligned with the agent and* $2 < \kappa \leq 4$*. Then* $\exists\ \hat{\pi}_1$ *such that if* $\pi \geq \hat{\pi}_1$ *all SPNE must be of the form*

- *The first legislator delegates in the first stage*
- *The agent chooses the first legislator unstable policy*
- *The first legislator retains this policy in the second stage, while the second legislator chooses his ideal point.*

Remark 1.4 (No delegation Equilibrium)**.** *Let* $\kappa > 4$ *or let* π *not satisfy the conditions from any other equilibria. Then there exists a unique Subgame Perfect Equilibrium where there is no delegation in either stage. In each stage, the legislator in power chooses his own ideal point with* 0 *quality.*

Proof: Proposition 1.3. Let $\pi < \bar{\pi}_2$ such that a stable policy is not optimal for the agent. The agent chooses $p = L_2 - \frac{(2-\pi)L_2}{\kappa}$ if

$$U_A\left(L_2 - \frac{(2-\pi)L_2}{\kappa}\right) \geq U_A\,(0)$$

This inequality holds if

$$\pi \leq 2 - \sqrt{\kappa}$$

Because this is an unstable policy, the first legislator would choose his ideal point in the second stage while the second legislator would retain the agent's policy. The first legislator will only delegate if

$$U_{L_1}\left(L_2 - \frac{(2-\pi)L_2}{\kappa}\right) \geq U_{L_1}\left(L_1\right)$$

This is only true if

$$\pi \leq 2 - \sqrt{\frac{\kappa\left(L_2 - L_1\right)}{2L_2}}$$

$2 - \sqrt{\frac{\kappa(L_2-L_1)}{2L_2}} \leq 2 - \sqrt{\kappa}$, so the first legislator will delegate if

$$\pi \leq min\left[\bar{\pi}_2,\ 2 - \sqrt{\frac{\kappa\left(L_2 - L_1\right)}{2L_2}}\right]$$

□

Proof: Remark 1.3. From Lemma 1.6.3, the agent will not choose $p = L_2 - \frac{(2-\pi)L_2}{\kappa}$. Since $\pi > \bar{\pi}_1$, the agent will not choose a stable policy (Proposition 1.1). The other possible equilibrium location is $p = L_1 - \frac{(1+\pi)L_1}{\kappa}$. The agent chooses $p = L_1 - \frac{(1+\pi)L_1}{\kappa}$ over his own ideal point if

$$U_A\left(L_1 - \frac{(1+\pi)L_1}{\kappa}\right) \geq U_A\left(0\right)$$

This inequality holds if

$$\pi > \sqrt{\kappa} - 1$$

$L_1 - \frac{(1+\pi)L_1}{k}$ gives the first legislator a utility of 0, and in equilibrium, he will retain the first stage policy (similar proof to the No Turnover Equilibrium). The second legislator will choose his own ideal point in the second stage. □

Proof: Remark 1.4. Let $L_1 < |L_2|$. Then for the agent to choose his own ideal point he needs $U_A(0) \geq U_A(L_1 - \frac{(1+\pi)L_1}{\kappa})$ and $U_A(0) \geq U_A(L_2 - \frac{2L_2}{\kappa})$. This is true $\forall \pi$ if $\kappa > 4$. □

Proof: Proposition 1.4. Will show for $\bar{\pi}_1$, similar for $\bar{\pi}_2$.

$$\bar{\pi}_1 = \frac{\kappa(L_1^2 - L_2^2) - 2L_1^2 + \sqrt{16L_1^2L_2^2 + k^2(L_1^2 - L_2^2)^2}}{2L_1^2}$$

or

$$\frac{L_2^2\,(4-\kappa)}{\kappa\left(L_2^2 - L_1^2\right)}$$

. For both, if $L_2 < 0$,

$$\frac{\partial \bar{\pi}_1}{\partial L_1} \geq 0$$

$$\frac{\partial \bar{\pi}_1}{\partial L_2} \leq 0$$

Similarly, if $L_2 > 0$

$$\frac{\partial \bar{\pi}_1}{\partial L_1} \leq 0$$

$$\frac{\partial \bar{\pi}_1}{\partial L_2} \geq 0$$

For $\hat{\pi}_2$, $L_2 < 0$. We have

$$\frac{\partial \hat{\pi}_2}{\partial L_1} \geq 0$$

$$\frac{\partial \hat{\pi}_2}{\partial L_2} \leq 0$$

□

Lemma 1.6.6 (Capacity Cutoffs)**.** *Assume that the legislator in vests in the agent's capacity. Then* $\exists$ *a* $\bar{\gamma}$ *and an interval* I_{L_2} *such that if* $\gamma < \bar{\gamma}$ *and* $L_2 \notin I_{L_2}$ *then the legislator will invest in capacity such that* $\kappa^* = 2 + \epsilon$.

Proof: Lemma 1.6.6. Assume the first legislator is aligned with the agent . The maximization problem for the legislator is

$$\max_{\kappa} \; U_{L_1}\left(L_2 - \frac{2L_2}{\kappa}\right) - \gamma\left(\kappa_0 - \kappa\right)$$

$$s.t.\; 2 + \epsilon \leq \kappa \leq \kappa_0$$

if $\gamma \leq \frac{4\left(L_2^2 - L_2\right)}{\kappa_0}$ and $L_2 \notin \left[1,\; \frac{1+\sqrt{5}}{2}\right]$ then

$$\kappa^* = 2 + \epsilon$$

otherwise

$$\kappa^* = \kappa_0$$

□

Proof: Proposition 1.5. From Lemma 1.6.6, we know that if the legislator invests in capacity, he will invest enough to make $\kappa = 2+\epsilon$. Therefore we only need to compare the utility from an Unstable Equilibrium to a Stable Equilibrium. If the conditions from the above Lemma hold such that $\kappa^* = 2 + \epsilon$, then

$$U_{L_1}(L_2 - \frac{2L_2}{1}) \leq U_{L_1}(L_1 - \frac{(1+\pi)L_1}{\kappa_0})$$

this inequality holds if

$$\kappa \leq \; min \left[\frac{4\left(L_2^2 - L_2\right)}{\gamma},\; 2 + \frac{1 + \pi + 2L_2 - 2L_2\pi - 3L_2^2 + L_2^2\pi}{\gamma}\right]$$

Note that $\kappa \leq \frac{4\left(L_2^2 - L_2\right)}{\gamma}$ must be true from 1.6.6. □

Remark 1.5 (Comparative Statics on Capacity Investment)**.** *Higher polarization increases the cutoffs for γ and κ_0*

Proof: Remark 1.5. We can take the derivative of the capacity investment cutoff with respect to L_2

$$\frac{\partial \frac{4(L_2^2 - L_2)}{\kappa_0}}{\partial L_2} > 0$$

if

$$L_2 > 0$$

and

$$\frac{\partial \frac{4(L_2^2 - L_2)}{\kappa_0}}{\partial L_2} < 0$$

if

$$L_2 < 0$$

Similarly,

$$\frac{\partial 2 + \frac{1+\pi+2L_2-2L_2\pi-3L_2^2+L_2^2\pi}{\gamma}}{\partial L_2} > 0$$

if

$$L_2 > 0$$

and

$$\frac{\partial 2 + \frac{1+\pi+2L_2-2L_2\pi-3L_2^2+L_2^2\pi}{\gamma}}{\partial L_2} < 0$$

if

$$L_2 < 0$$

Which states that both cutoffs are increasing in polarization □

Proof: Proposition 1.6. Without loss of generality, assume $0 < L_1 < L_2$. Consider any two agents with ideal points $A_1 < A_2$ and assume both would choose a stable policy. There are three cases: 1) The first legislator is misaligned with both. 2) The first legislator is aligned with one and misaligned with the other. 3) The first legislator is aligned with both.

Case 1: Any stable equilibria with a misaligned first legislator always guarantees him a utility of 0. Therefore it does not matter which agent he chooses.

Case 2: Any stable equilibria with an aligned first legislator guarantees him a utility strictly greater than 0. If only one agent is aligned with the first legislator, it must be A_1. Therefore the legislator will choose A_1, which is the legislator farther from L_2.

Case 3: A stable equilibria with an aligned first legislator will have a policy location of $L_2 + \frac{2(A-L_2)}{\kappa}$ and a quality of $\left(\frac{2(A-L_2)}{\kappa}\right)^2$. The first legislator will choose A_1 if

$$U_{L_1}\left(L_2 + \frac{2\left(A_1 - L_2\right)}{\kappa}\right) \geq U_{L_1}\left(L_2 + \frac{2\left(A_2 - L_2\right)}{\kappa}\right)$$

This inequality holds if

$$A_1 \leq A_2$$

□

CHAPTER 2

DELEGATION TO AN OVERCONFIDENT EXPERT (W/ SCOTT ASHWORTH)

Policy-making inevitably involves delegating some decision-making power to experts with superior knowledge. Strikingly, delegation in the political realm rarely involves explicit monetary incentives. This poses a puzzle for the standard theory of incentives. Indeed, Baron (2000) and Krishna and Morgan (2008) show that using monetary transfers would benefit the policymaker in the canonical models political scientists use to study delegation to experts.

