Allies or Commitment Devices?
A Model of Appointments to the Federal Reserve

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Abstract

We present a model of executive-legislative bargaining over appointments to independent central banks in the face of an uncertain economy with strategic economic actors. The model highlights the contrast between two idealized views of Federal Reserve appointments. In one view, all politicians prefer to appoint conservatively biased central bankers to overcome credible commitment problems that arise in monetary policy. In the other, politicians prefer to appoint allies, and appointments are well described by the spatial model used to describe appointments to other agencies. Both ideals are limiting cases of our model, which depend on the level of economic uncertainty. When economic uncertainty is extremely low, politicians prefer very conservative appointments. When economic uncertainty increases, politicians' prefer central bank appointees closer to their own ideal points. In the typical case, the results are somewhere in between: equilibrium appointments move in the direction of politician's preferences but with a moderate conservative bias.

Keywords: Central banks; Appointments; Formal theory; Bargaining; Spatial model
JEL Classification: C72, C78, E50

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In the United States, the process of Presidential appointment and Senate confirmation of Federal Open Market Committee (FOMC) members is an important avenue for political influence on monetary policy. Two theoretical traditions inform political scientists' understanding of Federal Reserve appointments. The first tradition holds that politicians face incentives to *ex ante* commit to low inflation policies and *ex post* break those commitments to generate short-term improvements in real economic outcomes, *e.g.,* growth and employment (Kydland and Prescott, 1977; Barro and Gordon, 1983). Thus, delegating monetary policy authority to a relatively conservative, independent central bank(er) can serve as a commitment device that allows politicians to *credibly* commit to low inflation policies thereby mitigating the time-inconsistency problem (Rogoff, 1985; Alesina and Summers, 1993). The second tradition assumes instead that politicians prefer to appoint bankers that agree with them on matters of monetary policy and represents appointments using spatial appointments models (Chang, 2001, 2003; Morris, 2000).[1] These models are consistent with "the ally principle" which states that politicians prefer agents that represent their preferences as closely as possible (Bendor and Meirowitz, 2004).

These two theoretical traditions contradict one another, yet both appear to be consistent with the data in important ways. In favor of the credible commitment approach, comparative empirical evidence suggests that countries with independent central banks experience lower levels of inflation (Alesina and Summers, 1993). In favor of the ally approach, empirical studies show that preferences of appointed FOMC governors track those of their appointing parties.[2] Though the theories are inconsistent with each other, we think that they represent a realistic trade-off that politicians face when delegating monetary policy: delegate to an ally and suffer high inflation due to the commitment problem, or appoint conservatively biased central bankers and allow some policy drift.

[1]These models are similar to those used for appointments to other agencies (Lewis, 2008) or to the judiciary (Binder and Maltzman, 2009).

[2]See, for example, Adolph (2013). However, as Adolph (2013) discussed, this finding is also consistent with Rogoff's approach.

We develop a model of executive-legislative bargaining over appointments to the Federal Reserve. In our model, the President nominates a central banker that is subject to veto by the Senate. Inflationary expectations in the market then adjust to account for the central banker, and then at some later point the central banker sets monetary policy in response to an economic shock. The nature of appointment bargaining depends on the level of economic uncertainty. In certain times, politicians of all stripes prefer delegation to conservative central bankers. In uncertain times, appointments are more politicized because politicians prefer to appoint allies. The results we present in this paper, therefore, provide theoretical underpinnings for why economic uncertainty — understood as inflation variability — is an important consideration when assessing the process of central bank appointments despite being mostly absent from the empirical literature in political science.

1 A Model of Appointments to the Federal Reserve

To formalize the appointment process to the Federal Reserve we develop a non-cooperative game with a *President*, a representative *Senator*, a *Central Banker*, and a *Wage Setter*. We define the preferences of the actors by relying on a set of familiar economic assumptions, which are similar to several papers in the central banks literature (*e.g.,* Alesina et al., 1997; Keefer and Stasavage, 2003). The economy is characterized by a "natural rate of unemployment," denoted by $\bar{y}$ and a slope parameter $\alpha > 0$ that quantifies the trade-off between unemployment and inflation. Unemployment is generated by the following function:

$$y(\pi, w) = \bar{y} - \alpha(\pi - w) - \varepsilon, \tag{1}$$

where π denotes the level of inflation, w is the nominal wage, and ε is a stochastic shock to output distributed around mean 0 with finite variance σ^2. Equation 1 captures the intuition from classic economic models: unemployment can be driven to an unnaturally low level if the rate of inflation is higher than the growth in nominal wages.

