Centre de Referència en Economia Analítica

Barcelona Economics Working Paper Series

Working Paper nº 60

Electoral Competition Between Two Candidates of Different Quality: The Effects of Candidate Ideology and Private Information

Enriqueta Aragones and Thomas R. Palfrey

February, 2004

Electoral Competition Between Two Candidates of Different Quality: The Effects of Candidate Ideology and Private Information*

Enriqueta Aragones[†] Thomas R. Palfrey[‡]
Barcelona Economics, WP n. 60

February 18, 2004

*Aragones acknowledges financial support from the Spanish Ministry of Science and Technology, grant number SEC2000-1186 and CREA. Palfrey acknowledges financial support from the National Science Foundation, grant number SES-0079301, and from the Institut d'Anàlisi Econòmica. He is also grateful for the hospitality of IAE in May 2003. We thank Clara Ponsati and participants of several seminars for helpful comments.
[†]Institut d'Anàlisi Econòmica, CSIC, Campus Universitat Autònoma, 08193 Bellaterra, Spain. enriqueta.aragones@uab.es

[‡](corresponding author) Division of Humanities and Social Sciences, Mail Code 228-77, California Institute of Technology, Pasadena, CA 91125. trp@hss.caltech.edu Fax:(626)432-1726

Abstract

This paper examines competition in a spatial model of two-candidate elections, where one candidate enjoys a quality advantage over the other candidate. The candidates care about winning and also have policy preferences. There is two-dimensional private information. Candidate ideal points as well as their tradeoffs between policy preferences and winning are private information. The distribution of this two-dimensional type is common knowledge. The location of the median voter's ideal point is uncertain, with a distribution that is commonly known by both candidates. Pure strategy equilibria always exist in this model. We characterize the effects of increased uncertainty about the median voter, the effect of candidate policy preferences, and the effects of changes in the distribution of private information. We prove that the distribution of candidate policies approaches the mixed equilibrium of Aragones and Palfrey (2002a), when both candidates' weights on policy preferences go to zero.

Key words: candidate quality; spatial competition; purification

JEL classification numbers: C73, D72, D82

1 Introduction

Several recent papers[1] have used a framework for studying the effect of candidate quality on political competition, based on the standard Downsian model competition between two candidates who maximize the probability of winning, but with an important twist: one candidate has a quality advantage. That is, any voter will strictly prefer the "higher quality" candidate (Candidate A) to the "lower quality" candidate (Candidate D) if the candidates locate so that the voter is indifferent between the two candidates on the policy dimension. In that paper, we showed that candidates diverge, and that this divergence occurs in predictable ways. In equilibrium the higher quality candidate ends up reinforcing her advantage by adopting relatively more centrist platforms, in a probabilistic sense.

Three limitations of that simple model are (1) candidates may have policy preferences, but the model assumes they only care about holding office; (2) the equilibrium is in mixed strategies;[2] and (3) candidates have perfect information about each other's objective function, which is unrealistic. This paper extends the model in a natural way that relaxes all three limitations, and leads to new insights about candidate competition when there are quality differences between the two candidates.

A key insight comes from Harsanyi's (1973) paper on purification of mixed strategies. That paper shows that for games like the one considered in Aragones and Palfrey (2002) one can almost always approximate a mixed strategy equilibrium by a pure strategy equilibrium of a game in which the players have private information. That is, if we consider the model with complete information to be only a first approximation to the real world, where the "correct" model would be one with private information, then indeed the mixed strategy equilibrium is reasonable since it is close to an equilibrium of a more complicated and realistic game.

Our approach is to introduce incomplete and asymmetric information about candidate policy preferences. We consider two-dimensional private information. It is common to assume that the candidates care not only about the probability of winning, but also about the policy that is implemented by the winning candidate.[3] In our model, the weight each candidate places on

[1] See, e.g., Aragones and Palfrey (2002, 2004) and Groseclose (2001).

[2] It is hard to imagine how candidates would actually implement mixed strategies in a location game.

[3] In a related paper, Groseclose (2001) examines a model of asymmetric candidates

winning is *private information* and is independently drawn for each of the two candidates. The second component of private information is that neither candidate is certain of the other candidate's exact ideal point. Both of these generalizations capture important and realistic aspects of political competition. While candidates may have some information about each other's ideal point, based on past records, and candidates may know a little bit about how much the other candidate trades off policy preferences and the value of holding office, both are arguments of a utility function, and neither can be observed directly. Moreover, much of what a candidate says is rhetorical, which makes it difficult to take campaign platforms of candidates as straightforward representations of their ideal points. In fact, we know from results by Wittman (1977, 1983), Calvert (1985), and others, that policy motivated candidates will generally not adopt their ideal point as a platform. Furthermore, the actual policies adopted by the elected candidate may not necessarily reflect her ideal point, since it may simply be done to fulfill campaign promises or to satisfy her constituency or party.