Most models of delegation simply assume away monetary incentives. This shortcut has the virtue of verisimilitude, and it has facilitated a rich applied literature (usefully surveyed in Gailmard and Patty, 2012). Still, it would be more theoretically satisfying to derive the lack of monetary incentives as a result, rather than assume it directly.

We suggest a new rationale for delegating without monetary incentives. We model a situation where the policymaker and the expert agree that the expert knows more about the effects of policies, but they disagree about how much more the expert knows.[1] The policymaker and the expert do not disagree about goals—they have the same preferences over outcomes. We characterize the optimal mechanism, assuming that monetary transfers are possible, subject to the expert's limited liability.

We focus on an expert who suffers from overprecision—she believes her information is more accurate than the policymaker thinks is warranted. Studies in psychology show, across many domains, that people are more confident in their probabilistic judgments than their information warrants (Griffin and Tversky, 1992).[2] Experts are not immune. For example, Haran et al. (2010) interpret the lack of overlap in the predictive confidence intervals of

1. See Hirsch (2016) for another model of disagreement between a principal and agent. In his model, the disagreement is over policy fundamentals, not over the accuracy of information about policy fundamentals.

2. See Ortoleva and Snowberg (2015) for a model of overprecision and voter behavior.

climate experts reported by Morgan and Keith (1995) as evidence of overconfidence about the possible ranges of both temperature outcomes and the environmental impacts of climate change. Based on such evidence, Keller and Nicholas (2013, p. 12) argue that "[t]he resulting overconfidence can lead to risk estimates that are biased toward smaller values and, as a result, too-small investments in risk management".

Our main result says that, when the expert suffers from overprecision, the policymaker sets monetary incentives identically to zero. A delegation window, in which the expert chooses policy from an interval of allowed choices, is optimal. The policymaker (partially) controls the expert by choosing an interval that excludes the more extreme choices the expert might find optimal.

This result contrasts sharply with the optimal mechanisms found by Baron (2000) and Krishna and Morgan (2008) in the standard additive-bias model. A key difference between their setting and ours is that overprecision leads to a variable degree of realized conflict of interest between the policymaker and the expert. The distance between the policy the policymaker would choose given the expert's information and the policy the expert would choose is increasing in the distance between the realization of that information and its prior expectation. As a result, there is an additional force that reduces the value using transfers to shape the policy choice.

Our result compliments other findings that a delegation window is optimal even when transfers are possible.[3] Gailmard (2009) argues that a delegation window will be optimal when the legislature cannot make an ex-ante commitment to monetary incentives. Our result shows that, in a substantively salient case, such a commitment, even if feasible, is not valuable.[4]

3. Our analysis is also related to the economics literature on contracting with overconfidence. See, for example, Grubb (2009), De la Rosa (2011), and Sandroni and Squintani (2007).

4. Diermeier and Feddersen (1998) and Callander et al. (2008) study other issues related to the possibility of commitment in a legislative context.

2.1 The Model

There are two actors, a Legislator and an Expert. Together, they will determine a policy $p \in [0, 1]$.

Information Structure The optimal policy depends on the state of the world $\omega \in [0, 1]$. Neither player knows this state. They share a common prior that the state is uniformly distributed on $[0, 1]$.

The Expert, but not the Legislator, observes a signal correlated with the state of the world. This signal is not verifiable, and cannot be shared with the Legislator.

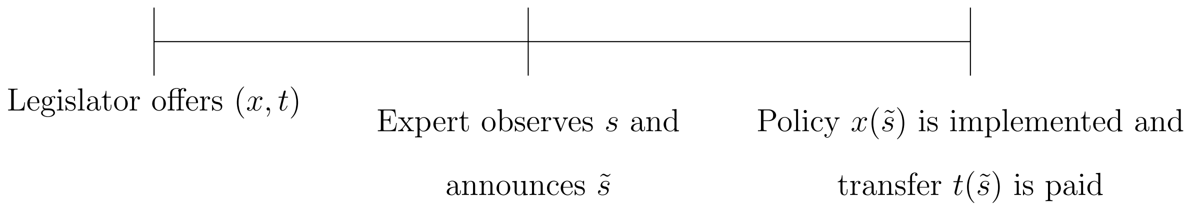
The players agree that, with some probability, the signal is equal to the state, and, with complimentary probability, the signal is the realization of a random variable distributed uniformly on $[0, 1]$, independent of the state. The players disagree about the probability that the signal equals the state. Denote player i's probability assessment the the signal equals the state by π^i. To capture the Expert's overprecision, assume $\pi^E > \pi^L$.

Contracts We take a mechanism design approach to the institutional choice. The policy and a transfer will be determined by the Expert's report about the signal he observes. Denote the reported signal by $\tilde{s}$.

A **mechanism** is a pair (x, t), where $x : [0, 1] \to [0, 1]$ specifies the policy choice as a function of the signal and $t : [0, 1] \to \mathbb{R}_+$ specifies a transfer paid by the Legislator to the Expert as a function of the signal. Notice that t takes nonnegative values; this reflects the limited liability of the Expert.

To facilitate using optimal control techniques, we impose some technical conditions on mechanisms. First, x and t are each continuous and piecewise differentiable. Second, there is a constant $K > 1$ such that $\left|\frac{dx}{ds}(s)\right| \leq K$ for all s at which t is differentiable. Denote by $\mathcal{M}$ the set of all such mechanisms.

The timing is as follows:



Preferences The Legislator and Expert share the same state-contingent preferences over policies, desiring to maximize the expectation of $-(p-\omega)^2$. Denote player i's expectation of this quantity, given signal s, by $u^i(p, s)$.

Transfers enter each player's payoffs quasi-linearly. Thus, if the signal is s, the policy is p, and the transfer is t, then the Legislator's Bernoulli utility is $u^L(p, s) - t$ and the Expert's Bernoulli utility is $u^E(p, s) + t$.

Interpretation Taken literally, a mechanism is a very particular kind of institution. The Expert simply reports (truthfully or not) the signal, and the policy and transfer are mechanically implemented. But the formalism is actually far more flexible. The famous *Revelation Principle* says that the outcome of any equilibrium in any institution can be replicated by a mechanism in which players maximize utility by reporting the truth. (For a textbook treatment by one of the principles's discoverers, see Myerson (1997, ch. 6).)

The Revelation Principle licenses the following procedure. First, we will characterize the mechanism that maximizes the Legislator's expected payoff, subject to the constraint that the Expert always wants to truthfully reveal her signal. Second, we will present a simple institution that attains the same expected payoff for the Legislator. By the Revelation Principle, we can conclude that that institution is in fact optimal for the Legislator.

2.2 The Optimal Mechanism

The mechanism (x, t) is **incentive compatible** if:

$$u^E(x(s), s) + t(s) \geq u^E(x(s'), s) + t(s') \quad \text{for all } s, s'. \tag{2.1}$$

In words, the Expert prefers to report the true signal s rather than any other signal s', no matter what the true s is.

To get a sense of what incentive compatibility implies, it will be useful to look at some examples. To facilitate this, let $x^i(s)$ be player i's privately optimal policy when the signal is s, so $x^i(s) = \text{argmax}_p\, u^i(p, s)$. We can calculate these directly:

Lemma 2.1. $x^L(s) = \pi^L s + (1 - \pi^L)\frac{1}{2}$ *and* $x^E(s) = \pi^E s + (1 - \pi^E)\frac{1}{2}$

Proof. See Appendix 2.4.1. ■

> **Example 1** Consider an incentive compatible mechanism (x, t) where transfers are identically zero, $t(s) = 0$ for all s. If s is an interior point where x is differentiable, then Inequality 2.1 implies:
>
> $$\frac{\partial}{\partial p} u^E(x(s), s) \frac{d}{ds} x(s) = 0.$$
>
> Two focal mechanisms satisfy this. In one, the Expert gets the policy $x^E(s)$ (and $\partial u^E / \partial p = 0$). In the other, the policy is constant (and $dx/ds = 0$).

The canonical **delegation window** a la Holmstrom et al. (1982) and Epstein and O'halloran (1994) combines the two possibilities from Example 1. A delegation window chooses the expert's optimal policy when the signal lies within an interval $[\underline{s}, \overline{s}]$ and chooses the policy equal to the closest interval endpoint when the signal lies outside the interval. But more is possible with non-constant transfers.

The calculation in Example 1 is a special case of a more general characterization of incentive compatibility.

Lemma 2.2. *The mechanism (x, t) is incentive compatible if and only if:*

1. *x is (weakly) increasing, and*

2. *$t'(s) = -\frac{\partial u^E}{\partial p}(x(s), s) \cdot x'(s)$ at all s where x is differentiable.*

Proof. See Theorems 7.1 and 7.3 in Fudenberg and Tirole (1991). ■

This result opens up possibilities rather different from the standard delegation window.