With the unemployment function in hand we now characterize the preferences of the *President*, *Senator*, and *Central Banker*. These preferences are given by the following utility function,

$$u_i(\pi, y(\pi, w)) = -\pi^2 - b_i y^2 \text{ for } i \in \{P, S, C\}. \tag{2}$$

Each actor has the same target rates of inflation and unemployment, which are normalized to 0, and differ only by the relative weights they place on inflation and unemployment represented by $b_i \geq 0$. We refer to b_i as the actor *i's ideal point* or monetary policy *position* where lower levels of b_i denote a more *conservative* or inflation-averse ideal point whereas a higher b_i denotes a *liberal* or more employment-focused ideal point.

The preferences of the *Wage Setter* are given by the following utility function,

$$u_W = -(\pi - w)^2. \tag{3}$$

Equation 3 ensures that nominal wages will be set equal to expected inflation in equilibrium.

Prior to any actions there is a status quo Central Banker with ideal point b^{SQ} who remains in office until replaced by a newly appointed Central Banker. We understand b^{SQ} to represent the common understanding of how current members of the FOMC will implement monetary policy in the absence of a new appointment. The timing of the game, then, is as follows.

1. The *President* selects a nominee by proposing $b > 0$.
2. The *Senator* accepts or rejects the nominee:
    (a) If S accepts the nominee, then $b_C = b$.
    (b) If S rejects the nominee, then $b_C = b^{SQ}$.
3. *Wage setters* choose w.
4. The output shock, ε, is realized.
5. The *Central Banker* sets the level of inflation, π.
6. Unemployment is generated, payoffs are realized, and the game ends.

2 Analysis

2.1 Equilibrium Inflation and Unemployment

We utilize subgame perfect Nash equilibrium (SPNE) as our solution concept, which can be found through backward induction. In the final stage of the game the *Central Banker* sets the target rate of inflation, π. Thus, the *Central Banker* takes an action solving the following problem:

$$\pi^*(b_c, w) = \arg\max_{\pi} \left[-\pi^2 - b_C(\bar{y} - \alpha(\pi - w) - \varepsilon)^2 \right].$$

Essentially, the *Central Banker* chooses the inflation rate that maximizes her expected utility. Solving this problem for the *Central Banker* leads to the following best response function,

$$\pi^*(b_C, w) = \frac{b_C \alpha(w\alpha + \bar{y} - \varepsilon)}{b_C \alpha^2 + 1}. \tag{4}$$

Notice that the best response $\pi^*(b_C, w)$ depends on w: the *Wage Setter's* choice of wage level. Thus, to fully characterize the subgame following approval (or rejection) of the central bank appointment we solve the *Wage Setter's* problem, given by:

$$w^*(b_C) = \arg\max_{w} \left[-\mathbb{E}[(w - \pi^*(b_C))^2] \right]. \tag{5}$$

At the solution, wages are simply set equal to the expected level of inflation. Thus, the wage rate in equilibrium is $w^*(b_C) = b_C \bar{y} \alpha$. We can substitute this expression into the solution for $\pi^*(b_C, w)$, which yields the following result.

Lemma 1. *In equilibrium, a Central Banker with monetary policy ideal point b_C sets the target level of inflation according to the following equation:*

$$\pi^*(b_C) = \frac{\alpha b_C \left(\alpha^2 \bar{y} b_C + \bar{y} - \varepsilon \right)}{\alpha^2 b_C + 1}. \tag{6}$$

The pair $(w^*(b_C), \pi^*(b_C))$ is an equilibrium to the subgame involving the *Wage Setter*'s and *Central Banker*'s decisions. The equilibrium to this subgame depends on b_C and therefore induce preferences for the *President* and *Senator* regarding the best central bank appointment. We can now characterize how economic outcomes are affected according to the preferences of the *Central Banker*. Proposition 1 describes how these economic outcomes—inflation and unemployment—depend on these preferences.

Proposition 1. *The preferences of the Central Banker affect economic outcomes as follows:*

1. *Expected **inflation** is both higher and more variable as the Central Banker becomes more liberal.*

2. *Expected **unemployment** levels are independent of the Central Banker but become less variable as the Central Banker becomes more liberal.*

The conclusions in Proposition 1 are straightforward. Central Bankers who place less emphasis on low inflation relative to low unemployment will be more tempted to generate inflation, therefore expected inflation is higher for these actors. Moreover, while conservative Central Bankers tend to moderate the effects of output shocks, liberal Central Bankers utilize shocks to generate lower unemployment, thereby creating higher levels of variability in the rate of inflation.

The inability of the *Central Banker* to raise expected unemployment is a result of the standard argument about rational expectations: wage setters anticipate the effect of a liberal central banker on expected inflation and incorporate this information into wage contracts, so that the average effect of monetary policy on unemployment is null. However, since the central banker is, at times, able to take advantage of output shocks, employment is more stable for more liberal central bankers.

2.2 Equilibrium Central Bank Appointments

With the equilibrium behavior of the *Wage Setter*, the *Central Banker*, and how the preferences of a given appointed *Central Banker* affect inflation and unemployment in hand we can now finish constructing the SPNE of the appointments game by characterizing the equilibrium appointment strategy of the *President* and the equilibrium approval strategy of the *Senator*. Given the strategies characterized in the previous section and the fact that both the *President* and the *Senator* must act prior to the realization of the output shock ε, their equilibrium strategies are based on expected utility. In particular, the expected (squared) level of inflation, as characterized in Lemma 1, is given by:

$$\pi^*(b_C)^2 = \text{Var}[\pi^*(b_C)] + \mathbb{E}[\pi^*(b_C)] = \frac{\alpha^2\sigma^2 b_C^2}{(\alpha^2 b_C + 1)^2} + b_C^2\bar{y}^2\alpha^2.$$

Similarly, the expected (squared) level of unemployment is given by:

$$\mathbb{E}[y(\pi, w)^2] = \frac{\sigma^2}{(\alpha^2 b_C + 1)^2} + \bar{y}^2.$$

Substituting these expectations into the utility functions for the *President* and the *Senator* yields the following expected utility:

$$U_i(b_C) = \mathbb{E}(u_i(\pi, y(\pi, w)|b_C) = -\frac{\left(\alpha^2 b_C^2 + b_i\right)\left(\bar{y}^2\left(\alpha^2 b_C + 1\right)^2 + \sigma^2\right)}{\left(\alpha^2 b_C + 1\right)^2},\ i \in \{S, P\}. \tag{7}$$

From this expected utility expression, we can conclude that there is a unique ideal appointee for the *President* and for the *Senator*. Furthermore, the ideal appointee for each actor is strictly more conservative than that actor. Thus, induced preferences over appointees take on a spatial structure, but it is one in which neither of the actors prefer to appoint an agent that exactly represents their own interests. The preferences of the actors therefore violate the ally principle, which holds in a wide range of other models of delegation (Bendor et al., 2001; Bendor and Meirowitz, 2004).[3]

[3] We use the term *ally principle* in the same way as Bendor and Meirowitz (2004), who take the term to mean that "the boss picks the most ideologically similar agent as delegatee." We do not mean to imply, however, that violation of the ally principle in this case runs counter to the logic of their model. In fact, a departure from the ally principle is to be expected when interpreting this model in light of Bendor and Meirowitz's (2004) results since the agent does not fully control unemployment. Thus, when we discuss our model in relation to the ally principle, we are comparing our results to other theoretical models (e.g. Chang (2001, 2003)) in which the assumptions are consistent with the ally principle.

Proposition 2. *The President and Senator each have an "ideal" Central Bank appointee and both actors prefer to delegate to a Central Banker who is strictly more conservative than themselves.*

A best response for the *Senator* involves accepting nominees for appointment such that the *Senator's* expected utility given the appointee's monetary policy ideology (weakly) outweighs the utility the *Senator* would receive from rejecting the nominee and retaining the status quo, *i.e.,* $U_S(b) \geq U_S(b^{SQ})$. This is akin to the *Senator* using a threshold acceptance strategy, which can also be represented by an equivalent "acceptance set." The Senator will approve a Central Bank nominee with monetary policy ideology b if and only if the nominee is in the Senator's acceptance set A_S (i.e., $b \in A_S = \{b : U_S(b) \geq U_S(b^{SQ})\}$). The *President* knows what nominees are acceptable to the *Senator* and which are not and therefore maximizes his expected utility subject to the constraint provided by A_S. Since $b^{SQ} \in A_S$ and the President is indifferent between choosing a status quo nominee and being rejected, we assume that the President chooses b^{SQ} in the event that no element of A_S is preferred to the status quo. The full SPNE to this game therefore is the solution to a standard spatial bargaining game (Romer and Rosenthal, 1978; Ferejohn and Shipan, 1990) with these induced preferences. In the next section, we characterize the predictions that arise from the equilibrium to the game.