> **Example 2** The Legislator's privately optimal policy has $\frac{dx^L}{ds}(s) = \pi^L > 0$. Thus Lemma 2.2 implies that the transfer function $\hat{t}^L(s) = -\int_0^s \frac{\partial u^E}{\partial p}(x^L(\tilde{s}), \tilde{s}) \cdot \pi^L \, d\tilde{s}$ makes $(x^L, \hat{t}^L)$ incentive compatible. Taking $t^L(s) = \hat{t}^L(s) - \min_{\tilde{s}} \hat{t}^L(\tilde{s})$ gives a mechanism (x^L, t^L) that is both incentive compatible and has nonnegative transfers.

The mechanism in Example 2 guarantees the Legislator the same policy she would get if she directly observed the state of the world. This is something no simple delegation window can achieve. Given that as a possibility, it comes as something of a surprise that positive transfers are not used at all in the optimum.

The optimal mechanism is determined by the Program:

$$\begin{aligned}
\max_{(x,t,v)} \int_0^1 & u^P(x(s), s) - t(s) \, ds \\
\text{st } & x(\cdot) \text{ is weakly increasing} \\
& t'(s) = -\frac{\partial u^E}{\partial p}(x(s), s) \cdot v(s) \\
& x'(s) = v(s) \\
& t(s) \geq 0 \\
& |v(s)| \leq K.
\end{aligned} \tag{2.2}$$

The new control variable v facilitates writing the optimization problem in the canonical form for optimal control; the constraints on that variable ensure that the mechanism is in $\mathcal{M}$.

Proposition 2.1. *Let* $\underline{s} = \frac{\pi^E - \pi^L}{2\pi^E - \pi^L}$. *The unique solution to Program 2.2 is* (x^*, t^*), *where:*

$$x^*(s) = \begin{cases} x^E(\underline{s}) & \text{if } s \leq \underline{s} \\ x^E(s) & \text{if } \underline{s} < s < \overline{s} \\ x^E(1-\underline{s}) & \text{if } 1-\underline{s} \leq s \end{cases},$$

and $t^*(s) = 0$ *for all* s.

Proof. See Appendix 2.4.2. ■

Corollary 2.1. *A delegation window is an optimal institution.*

Proof. The payoffs from the mechanism in Proposition 2.1 are attained when the Expert is allowed to choose any policy in the interval $[x^E(\underline{s}), x^E(1-\underline{s})]$. ■

Figure 2.1 illustrates the optimal mechanism.

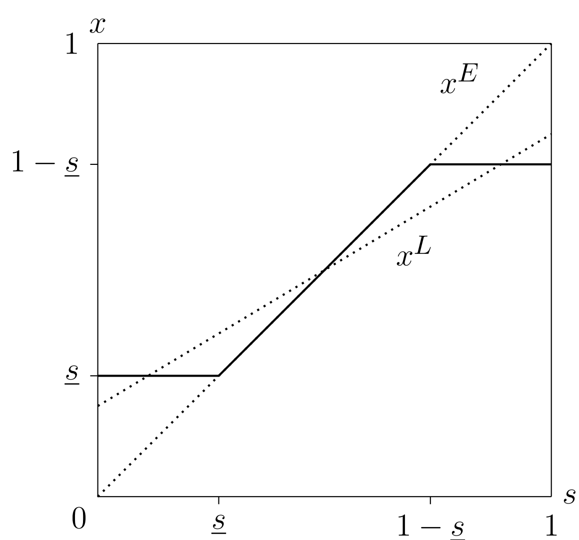


Figure 2.1. The solid curve in the policy function in an optimal mechanism. The dashed lines are the privately optimal policies.

2.3 Discussion

When the Legislator believes the Expert is overconfident about the quality of her information, monetary transfers are not used in the optimal delegation mechanism. Why is this?

To start thinking about an answer, it is instructive to consider how transfers could be used. Lemma 2.2's condition on $t'(s)$ has an important implication. Suppose the mechanism (x, t) has policy more moderate than what the Expert would choose left to her own devices: $s < \frac{1}{2}$ implies $x(s) > x^E(s)$ and $s > \frac{1}{2}$ implies $x(s) < x^E(s)$. Since:

$$t'(s) = 2\left(x(s) - x^E(s)\right)x'(s),$$

the transfer to the Expert must be increasing for $s < 1/2$ and decreasing for $s > 1/2$. Intuitively, the Expert gets incentives to accept moderate policies because transfers are used to boost her payoff at $s = 1/2$, and these transfers are taken away as the reported signal becomes more extreme. Since the policy at s affects the rate of change of the Expert's payoff at s, there is a linkage between the choice at s and at a nearby signal $s + \epsilon$.

A central idea of optimal control is to capture this linkage via a dynamic analogue of Lagrange multipliers. In Appendix 2.4.3, we use these techniques to find out what the policy would have to be in a mechanism that used positive transfers. Specifically, if there were a solution to Program 2.2 in which x is symmetric about $\frac{1}{2}$ and has positive transfers on some interval around $\frac{1}{2}$, then it must have:

$$x(s) = \frac{x^L(s) + x^E(s)}{2} + \left(s - \frac{1}{2}\right)\frac{\pi^E}{2}$$

on that interval. The first term is the maximizer of $u^L(x, s) + u^E(x, s)$, and is the policy that would be implemented if the limited liability constraint were weakened to an ex-ante participation constraint. The second term is an adjustment designed to help economize on transfers.

Notice that $x'(s) = \pi^E + \frac{1}{2}\pi^L$, so the rate of increase of this policy function is strictly greater than π^E. But this slope is a problem. Consider, for example, the mechanism with policy function shown in Figure 2.2. The Legislator would do better with the delegation window shown in Figure 2.1—it has (weakly) better policy for every signal, and involves no transfers.

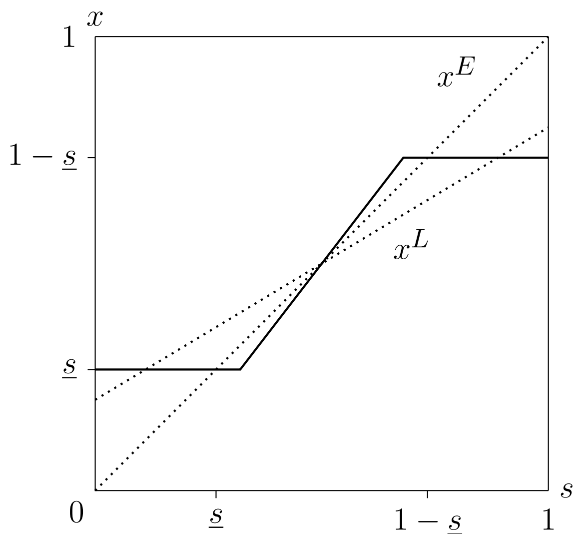


Figure 2.2. The solid curve in the policy function in a mechanism that uses positive transfers. The dashed lines are the privately optimal policies.

We can compare this to what obtains in the more usual additive-bias model a la Crawford and Sobel (1982). Krishna and Morgan (2008) solve for the optimal mechanism in this case. Like us, they find that, when transfers are positive, the slope of the policy function must be greater than the slope of the joint surplus maximizing policy function. But in their model, this is a perfectly sensible mechanism to use. Figure 2.3 shows that the slope can be steep until the policy function hits the line representing the Expert's ideal policy, and then continue as in a delegation window.

The key difference between the models is that their Legislator and Expert have ideal policies that are parallel shifts of one another, while in our model they cross. This is because our Legislator and Expert have a conflict of interest that depends on the signal, and actually vanishes at the neutral news signal $s = \frac{1}{2}$, as in Che and Kartik (2009).

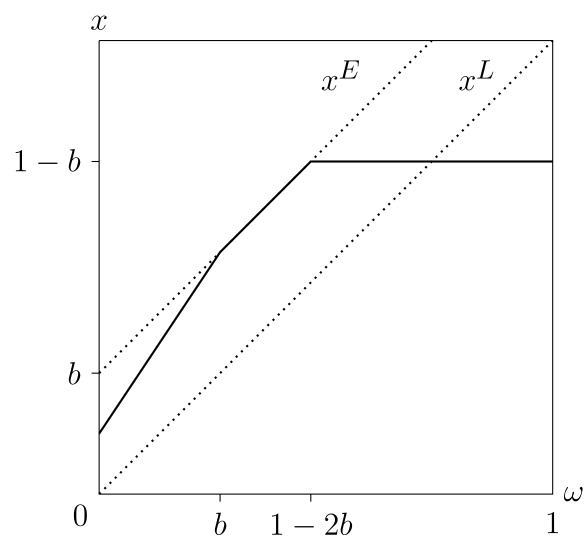


Figure 2.3. The solid curve in the policy function in an optimal mechanism for the additive bias model. The dashed lines are the privately optimal policies. This is a case with $b < \frac{1}{3}$.

2.4 Appendix

2.4.1 Preliminary Results

Lemma 2.3. *Fix a signal realization s.*

1. *Player i's posterior distribution on ω is:*

$$F^i(\omega \mid s) = \begin{cases} 0 & \text{if } \omega < 0 \\ (1-\pi^i)\omega & \text{if } 0 \le \omega < s \\ \pi^i + (1-\pi^i)\omega & \text{if } s \le \omega \le 1 \\ 1 & \text{if } 1 < \omega \end{cases} . \tag{2.3}$$

2. *Player i's posterior expectation of ω is:*

$$\mathbb{E}^i(\omega \mid s) = \pi^i s + (1-\pi^i)\frac{1}{2}.$$

Proof. Part 1 is the example in Section 4 of Macci (1996), specialized to the uniform distribution on $[0,1]$. Part 2 follows by integration. ■

Lemma 2.4. *Fix a signal realization s.*

1. $\frac{\partial u^i}{\partial p}(p,s) = -2(p - \mathbb{E}^i(\omega \mid s))$.

2. u^i *is concave in* p.

3. $x^i(s) = \mathbb{E}^i(\omega \mid s)$.

Proof. From the law of total variance:

$$\begin{aligned} u^i(p,s) &= \int_0^1 -(p-\omega)^2 \, dF^i(\omega \mid s) \\ &= -(p - \mathbb{E}^i(\omega \mid s))^2 - \mathrm{var}^i(\omega \mid s) \end{aligned}$$

Differentiate to get parts 1 and 2; solve $\frac{\partial u^i}{\partial p}(p,s) = 0$ to get part 3. ■

Proof of Lemma 2.1. Immediate from part 2 of Lemma 2.3 and part 2 of Lemma 2.4. ■

2.4.2 Proof of Proposition 2.1

Recall the optimal mechanism is determined by Program 2.2. Consider the *relaxed program:*

$$\begin{aligned} \max_{(x,t,v)} & \int_0^1 u^P(x(s),s) - t(s) \, ds \\ \text{st } t'(s) &= -\frac{\partial u^E}{\partial p}(x(s),s) \cdot v(s) \\ x'(s) &= v(s) \\ t(s) &\geq 0 \\ \left| \frac{dt}{ds}(s) \right| &\leq K. \end{aligned} \tag{2.4}$$

We will show that the (essentially) unique solution to the relaxed program is (x^*, t^*, v^*), where:

$$v^*(s) = \begin{cases} \pi^E & \text{if } s \in [\underline{s}, 1 - \underline{s}] \\ 0 & \text{otherwise.} \end{cases}$$

Since x^* is weakly increasing, that will imply that (x^*, t^*) is in fact the optimal mechanism.

Writing λ_1 for the co-state on x and λ_2 for the co-state on t, the Hamiltonian is:

$$\mathcal{H}(s, v, x, t, \lambda_1, \lambda_2) = u^L(x, s) - t + \lambda_1 v - \lambda_2 \frac{\partial u^E}{\partial p}(x, s) \cdot v.$$

Writing $\mu \geq 0$ for the multiplier on the state-variable inequality constraint, the Lagrangian is:

$$\mathcal{L}(s, v, x, t, \lambda_1, \lambda_2, \mu) = \mathcal{H}(s, v, x, t, \lambda_1, \lambda_2) + \mu \cdot t(s). \tag{2.5}$$

The **Pontryagin conditions** are:

$$\frac{\partial \lambda_1}{\partial s} = -\frac{\partial \mathcal{L}}{\partial x} \qquad \text{(Co-state 1)}$$

$$\frac{\partial \lambda_2}{\partial s} = -\frac{\partial \mathcal{L}}{\partial t} \qquad \text{Co-state 2)}$$

$$v \in \arg \max_{v \in [-K, k]} \mathcal{L} \qquad \text{(Static optimality)}$$

$$\lambda_1(0) = \lambda_1(1) = 0 \qquad \text{(Transversality condition 1)}$$

$$\lambda_2(0) = \lambda_2(1) = 0 \qquad \text{(Transversality condition 2)}$$

$$\mu \cdot t(s) = 0 \qquad \text{(Complementary slackness)}$$

Lemma 2.5. *Fix $(x, t) \in \mathcal{M}$, and let $v(s) = x'(s)$ for all differentiability points of x. Suppose there is a $(\lambda_1, \lambda_2, \mu)$ such that:*

1. *λ_1 and λ_2 are continuous and piece-wise differentiable,*

2. μ is piece-wise continuous, and

3. $(v, x, t, \lambda_1, \lambda_2, \mu)$ satisfy the Pontryagin conditions.

Then (v, x, t) solves the relaxed program, and any solution to the relaxed program has state trajectories (x, t).

Proof. We apply Theorem 8.2 and Corollary 8.1 in Hartl et al. (1995). There is only one hypothesis that is not trivial to verify.

The maximized Hamiltonian is:

$$\mathcal{H}^*(s, x, t, \lambda_1, \lambda_2) = \max_{v \in [-K, K]} \mathcal{H}(s, v, x, t, \lambda_1, \lambda_2).$$

Because the Hamiltonian is linear in v, the maximum is either $\mathcal{H}(s, -K, x, t, \lambda_1, \lambda_2)$ or $\mathcal{H}(s, K, x, t, \lambda_1, \lambda_2)$. In either case, Lemma 2.4 implies that $\mathcal{H}^*(s, x, t, \lambda_1, \lambda_2)$ is concave in x and t. ■

Substituting our functional forms, the first three Pontryagin conditions become:

$$\begin{aligned} \lambda_1' &= 2(x - \pi^L s - (1 - \pi^L)\frac{1}{2}) - 2\lambda_2 v \\ \lambda_2' &= 1 - \mu \\ 0 &= \lambda_1 + 2\lambda_2(x - \pi^E s - (1 - \pi^E)\frac{1}{2}) \end{aligned}$$

Recalling that $\underline{s} = \frac{\pi^E - \pi^L}{2\pi^E - \pi^L}$, it is straightforward to verify the Pontryagin conditions for

$(v^*, x^*, t^*, \lambda_1^*, \lambda_2^*, \mu^*)$, where:

$$\lambda_1(s) = \begin{cases} 2\left(\pi^E(1-\underline{s}) + (\pi^L - \pi^E)\frac{1}{2}\right)(1-s) - \pi^L(1-s^2) & \text{if } s > 1-\underline{s} \\ 0 & \text{if } 1-\underline{s} \geq s \geq \underline{s} \\ 2\left(\pi^E\underline{s} + (\pi^L - \pi^E)\frac{1}{2}\right)s - \pi^L s^2 & \text{if } \underline{s} > s \end{cases}$$

$$\lambda_2(s) = \begin{cases} \frac{\pi^L}{2\pi^E}(1-s) & \text{if } s > 1-\underline{s} \\ \frac{(\pi^E - \pi^L)(s-\frac{1}{2})}{\pi^E} & \text{if } 1-\underline{s} \geq s \geq \underline{s} \\ -\frac{\pi^L}{2\pi^E}s & \text{if } \underline{s} > s \end{cases}$$

$$\mu(s) = \begin{cases} 1 - \frac{\pi^L}{2\pi^E} & \text{if } s > 1-\underline{s} \\ \frac{\pi^L}{\pi^E} & \text{if } 1-\underline{s} \geq s \geq \underline{s} \\ 1 + \frac{\pi^L}{2\pi^E} & \text{if } \underline{s} > s \end{cases}.$$

2.4.3 Calculations for Section 2.3

Recall that the Pontryagin conditions are:

$$\begin{aligned} \lambda_1' &= 2(x - \pi^L s - (1-\pi^L)\frac{1}{2}) - 2\lambda_2 v \\ \lambda_2' &= 1 - \mu \\ 0 &= \lambda_1 + 2\lambda_2(x - \pi^E s - (1-\pi^E)\frac{1}{2}) \\ \lambda_1(0) &= \lambda_1(1) = 0 \\ \lambda_2(0) &= \lambda_2(1) = 0 \\ \mu(s)t(s) &= 0 \end{aligned}$$

Conjecture a solution in which x is symmetric about $\frac{1}{2}$ and, on some interval around $\frac{1}{2}$, transfers are positive. In such a case, $\mu = 0$. Using the second co-state equation, differentiate the static maximization condition to get:

$$0 = \lambda_1' + 2(x - \pi^E s - (1 - \pi^E)\frac{1}{2}) + 2\lambda_2(x' - \pi^E).$$

Substitute from the first co-state equation and use $x' = v$ to solve for x:

$$x(s) = \frac{x^L(s) + x^E(s)}{2} + \frac{1}{2}\lambda_2(s)\pi^E.$$

Integrate the second co-state equation to get $\lambda_2(s) = s - K$. Symmetry of x about $\frac{1}{2}$ then implies:

$$x(s) = \frac{x^L(s) + x^E(s)}{2} + (s - \frac{1}{2})\frac{\pi^E}{2}.$$

CHAPTER 3

DELEGATION, INFORMATION, AND FEDERALISM

3.1 Introduction

The European Union has a distinction between Regulations (binding legal acts applicable with discretion for all member states) and Directives (framework with discretion for member states to pursue the law's goal as they see fit within bounds). In the United States some policy areas are left in the hands of the states and some apply equally across state lines. This then inspires a question: When is it optimal for the the central government to implement a single law over delegating to local authorities when there are multiple, independent agents?