3 Economic Uncertainty and the Optimal Central Banker

When are central bank appointments characterized by a tendency to appoint allies? When do politicians instead use central bankers as commitment devices to keep inflation low? To answer these questions we provide a series of results that speak directly to how politicized the appointments process is conditional on the economic environment. The first result concerns the relationship between the positions of the *President* and *Senator* and that of the equilibrium nominee. Although Proposition 2 predicts that the *President* and *Senator* both prefer a nominee more conservative than themselves the following result confirms that the ideal position of nominees is positively correlated with the positions of the *President* and *Senator*.

Proposition 3. *The ideological position of the equilibrium Central Bank appointment is weakly increasing in the positions of the President and the Senator.*

The *President* and the *Senator* prefer a central bank appointee that is more conservative than they are (Proposition 2), but *how* conservative the equilibrium appointment will be relative to the political actors bargaining over the appointment depends on the ideological positioning of the *President* and *Senator*. As Adolph (2013) has noted, the prediction of Proposition 3 holds both in the spatial models of Chang (2001, 2003) and in the economic models like that of Rogoff (1985). Notice, however, that Proposition 3 merely shows that as the *President* and the *Senator* become more liberal, the *Central Banker* appointed in equilibrium could become more liberal as well. The main insight here is that as the ideal points of the actors bargaining over the appointment move toward more liberal monetary policy preferences, the ideal appointment become (weakly) more liberal. This result does not, in itself, provide insight into when and why the appointments process is more or less politicized. Combined with the following results, however, we do begin to generate insight into the effect of economic uncertainty on the political appointment process.

As described informally in the previous section, the relationship between politicians' preferences and equilibrium appointees observed in this model depends critically on uncertainty in the economy. Since large variations in unemployment can occur with very conservative central bankers, risk averse politicians will strike a balance between delegating to conservative central bankers and appointing allies. This dynamic leads to the following result.

Proposition 4. *Equilibrium Central Banker appointments become more liberal as the economy becomes more volatile.*

Combined with the previous result, Proposition 4 presents two limiting cases for equilibrium appointments. As economic uncertainty approaches zero, *i.e.,* $\sigma \to 0$, appointments become perfectly conservative; all politicians prefer appointees that are fully focused on inflation and do not care at all about unemployment. Conversely, as economic uncertainty rises, *i.e.,* $\sigma \to \infty$, individual behavior resembles a politicized appointment process in which both the *President* and the

Senator prefer ideological allies. The second observation follows from the fact that, for any finite σ, Proposition 2 tells us that politicians prefer appointees that are strictly more conservative than themselves. Thus, since preferred appointments are strictly increasing in economic uncertainty, σ, the politician's ideal appointment approaches their own position from below as this uncertainty becomes large. The combination of the limiting cases provided by Propositions 3 and 4 lead to the main insight of this paper.

Proposition 5. *As σ goes to zero, the game converges to one in which the President and Senator mutually prefer a perfectly conservative central banker ($b_c = 0$). As σ goes to infinity, the game converges to one in which the President and Senator each prefer central bankers with preferences identical to their own.*

Proposition 5 provides a testable restriction on the strategies of the *President* and the *Senator* that can be contrasted with traditional spatial models of central bank appointments (*e.g.,* Chang, 2001, 2003; Morris, 2000). In particular, Proposition 5 suggests that all politicians prefer very conservative central bankers in times of certainty and that bargaining over appointments should be more politicized in uncertain times.

4 Examples and Empirical Implications

In this section, we provide concrete examples to crystallize the relationship between the formal model and the empirical cases that motivated our study. We focus on the ways that predictions about how Presidential and Congressional preferences map onto appointments should be conditioned on the level of economic uncertainty in the economic environment. In empirical work, economic uncertainty has been measured using the level of disagreement in inflation forecasts (*e.g.,* Carlson, 1977; Cukierman and Wachtel, 1979; Wachtel, 1977), which would correspond well to the way the variable operates in our theoretical model.