Local governments are able to tailor policies to their own local conditions, but they might also have preferences that diverge from the central government. This is then a classic principal-agent problem that takes on a new dimension with multiple, distinct agents. States must base their policy decisions not only on their local conditions, but also on the policies chosen by the other states and the central government.

To analyze this setting, I consider a one period model with one principal (called a central government) and two agents (called districts). All players care about their own specific state of the world, and coordination between policies. That is, regardless of the realized state of the world, there is some benefit to having similar policies. In addition to the coordination of policies, the central government also cares about the district utilities; she wants the districts to do well. Crucially, the districts only care about the other governments' policies through the coordination mechanism; there are no public good spillovers.

We will analyze two different institutional starting points: *centralization*, where the central government has full policy authority *decentralization*, where the districts retain authority to make policy for themselves. These institutions are not fixed, and players can choose to move from one to the other. The beginning institution will lead to different predictions about player behavior, even though both options are available.

The game has two stages. The game begins at the institutional choice stage. When centralization is the starting institution, the central government must decide whether to delegate some policy making authority to the districts or retain all authority for herself. If decentralization is the starting institution, than the districts must decide whether to give their policy making authority to the central government, or keep it for themselves.

After the institutional choice decision comes the policy making stage. In a centralized system, the central government implements a single policy across all levels of government. That is, both districts and the central government experience one uniform policy. In a decentralized system, however, each government implements its own player-specific policy.

We compare the institutional choice decisions under three different informational settings: complete information, no information and finally with player-specific private information. When making policy, players always have private information about their local conditions. However, the timing of this information revelation affects their institutional choice decision.

With perfect information, all governments know the other governments' local conditions when both making the institutional choice and when making policy. Regardless of the externality level (that is, the level of the coordination benefit), decentralization dominates regardless of the starting institution. The central government will always delegate policy making authority and the districts will always retain authority.

When governments must make their institutional decision before their local conditions are realized, the results are quite stark, but separating: Centralized systems *always* remain centralized and Decentralized systems remain decentralized the vast majority of the time. Governments do not give up control when they do not have information.

The situation is more complicated when governments have private information. Surprisingly, the central government has no information about the district-specific conditions. When district states of the world are common knowledge, decentralized policy making always dominates centralization. When local conditions are only known locally however, the central government has an incentive to keep policy centralized, even if the local districts would prefer decentralized policy.

The central government delegates some policy making authority to the districts when its state of the world is relatively moderate. Since a moderate state of the world is close to the districts' expectation, coordination is relatively easy and the districts can take advantage of their local knowledge. When the state of the world is extreme, however, the coordination fails and the central government is better off with a uniform policy.

The situation is reversed when the districts have the institutional choice. Here, somewhat counter intuitively, we show that the districts will give up policy making autonomy when their local conditions are extreme. That is, the districts prefer a uniform policy when their own local conditions will be far away from the centralized policy.

Both of these results highlight how localities and central governments view centralized policy making. The central government uses centralization to fix the severe coordination problem of an extreme policy by choosing a relatively extreme uniform policy. The districts, on the other hand, know that a centralized policy will always be far away from their own extreme state of the world. Therefore they only see benefits from centralization when their own local conditions are moderate.

We can then show that the externality size has different effects on the probability of centralization depending which group starts with decision making power. When externalities are low, centralization is more likely when localities begin with policy making authority. However, when externalities are high, centralization occurs more often when the central government begins with policy making authority. All of these results demonstrate how path dependence from the starting institution matters greatly for the ending institution and therefore the implemented policies.

We then extend the model to allow the districts to (possibly) communicate their states of the world to the other districts and the central government. From the first result, we know that if the central government has perfect information it will always delegate to the districts. However, the districts have an incentive to reveal a state more extreme induce the other governments into a more coordinated policy. This makes it impossible to fully reveal information even though all players would be better off under full revelation.

Then we allow districts to have different preferences over the state of the world. For example, for the exact same local conditions, one districts may prefer a more liberal policy and one may prefer a more conservative policy. Within this setup, we find that the central government will decentralize more often when districts have opposing biases as opposed to the same bias. This allows our model to recover the classic fiscal federalism results about the benefits of decentralization.

This framework is especially conducive to a studying non-fiscal policies; it makes no claims about public good provision that the fiscal federalism literature focuses on. Instead, this paper is concerned with policies such as laws, regulations, product standards and diplomatic positions. This creates a different type of externality than the standard fiscal externalities. Instead of the fiscal externalities, there are instead coordination externalities. Policy coordination between districts and also between districts and the central government gives benefits independent of each government's unique favored policy.

As an example, consider marijuana policy within the United States. States such as Colorado and Oregon have different legal rules than the federal government. This leads to inefficiencies such as legal (by state law) growers and sellers unable to to procure a bank loan, as banks are unsure about possible federal response. These capital frictions occur because policy is not coordinated between levels of government.

3.2 Literature Review

This model presented here most closely resembles Loeper (2011) and Loeper (2012). These papers also study laws and regulations with coordination externalities. There is no strategic central government and no informational advantage owned by the districts. This leads decentralization to dominate in most cases even with large externalities. When voters can decide on themselves on the federal policy, there is often too little coordination. I instead assume there is asymmetric information over the states of the world. In contrast to the two papers above, this uncertainty breaks the conclusion that decentralization is always optimal.

The fiscal federalism literature starting with Oates (1972), and continuing with papers such as Besley and Coate (2003), Oates (2005), and Weingast (2009), emphasizes the fiscal externalities mentioned above. These papers are complementary to the results presented here. They deal with separate, but similar sets of issues. In particular, they emphasize how homogeneity and fiscal externality levels increase the benefits of centralization. My findings also show that externalities decreases the benefits of decentralization. However, it this works through an information channel that is different from the fiscal federalism literature.

This model uses a similar information structure to a number of canonical delegation models starting with Epstein and O'halloran (1994). In these papers, including Huber and Shipan (2000) and Gailmard and Patty (2007), preference convergence between principal and agent leads to more delegation. However, there is no preference divergence over ideal policies in this paper; instead conflict comes from the different level coordination desired by the principal and agents.

Costless communication (also known as cheap-talk) follows the canonical treatment from Crawford and Sobel (1982). The payoffs for the players are a bit different from the standard model, and this leads to results that differ from the standard information intervals.

3.3 Model

This is a one stage game with three players. There is one principal, called the central government and two agents, called districts. Each player $i \in \{c,\ 1,\ 2\}$ has a player-specific state of the world ω_i independently drawn from a standard normal distribution. Players know their own state of the world, but have no information besides the distribution about the other states of the world.

Utilities for each district include policy location and policy coordination:

$$U_i\left(x_i,\ x_j\ x_c\right) = -\left(x_i - (\omega_i)\right)^2 - \alpha\left(\left(x_i - x_j\right)^2 + \left(x_i - x_c\right)^2\right), \tag{3.1}$$

where α represents the magnitude of the externalities. The central government utility is similar, but also incorporates the district utilities:

$$U_c\left(x_i,\ x_j\ x_c\right) = -\left(x_c - \omega_c\right)^2 - \alpha\left(\left(x_c - x_1\right)^2 + \left(x_c - x_2\right)^2\right) + \left(U_1 + U_2\right), \tag{3.2}$$

When centralization is the starting institution, the central government begins the game with full policy-making authority; it can set policies for all three districts. However, it is restricted to implementing a single uniform policy across all three levels of government, setting $x_c = x_1 = x_2 = x$. Instead of implementing a uniform policy the central government, it can delegate district policy making to the districts themselves. Before the delegation decision, states of the world are realized, but only by the relevant localities. If the central government delegates, all three players simultaneously make policy for themselves. Outcomes are realized, and the game ends.

The timing for decentralization is similar, except that the districts can only make policy for themselves; the central government still has policy authority over x_c. The game timing remains the same.

When we allow the districts to communicate their information, the communication will occur after the states of the world are realized, but before the decentralization decision from the central government. We will refer to the player(s) with policy making authority at the beginning at the Decision Maker(s).

We will make a couple assumptions to make the following analysis clearer. First, we assume α is bounded between 0 and 1. That is, externalities are always (weakly) positive and never more important than the government-specific state of the world and policy. Second, we have also assumed that vertical coordination (between the central government and districts)

Figure 3.1. Game Timing for Centralization with Private Information

has the same effect as horizontal coordination (coordination between districts).