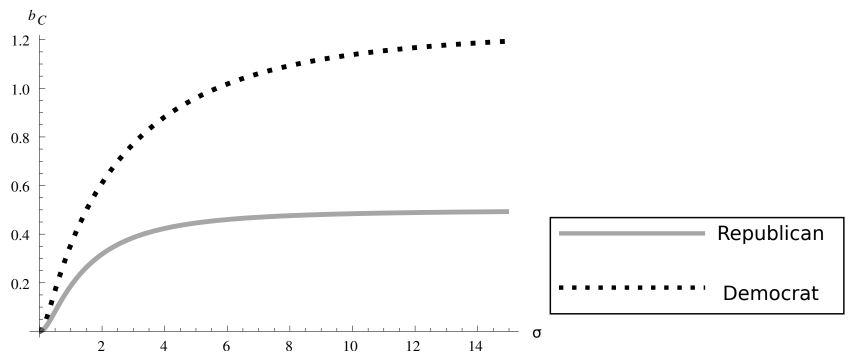

Figure 1: Equilibrium appointments (b_C) from (unconstrained) Republican and Democratic Presidents as a function of economic uncertainty (σ).

4.1 Partisan differences in appointments

Empirical studies of central bank appointments are often concerned with estimating partisan differences in appointees. In the context of the United States Federal Reserve, Chappell et al. (1993) and Adolph (2013), among others, have identified systematic differences between Republican and Democratic appointees. However, Proposition 5 suggests that partisan differences in appointments should depend on the level of economic uncertainty near the time of the appointment.

Example 1. To focus on the influence of economic uncertainty, we will analyze simplified examples in which α and $\overline{y}$ are each held constant at one. Furthermore, we assume that the policy preferences of each politician depend only on her party: Republicans are described by a preference parameter $b_{\text{Rep}} = \frac{1}{2}$ and Democrats are described by a preference parameter of $b_{\text{Dem}} = \frac{5}{4}$. Though these numbers are arbitrary, it captures the intuition that, relative to one another, Republicans place a higher emphasis on reducing inflation and Democrats place a higher emphasis on reducing unemployment.

Figure 1 illustrates how partisan differences in appointments depend on economic uncertainty in the context of our example. In this particular case, we are ignoring the influence of the legislative veto and focusing on the behavior of unconstrained Presidents. We address separation of powers concerns in the following section.

Three points are particularly notable from Figure 1. First, as Proposition 4 implied, appointees are more liberal when the economy is more unpredictable. Second, at low levels of uncertainty, differences between Republican and Democratic appointees can be quite small, perhaps statistically undetectable in most samples. Thus, a failure to find evidence that partisan differences in monetary preferences lead to partisan differences in appointments may not imply that politicians are not influential in the appointment process. Instead, this finding may simply reflect a lack of preference divergence over appointees because of a high level of predictability in the economy. Third, the difference between Republican and Democratic appointees increases when the economy is more uncertain, suggesting that appointments may reflect an interactive effect between partisanship of the President and the level of economic uncertainty.

4.2 Separation of powers and central bank appointments

Political scientists have studied the ways that separation of powers institutions affect appointment politics in the Federal Reserve (Chang, 2003) and other institutions (Ferejohn and Shipan, 1990). One of the effects of interest in this literature is the extent to which Presidents choose nominees that differ from the ones they would choose if they were unconstrained. In the two-party context this corresponds to the difference between nominees chosen under unified government (i.e. when the legislature is controlled by the President's party) and those chosen under divided government.

Our model leads to different substantive conclusions about the influence of separation of powers on Presidential appointments to the Federal Reserve. In our model, the President is only constrained by the legislative veto when economic uncertainty is large enough to generate substantially divergent preferences over potential nominees. For example, we may observe more inter-branch conflict over central bank appointments during financial crises when inflation uncertainty is high.