3.4 Analysis - Perfect Information

As a baseline, we will consider the optimal central government decentralization decision when there is no uncertainty. This will allow us to highlight the importance of private information and uncertainty later. It will also introduce the procedure for solving for the equilibrium that will use in subsequence sections. It will be shown in detail here, and then We will then compare the results obtained here to the results from different institutional setups. First, we solve for the districts' optimal decentralized policies. We will illustrate with the first district, but the second district will exactly the same.

$$\max_{x_1} -(x_1-\omega_1)^2-\alpha\left((x_1-x_2)^2+(x_1-x_c)^2\right) \tag{3.3}$$

The first order condition gives the optimal policy, taking the other district's policy as given:

$$x_i^* = \frac{\omega_1+\alpha\,(x_2+x_c)}{1+\alpha} \tag{3.4}$$

Notice the district's 2 policy and the central government's policy directly influences the optimal policy for district 1. Therefore in equilibrium district 1 must use the optimal policies of the other two players to determine her unconditional optimal policy.

The central government maximizes

$$\max_{x_c} -(x_c-\omega_c)^2-\alpha\left((x_c-x_1)^2+(x_c-x_2)^2\right)+\beta\,(U_1+U_2) \tag{3.5}$$

This also gives an optimal policy conditional on the districts' policies, but with different weights:

$$x_c^* = \frac{\omega_c + 2\alpha\left(x_1 + x_2\right)}{1 + 4\alpha} \tag{3.6}$$

Note that because the central government's utility incorporates the district utilities, it actually desires more coordination than the districts. Each player will then have solve the same system of these three equations to find their own equilibrium policy. Solving for the equilibrium, we get these decentralized policies.

Lemma 3.1. [1] *Let there be no private information. Then the optimal decentralized policies are*

$$x_1^* = \omega_1 \frac{1 + 6\alpha + 6\alpha^2}{1 + 8\alpha + 15\alpha^2} + \frac{\alpha\left(\omega_c + \omega_2\right) + 3\alpha^2\left(\omega_c + 2\omega_2\right)}{1 + 8\alpha + 15\alpha^2} \tag{3.7}$$

$$x_2^* = \omega_2 \frac{1 + 6\alpha + 6\alpha^2}{1 + 8\alpha + 15\alpha^2} + \frac{\alpha\left(\omega_c + \omega_1\right) + 3\alpha^2\left(\omega_c + 2\omega_1\right)}{1 + 8\alpha + 15\alpha^2} \tag{3.8}$$

$$x_c^* = \omega_c \frac{1 + \alpha}{1 + 5\alpha} + \frac{2\alpha\left(\omega_1 + \omega_2\right)}{1 + 5\alpha} \tag{3.9}$$

The exact expression of the central government's utility from these optimal policies is unenlightening and will be left to the appendix. We will denote it as $U\left(x_c^*, \hat{x}_1^*, x_2^*\right)_c$. We then need to compare $U\left(x_c^*, \hat{x}_1^*, x_2^*\right)_c$ with the uniform policy. When choosing a uniform policy, the central government maximizes

$$\max_x = -\left(x - \omega_c\right)^2 - \left(x - \omega_1\right)^2 - \left(x - \omega_2\right)^2 \tag{3.10}$$

Note that the coordination portion of the utility function disappears; a uniform policy has a perfect coordination for all governments. This means the optimal policy is independent

1. All proofs in the appendix

of α. The externality size will still be relevant for comparisons with the non-uniform policies. With perfect information, the best the central government can do it chooses the average of the three states of the world, $x^* = \frac{\omega_1+\omega_2+\omega_c}{3}$. We will denote the centralized utility as $U\left(\hat{x^*}\right)_c$.

Proposition 3.1. *Let there be no private information. Then* $U\left(x_c^*,\ \hat{x_1^*},\ x_2^*\right)_c \geq U\left(\hat{x^*}\right)_c$.

When all players know all of the information at the policy implementation stage, they can coordinate optimally without needing a uniform policy. Everyone makes the same institutional choice of decentralization regardless of the starting institution. Crucially, unlike with spillovers, players internalize the externalities. The districts, for example, want exactly the same amount of policy coordination. A uniform policy provides *too much* coordination, relative to the ideal policy cost. No level of externalities makes full coordination worth the policy cost.[2]

3.5 Analysis - Uncertainty

3.5.1 Optimal Policies

Now instead of assuming players have perfect information, instead we assume that players know their own states of the world when making policy, but only the distribution of the other states. Therefore they will have to form beliefs about other players behavior to choose optimal policies. Note that this will be true regardless of the information available at the institutional choice decision.

As before we first need to study the decentralized optimal policies chosen by the districts and the central government. The procedure remains the same from before, with minor changes to the optimal policies to reflect the lack of exact knowledge about other states of the world

2. This is very similar to the result in Loeper (2011).

The maximization problems remain the same for the districts:

$$\max_{x_i} -(x_i - \omega_i)^2 - \alpha\left(\left(x_i - x_j\right)^2 + (x_i - x_c)^2\right) \tag{3.11}$$

This gives the same first order condition of

$$x_i^* = \frac{\omega_i + \alpha\left(x_j + x_c\right)}{1 + 2\alpha} \tag{3.12}$$

So far, nothing has changed from the baseline. Similarly, the central government will maximize the same utility function. However, when solving the for the equilibrium policies, all players must take expectations over the non-local states of the world. Since the players have no information besides the distribution about the other players' states of the world, the best they can do is assume these states of the world are 0. The optimal policies given in the next lemma:

Lemma 3.2. *The optimal decentralized policy for a district is*

$$x_i^* = \omega_i \frac{1 + 6\alpha + 6\alpha^2}{1 + 8\alpha + 15\alpha^2} \tag{3.13}$$

The optimal decentralized policy for a central government is

$$x_c^* = \omega_c \frac{1 + \alpha}{1 + 5\alpha} \tag{3.14}$$

Denote the districts' decentralized utility as $\bar{U}_i\left(x_c^*,\ x_1^*,\ x_2^*\right)$. Similarly, denote the central government's decentralized utility as $\bar{U}_c\left(x_c^*,\ x_1^*,\ x_2^*\right)$ Next, we will check the central government's optimal uniform policy. The uniform policy will fully maximize the value of the externalities, but at the cost of misalignment with the district state of the world. The central government uniform maximization problem is

$$\max_x -(x-\omega_c)^2 - E\left[(x-\omega_1)^2 + (x-\omega_2)^2\right] \tag{3.15}$$

Lemma 3.3. *The central government's optimal uniform policy is*

$$x^* = \frac{\omega_c}{3} \tag{3.16}$$

We will then denote the uniform policy utilities as $\bar{U}_i(x^*)$ and $\bar{U}_c(x^*)$.

3.5.2 Institutional Choice

Full Uncertainty

With these optimal policies, we can now solve for the institutional choice. First, we will show the equilibrium institutional choices that arise from centralization and decentralization when no player has private information. That is, players must choose how policy will be implemented before their own specific states of the world are realized. Therefore, all governments must use their ex-ante expected utility in the first stage.

Proposition 3.2. *Let centralization be the starting institution and let the institutional choice happen before the information revelation. Then centralization is always the final institution.*

When the central government cannot use any private information, it never gives up policy making authority to the districts. Note that this is true even for very low externality levels and the knowledge that the local districts will have private information when making policy. In expectation, this is not enough of an incentive to give up policy authority.

Proposition 3.3. *Let decentralization be the starting institution and let the institutional choice happen before the information revelation. Then decentralization will be the final institution if* $\alpha \leq 0.893$.

Only very large externalities incentivize districts to give up policy making power. When the benefits of coordination are smaller, the value of one's private information outweighs the coordination benefit of a uniform policy.

Crucially, making a decision on decentralization without information leads to very little institutional change. The path dependence is very strong when the institutional choice comes before private information is realized. This strong path dependence will be weakened when governments can use their own information to make the institutional choice.

Private Information

Now we shift the timing of the institutional choice to after the realization of the player-specific states of the world. The central government will still delegate local policy making authority to the districts if its utility from decentralization is greater than it's utility from centralization. However, it will not the expectation over just ω_1 and ω_2, not also over ω_c as it was forced to do in the previous setting. This reflects its ability to use its extra information in making the delegation decision. We can make a precise statement about exactly when the central government will decentralize:

Proposition 3.4. *Let* $\underline{\alpha} \leq \alpha \leq \overline{\alpha}$. *Then the central government will delegate making authority if* $\omega_c \in [\underline{\omega_c}, \overline{\omega}_c]$. *If* $\alpha > \overline{\alpha}$, *the central government will never delegate.*

The central government will give up authority over district policies when its own state of the world is moderate. A moderate policy is relatively close to the expectation of the state of the world. Therefore the districts will make a relatively accurate guess of the central government's conditions when using the expectation. This allows the central government to

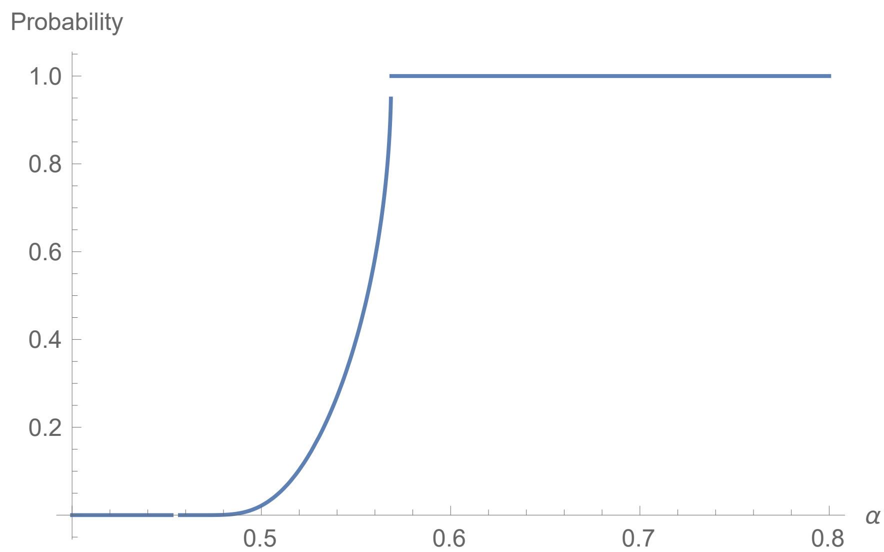


Figure 3.2. Probability of Centralization - Central Government

receive most of the coordination benefits while still reaping the benefits of the districts local knowledge.

If the state of the world is extreme, however, the district guesses will be incorrect. Decentralization will lead to poor coordination. The central government can solve the coordination problem with a uniform policy and this benefit dominates the cost of losing the local knowledge. As Figure 3.2 demonstrates, centralization becomes more attractive the greater the externality salience. When externalities are large enough, centralization is always preferred to decentralization and the central government will never give up policy making authority.

If the Districts start with decision making powers, then we will require unanimity for them to give up policy making authority. That is, both districts must prefer centralization to decentralization. We will also assume that once the districts have divested themselves of the ability to make policy, the central government cannot then return this ability to the districts.

Proposition 3.5. *Let $\alpha \geq \hat{\alpha}$. Then the districts will delegate making authority to the central government if $\omega_i \in \left[\underbrace{\omega}, \overbrace{\omega}\right]$ for both $i = 1,\ 2$.*

The crucial difference between this proposition and proposition 3.4 is that delegation in

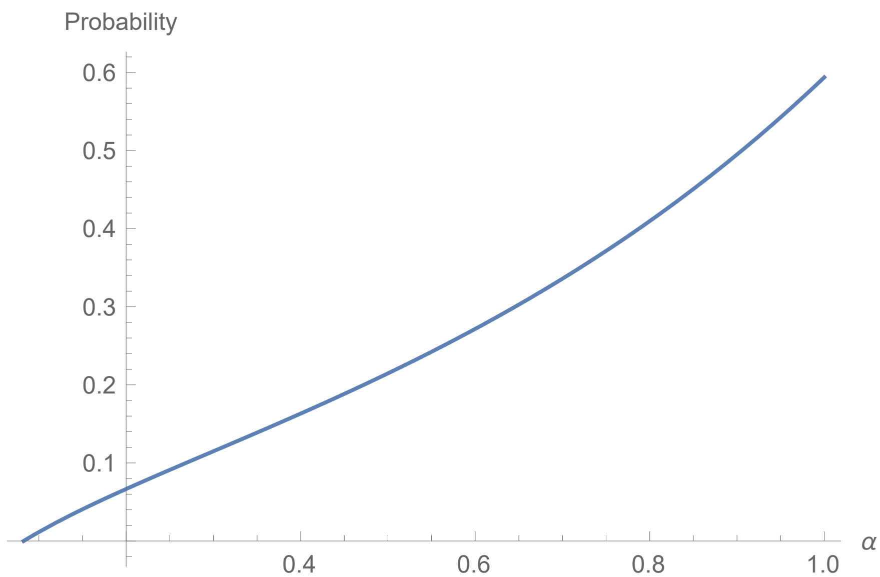


Figure 3.3. Probability of Centralization - Districts

this case means centralization. Notice how a moderate policy makes districts want to give up authority and let the central government choose a uniform policy. This is the exact opposite of how the central government behaves when it starts as the decision maker. The central government chooses centralization when its faced with an *extreme* state of the world, not moderate.

Also, there is no externality level such that the districts always want centralization. There is always some probability the realized states of the world induce at least one district to prefer retaining policy making authority.

We can then compare the probability of centralization across the two decision making regimes. As Figure 3.4 shows, for low externalities centralization is actually more likely when local government begin as decision makers. Low externalities sometimes induce centralization from the districts, but low externalities *never* induces the central government to retain full powers.

However, as the externality level rises these positions reverse. Once α crosses a threshold, the central government becomes more likely than the districts to choose centralization. For high externality levels, the districts are now more likely than the central government to

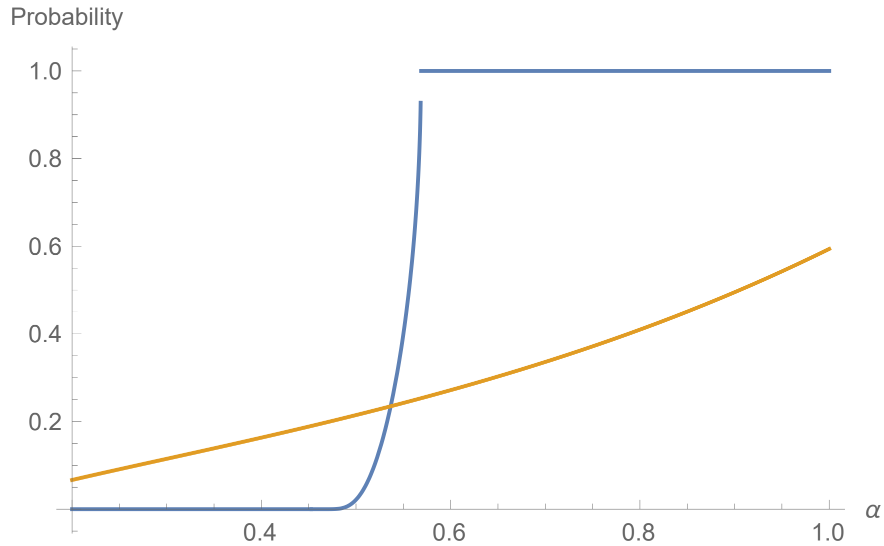


Figure 3.4. Probability of Centralization Comparison

prefer decentralization.

3.6 Extensions

3.6.1 Communication

Now we will allow the players to communicate before the institutional choice (centralization or decentralization) stage. Remember from the baseline that if all players have perfect information, then decentralization is always optimal. However, full information revelation is impossible:

Lemma 3.4. *Let the Districts communicate with the central government before the institutional decision. Then full information revelation is never possible.*

Why can players not fully real their own states of the world? Consider just the two districts and the coordination incentives. District 1 would like to both choose a policy exactly at ω_1 and also have District 2 choose a policy exactly at ω_1. However, honestly telling District 2 the value of ω_1 will cause District 2 to choose a policy in between ω_1 and ω_2. Therefore the first district has incentive to tell the second district a more extreme state of the world than is accurate. This would induce a more coordinated second district policy. Even if all players would like to play honest strategies, there are incentives to deviate.

3.6.2 Biased Districts

Now we show how the delegation decision for the central government changes if districts are biased in a positive or negative way. This allows us to analyze how preference convergence and divergence affects decentralization. We will start with opposing biases, or *balanced* districts. That is District's 1 ideal individual policy is $\omega_1 + b$ and District's 2 ideal individual policy is $\omega_2 - b$.

Proposition 3.6. *For any α, there exists a $\hat{b}(\omega_c)$ such that if $b \geq \hat{b}$, the central government will delegate. All players will choose policies x_i^{B*}. If $b \leq \hat{b}$, the central government does not delegate and chooses x^{B*}.*

Crucially, there is always some level of vertical heterogeneity such that delegation is beneficial to the central government. A large amount of preference divergence from the central government means the uniform policy will be too from the districts' ideal policies. Because the central government cares about the well being

As the biases grow larger, coordination becomes more difficult for the balanced districts', as their optimal policies will be farther apart in expectation. However, there is always some level of bias such that the policy loss of a uniform policy is worse than the coordination loss of decentralized policies.