5 Conclusion

Theoretical work on Federal Reserve appointments has followed two different traditions which appear to contradict one another: the spatial model assumes that politicians wish to appoint allies and the rational expectations tradition predicts that politicians will appoint biased central bankers in order to commit to low inflation policies. We show that the predictions of each theoretical tradition can be recovered from a simple political economic theory of appointments. Our model predicts that credible commitment incentives will dominate in times of economic certainty, when politicians of all stripes will agree on relatively conservative central bankers. In times of crisis or high uncertainty, we predict that central bank appointments will be more politicized as the President and members of the Senate push to appoint their allies to the Federal Reserve.

Though our model is motivated by the application to the United States Federal Reserve, in principle the model applies equally well to any system in which central bankers are nominated by an executive and nominees are subject to veto by a legislative body. For instance, members of the Bank of Japan are appointed by the Prime Minister and may be rejected by the Diet. Furthermore, since the main comparative statics result remains unchanged when the legislative veto player is removed, the main insights of the model apply to other cases such as the Bank of England,[4] where the Chancellor of the Exchequer has unilateral appointment power, or the European Central Bank, where the European Commission has only an advisory role in appointments but lacks a formal veto.

In addition, some of the insights of the model may extend well beyond the domain of monetary policy. It has also been observed in other domains that problems of credible commitment may generate deviations from the ally principle. For instance, Bertelli and Feldmann (2007) show that, when policy outcomes are the result of bureaucrats negotiating with constituents, Presidents may prefer appointees with preferences that offset those of organized interests in the constituency. Gailmard and Hammond (2011) make a similar point about delegation to biased committee members in the presence of intercameral bargaining. Both environments are similar to our monetary policy environment in that delgation to a biased (relative to the principal) agent solves a commitment problem for the principle that allows her to obtain a superior outcome. Our main result suggests that more explicitly considering the role of policy uncertainty in these processes could generate a

[4]See Hix et al. (2010) and Eijffinger et al. (2013) for an empirical analysis of ideological variation in appointments to the Bank of England.

more nuanced understanding of when commitment problems should generate large differences in delegation behavior.

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6 Appendix

Proof of Lemma 1. Recall the *Central Banker* solves the following problem:

$$\max_{\pi}\left[-\pi^2 - b_C(\bar{y} - \alpha(\pi - w) - \varepsilon)^2\right].$$

The first order condition for a maximum is:

$$-2\pi - b_C\alpha(\bar{y} - \alpha(\pi - w) - \varepsilon) = 0.$$

Solving the first order condition and substituting in $w^*(b_C)$ yields the best response given by Equation 6. The second order condition is met since u_C is concave. Therefore, this is a best response for the *Central Banker* and $\pi^*(b_C)$ is the inflation rate chosen in a SPNE. ■

Proof of Proposition 1. Claim (1) follows easily from the derived strategies. The expected value of inflation is $b_c\bar{y}\alpha$ which is clearly increasing in b_C. The variance of inflation is

$$\frac{\alpha^2\sigma^2 b_C^2}{(\alpha^2 b_C + 1)^2} \tag{8}$$

which is increasing in b_C since

$$\frac{\partial}{\partial b_C}\frac{\alpha^2\sigma^2 b_C^2}{(\alpha^2 b_C+1)^2}=\frac{2\alpha^2\sigma^2 b_c}{(\alpha^2+1)^2}>0. \tag{9}$$

Since $E(w^*(b_C)-\pi^*(b_C))=0$ for any b_C and $E(\epsilon)=0$, the expected value of unemployment is simply $\overline{y}$ for all b_C. The variance of $y(\pi^*(b_C),w^*(b_C))$ is

$$\frac{\sigma^2}{(\alpha^2 b_C+1)^2} \tag{10}$$

which is strictly decreasing in b_C, proving claim (2). ■

Proof of Proposition 2. We will show that there exists one local maximum to U_i which lies in the open interval $(0,b_i)$ for any $b_i>0$. The first order condition is

$$\begin{aligned}\frac{\partial U_i}{\partial b_C}&=\frac{2\alpha^2\left(\alpha^2 b_C^2+b_i\right)\left(\bar{y}^2\left(\alpha^2 b_C+1\right)^2+\sigma^2\right)}{(\alpha^2 b_C+1)^3}-\frac{2\alpha^2\bar{y}^2\left(\alpha^2 b_C^2+b_i\right)}{\alpha^2 b_C+1}\\&-\frac{2\alpha^2 b_C\left(\bar{y}^2\left(\alpha^2 b_C+1\right)^2+\sigma^2\right)}{(\alpha^2 b_C+1)^2}\\&=-\frac{2\alpha^2\left(\alpha^6\bar{y}^2 b_C^4+3\alpha^4\bar{y}^2 b_C^3+3\alpha^2\bar{y}^2 b_C^2+b_C\left(\bar{y}^2+\sigma^2\right)-\sigma^2 b_i\right)}{(\alpha^2 b_C+1)^3}=0\end{aligned}$$

Since the denominator and the term $2\alpha^2$ must be strictly greater than zero, the solution to the first order condition must be a root to the quartic equation in the numerator:

$$\alpha^6\bar{y}^2 b_C^4+3\alpha^4\bar{y}^2 b_C^3+3\alpha^2\bar{y}^2 b_C^2+b_C\left(\bar{y}^2+\sigma^2\right)-\sigma^2 b_i=0.$$

We can re-write this expression as

$$b_C=g(b_C)=b_i\cdot\frac{\sigma^2}{\bar{y}^2\left(\alpha^2 b_C+1\right)^3+\sigma^2}. \tag{11}$$

Thus, the solution to our first-order condition is a fixed point of the function $g(\cdot)$. Since the fraction in Equation 11 is always less than 1, g is bounded above by b_i. Since g is also strictly positive, g is a continuous function mapping the interval $[0,b_i]$ onto itself. By Brouwer's fixed point theorem, there exists a fixed point of g on this interval. By the arguments above, the fixed point is on the interior of this interval. Since U_i is strictly concave, this fixed point is a maximum of U_i and is unique. ■

Lemma 2. For any parameter θ, if U_S satisfies increasing differences[5] for (b_C,θ), A_S is weakly increasing in θ in the strong set order.[6]

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[5]A function $f(x,\theta)$ satisfies **increasing differences** for (x,θ) if the incremental return, $f(x,\cdot)-f(x',\cdot)$, is weakly increasing in the parameter, θ.

[6]The strong set order is denoted $\geq_s$. When the choice set is a subset of the real line as in this paper and S^* and S^o

Proof: Let $\bar{\theta} > \underline{\theta}$ and denote $\overline{A_S}$ and $\underline{A_S}$ denote the set A_S when the parameter θ is set equal to $\bar{\theta}$ and $\underline{\theta}$, respectively. We consider three cases: (1) there is no $b'_C \neq b^{SQ}$ such that $U_i(b'_C, \underline{\theta}) = U_i(b^{SQ}, \underline{\theta})$; (2) there exists such a b'_C, and $b'_C > b^{SQ}$; and (3)there exists such a b'_C, and $\underline{b'_C} > b^{SQ}$. If there does not exist b'_C such that $U_i(b'_C, \theta) = U_i(b^{SQ}, \theta)$, then $\underline{A_S} = [0, b^{SQ}]$. Since $\overline{A_S})$ must be an interval including b^{SQ}, we have $\overline{A_S} \geq_s \underline{A_S}$.

Now assume there exists a $\underline{b'_C}$ such that $U_i(b'_C, \underline{\theta}) = U_i(b^{SQ}, \underline{\theta})$. If $b'_C > b^{SQ}$, then $\underline{A_S} = [b'_C, b^{SQ}]$. In this case, we must show that, for any $b''_C < b'_C$, $b''_C \notin \overline{A_S}$. By increasing differences,[7]

$$U_S(b'_C, \underline{\theta}) - U_S(b''_C, \underline{\theta}) > 0 \Rightarrow U_S(b'_C, \bar{\theta}) - U_S(b''_C, \bar{\theta}) \geq 0$$
$$U_S(b^{SQ}, \underline{\theta}) - U_S(b'_C, \underline{\theta}) = 0 \Rightarrow U_S(b^{SQ}, \bar{\theta}) - U_S(b'_C, \bar{\theta}) \geq 0.$$

Hence, $U_S(b^{SQ}, \bar{\theta}) \geq U_S(b'_C, \bar{\theta}) > U_S(\underline{b''_C}, \bar{\theta})$, which implies that $b''_C \notin \overline{A_S}$. Since $\overline{A_S}$ must be an interval including b^{SQ}, this implies that $\overline{A_S} \geq_s \underline{A_S}$.