We can also re-express the cutoff as an interval of delegated states of the world, similar to the interval used earlier. The Central Government delegates if

$$\omega_c \in \left[-\gamma\hat{b},\ \gamma\hat{b}\right] \tag{3.17}$$

where γ is a scaling factor taken from the bias cutoff expression. Expressed in this form, we can see that the central government will delegate in relatively moderate states of the world, just as in the baseline model. Moderate states are close to the expectation, and therefore the coordination attempts by the districts will be more accurate. We can then plot the probability of delegation for different bias magnitudes:

For moderate bias magnitudes, there is a relatively large chance the of centralization. When the central government's state of the world is moderate, then, in expectation, the centralized policy will be close to to the districts' states of the world. Low biases mean that being close to the states of the world will also be close to the districts' ideal policies.

An extreme central government state of the world, however, means that a uniform policy will be too far from both of the districts' ideal policies (again, in expectation). As the biases increase, the districts' ideal policies are also far from a moderate central state of the world. The benefits of perfect coordination never counteract the problems very heterogeneous preferences.

Comparison to Balanced Districts

Lemma 3.5. *Optimal decentralized unbalanced policies are always (weakly) greater in magnitude than optimal decentralized balanced policies for all players*

Balanced districts pull all of the optimal policies towards 0 and away from ω_i, regardless of bias magnitude or externality salience. Because the central government has no policy bias, this also pushes its policy closer to ω_c, the ideal outcome. Coordination incentives, however, pull the districts' policies away from their ideal policies.

When districts are unbalanced, however, coordination between districts is easier. The homogeneous preferences allows districts to choose policies very close to their ideal policies (in fact, without a central government, there is almost no distortion at all). The central government, however, has to choose a policy greater than its state of the world to coordinate successfully with the districts.

Proposition 3.7. $\hat{b}_B \geq \hat{b}_U$ *for all* α

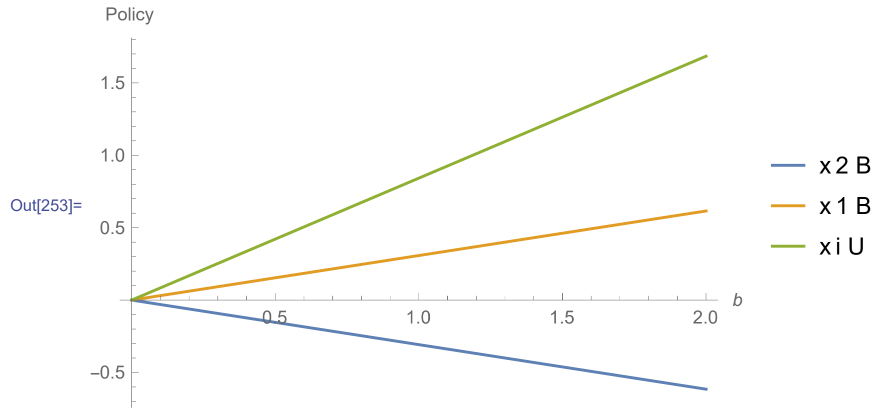


Figure 3.5. Comparison between balanced and unbalanced policies for $\omega_i = 0$

Preference divergence between districts means less vertical heterogeneity is needed for delegation. A uniform policy is less effective when districts do not agree. For the same bias magnitude, the delegation interval is narrower for unbalanced districts.

Proposition 3.8. $\frac{\partial \hat{b}}{\partial \alpha} \geq 0$ *for both balanced and unbalanced districts.*

Proposition 3.7 follows the normal logic of decentralization from the fiscal federalism literature: heterogeneous preferences between localities makes federalism more appealing than centralization.

The vertical heterogeneity cutoff is higher the greater the externalities. That is, as externalities become more salient, a higher bias level is needed for the central government to delegate. A uniform policy is more beneficial to the central government as the benefits from coordination grow. However, there is always some level of preference mismatch

Propositions 3.7 and 3.8 give the result that delegation benefits the central government most when preferences are horizontally heterogeneous but externalities are low. We also want to highlight the complementarity between the magnitude of the biases and distribution of biases.

3.7 Conclusion

This paper models federalism as a strategic choice made by a central government or a set of localities. This allows us to see how we might expect the decision to centralize or decentralize to be different depending on who starts with decision making power. We can then see that the starting institution sets a federation on a path that influences how its policy making institutions will look in the future.

In particular, we have shown that the political economy incentives of non-fiscal externalities are different for a central government and for local governments. We are more likely to observe localities giving up policy making authority when externalities are low and when local conditions are moderate; and we should expect the exact opposite conditions to produce centralization from central government. In addition, we have shown that the type of preference heterogeneity has large effect on decentralization. Even when districts are homogeneous, divergence from the central government leads to delegation and decentralization.

3.8 Appendix

Proof. **Lemma 3.1** Solving the system of equations

$$x_1 = \frac{\omega_+ \alpha\left(x_2 + x_c\right)}{1+\alpha}$$

$$x_2 = \frac{\omega_2 + \alpha\left(x_1 + x_c\right)}{1+\alpha}$$

$$x_c = \frac{\omega_c + 2\alpha\left(x_1 + x_2\right)}{1+4\alpha}$$

gives the desired result. □

Proof. **Proposition 3.1** The central government utility from centralization with perfect information:

$$-\frac{\alpha}{(1+3\alpha)^2(1+5\alpha)^2} * \Big((4+9\alpha)(\omega_c + 3\alpha\omega_c)^2 + \omega_1^2\left(4+45\alpha+156\alpha^2+153\alpha^3\right) \\ -4\omega_1\omega_2\left(1+12\alpha+42\alpha^2+36\alpha^2+\right) + \omega_2^2\left(4+45\alpha+156\alpha^2+153\alpha^3\right) \\ -2\omega_c(\omega_1+\omega_2)(2+9\alpha)(1+3\alpha)^2\Big) \quad (3.18)$$

The central government utility from decentralization with perfect information:

$$-\frac{2}{3}(\omega_1-\omega_2)^2\left(\omega_c^2 - \omega_c\omega_1 - \omega_c\omega_2\right) \quad (3.19)$$

Equation 3.19 is always greater than equation 3.18 □

Proof. **Lemma 3.2** Take the optimal policies from Lemma 3.1. For each player, take the expectation over the states of the world they do not have information about. This leaves

$$x_i^* = \omega_i \frac{1+6\alpha+6\alpha^2}{1+8\alpha+15\alpha^2}$$

and

$$x_c^* = \omega_c \frac{1+\alpha}{1+5\alpha}$$

□

Proof. **Lemma 3.3** Maximize

$$\max_x \; -(x-\omega_c)^2 - E\left[(x-\omega_1)^2 + (x-\omega_2)^2 \,|\omega_1,\ \omega_2\right]$$

to get the first order condition

$$x^* = \frac{\omega_c}{3}$$

□

Proof. **Proposition 3.2** We need to compare the utility from centralization to the utility of decentralization with the expectation taken over the central government's state of the world.

$$E\left[\bar{U}_c\left(x_c^*,\ x_1^*,\ x_2^*\right)|\omega\right] \geq E\left[\bar{U}_c\left(x^*\right)|\omega\right]$$

for all α. □

Proof. **Proposition 3.3** We need to compare the utility from centralization to the utility of decentralization with the expectation taken over each district's state of the world.

$$E\left[\bar{U}_i\left(x_c^*,\ x_1^*,\ x_2^*\right)|\omega_i\right] \geq E\left[\bar{U}_i\left(x^*\right)|\omega_i\right]$$

if $\alpha \geq 0.893$. □

Proof. **Proposition 3.4** We do the same comparison as above, but without taking the expectation over ω.

$$\bar{U}_c\left(x_c^*,\ x_1^*,\ x_2^*\right) \geq \bar{U}_c\left(x^*\right)$$

This is always true if $\alpha < .45268 \equiv \underline{\alpha}$ and is never true if $\alpha > .56858 \equiv \overline{\alpha}$. If $\alpha \in [\underline{\alpha},\ \overline{\alpha}]$, then the above expression is true if

$$|\omega_c| \leq \left| \sqrt{\frac{-432\alpha^5 - 432\alpha^4 + 36\alpha^3 + 126\alpha^2 + 36\alpha + 3}{54\alpha^5 + 135\alpha^4 + 36\alpha^3 - 22\alpha^2 - 10\alpha - 1}} \right|$$

□

Proof. **Proposition 3.5** The centralization versus decentralization problem for districts:

$$\bar{U}_i\left(x_c^*,\ x_1^*,\ x_2^*\right) \geq \bar{U}_i\left(x^*\right)$$

This is always true if $\alpha < 0.08248$. $\alpha \geq 0.08248$, this is true if

$$|\omega_i| \geq \left| \sqrt{\frac{-405\alpha^5 - 639\alpha^4 - 390\alpha^3 - 86\alpha^2 - 2\alpha + 1}{648\alpha^5 - 972\alpha^3 - 594\alpha^2 - 126\alpha - 9}} \right|$$

□

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