Finally, if $b'_C > b^{SQ}$, then $\underline{A_S} = [b^{SQ}, b'_C]$. In this case, we must show that $b'_C \in \overline{A_S}$. By increasing differences,

$$U_S(b'_C, \underline{\theta}) - U_S(b^{SQ}, \underline{\theta}) = 0 \Rightarrow U_S(b'_C, \bar{\theta}) - U_S(b^{SQ}, \bar{\theta}) \geq 0$$

which implies that $b'_C \in \overline{A_S}$. The argument in Case 2 shows that there is no point in $\overline{A_S}$ smaller than b^{SQ}. □

we will use the following result, which follows from the monotone selection theorem of Milgrom and Shannon (1994):[8]

Monotone Selection Theorem (Milgrom and Shannon (1994)): Let $X \subseteq \mathbb{R}$ be the set of all possible choices of x and $\Theta \subseteq \mathbb{R}$ be the set of possible values of a parameter θ. Let $f : X \times \Theta \to \mathbb{R}$. If $S : \Theta \to 2^X$ is nondecreasing and f satisfies the single-crossing condition for (x, θ), then every selection $x^*(\theta)$ from $\arg\max_{x \in S(\theta)} f(x, \theta)$ is monotone nondecreasing in θ.

Proof of Proposition 3: Using the theorem of Milgrom and Shannon (1994), it is sufficient to show that $U_P(b)$ satisfies single-crossing for (b, b_P) and for (b, b_S) and that A_S is nondecreasing in b_P and b_S. Since b_S does not enter $U_P(b)$, so $U_P(b)$ satisfies single-crossing for (b, b_S) since the cross-partial derivative of $U_P(b)$ with respect to b and b_S is zero. Similarly, since $U_S(b_C)$ does not depend on b_P, A_S is non-decreasing in b_P. To show that $U_P(b)$ satisfies single-crossing for (b, b_P), note that

$$\frac{\partial U_P}{\partial b_C \partial b_P} = \frac{2\alpha^2\sigma^2}{(\alpha^2 b_C + 1)^3} > 0,$$

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are intervals, we will have $S^* \geq_s S^o$ provided that the end-points of S^* are greater than or equal to the end-points of S^o.

[7]This statement is an application of the single-crossing condition, which is implied by increasing differences.

[8]This is Theorem 4' in Milgrom and Shannon (1994). Their result is stated for more general multidimensional problems and requires introducing concepts that we have not defined above, so we restate it for the special case of one-dimensional choice sets and parameters and using the notation introduced above.

which shows that the increasing differences condition is satisfied, implying that the single-crossing is met. Since, by the same argument, $U_S(b_C)$ satisfies single-crossing for (b_C, b_S), Lemma 2 establishes that A_S is nondecreasing in b_S, completing the proof.■

Proof of Proposition 4. By the arguments above, we need to show that U_i satisfies single crossing for (b_C, σ) when b_C is in the interval $(0, b_i)$. Note that

$$\frac{\partial U_i}{\partial b_C \partial \sigma} = \frac{4\alpha^2 \sigma (b_i - b_C)}{(\alpha^2 b_C + 1)^3},$$

which is strictly positive given that $b_C < b_i$. Thus, U_i satisfies increasing differences (therefore single-crossing) for (b_C, σ), completing the proof. ■

Proposition 5. By Equation 11 in the proof of Proposition 2, the ideal appointment of each agent i satisfies

$$b_i \cdot \frac{\sigma^2}{\bar{y}^2 (\alpha^2 b_C + 1)^3 + \sigma^2}.$$

We have

$$\lim_{\sigma \to 0} b_i \cdot \frac{\sigma^2}{\bar{y}^2 (\alpha^2 b_C + 1)^3 + \sigma^2} = 0$$

and

$$\lim_{\sigma \to \infty} b_i \cdot \frac{\sigma^2}{\bar{y}^2 (\alpha^2 b_C + 1)^3 + \sigma^2} = b_i \lim_{\sigma \to \infty} \frac{\sigma^2}{\bar{y}^2 (\alpha^2 b_C + 1)^3 + \sigma^2} = b_i.$$

Furthermore, Proposition 4 shows that every agent's ideal appointment is increasing in σ. Thus, as σ goes to zero, the game approaches one with perfectly conservative appointments and as σ gets large the game monotonically approaches the spatial model of appointments in which agents seek appointees at their own ideal point. ■