In this two-dimensional asymmetric information model, we characterize the best response functions of the two candidates and use the properties of these best response functions to fully characterize the equilibrium. Best responses of each candidate depend on five variables: the candidate's quality, the amount of uncertainty, the probability the other candidate locates at the center, the candidate's ideal point, and the candidate's own value of holding office.

First, we show that locating at an extreme position other than one's own ideal point is never a best response for either candidate. Next, we show that this implies, that best responses are fully characterized by cutoff rules, which means that it is optimal for a candidate to locate in the center if and only if his or her value of holding office is sufficiently great.

Third, we show that, for the advantaged candidate, best responses are upward sloping, in the sense that her cutoff value increases in the cutoff value of the disadvantaged candidate. That is, candidate A is more likely to locate in the center if she thinks candidate D is more likely to locate at the

---

where candidates have a mixture of policy preferences and preferences for holding office. However, in that paper the exact weights between the two objectives are the same for both candidates and are common knowlegde. As a result, pure strategies equilibrium often fails to exist in that model. Other recent theoretical papers on candidate competition with quality asymmetry are Ansolobehere and Snyder (2000) and Berger, Munger, and Potthoff (2000).

center. The opposite is true for candidate D, who is less likely to locate in the center, the more likely he thinks A will locate at the center.

Fourth, we show that an increase in uncertainty about the median voter leads both candidates to be less likely to adopt the moderate platform. An alternative interpretation is that as the electorate becomes more polarized (i.e. the probability the median voter is moderate decreases), the candidates also become more polarized.

Fifth, putting these results together we can show how the equilibrium distributions of candidate locations vary with the polarization parameter. Here we find that the equilibrium platform of A becomes more polarized when the electorate becomes more polarized, but that is not the case for candidate D. In fact, for D the effect can go either way because of conflicting forces. On the one hand, locating at his ideal point is more attractive for D because the probability the median voter has the same ideal point as D has increased. On the other hand, since that is A's equilibrium response, it is less attractive. The sum of these two effects can be either positive or negative.

We then look at the effect of decreasing the asymmetric information between the two candidates. When both candidates' office-holding weights collapse to 1 (it becomes common knowledge between the candidates that both only care about holding office), we recover all of the results of the symmetric information model. However, the direction of convergence is interesting. The equilibrium probability that D locates in the center converges from above, and the equilibrium probability that A locates in the center converges from below. Thus, one surprising effect of asymmetric information is that it leads D to moderate. This occurs even though the expected value of holding office is decreasing. In contrast, however, asymmetric information leads A to adopt more extreme policies on average.

Finally, we characterize the boundary case of complete information about λ, which provides insights into the intuition for the general case. First, we show that only mixed strategy equilibria exist when the value of holding office is high enough. If this occurs, then we obtain comparative statics similar to Aragones and Palfrey (2002). Increased uncertainty leads the advantaged candidate to adopt more extreme positions and the disadvantaged candidate to be more moderate. However, in contrast to the earlier paper, each candidate simply mixes between its ideal point and the central policy rather than mixing over all three policies. Thus, a new interpretation of this result is that the effect of increased uncertainty is for the advantaged candidate to move closer to her ideal point (in expectation) and for the disadvantaged candidate to move away from his ideal point. Results of previous work on competition with policy preferences suggest that more uncertainty would lead both candidates to move toward their ideal points. This points to an interesting interaction effect between candidate quality, uncertainty, and policy preferences, which can lead to non-intuitive results.

In this boundary case we also analyze the effect of the value of holding office on equilibrium location choices. We again find an opposite effect for the two candidates. Candidate A adopts more central locations when the value of holding office increases, but Candidate D adopts more extreme locations when the value of holding office increases, another counterintuitive effect, driven by the fact that candidate D needs to differentiate his position from A in order to win.

The rest of the paper proceeds as follows. The next section describes the formal model. Section 3 presents the derivation of the unique equilibrium. The properties of the equilibrium are analyzed in section 4. Finally, section 5 contains some concluding remarks.

2 The Model

The policy space, $\wp$ consists of 3 points on the real line, $\{0, .5, 1\}$, which we will refer to as L (left) C (center), and R(right). There are two candidates, A and D, who are referred to as the advantaged candidate and the disadvantaged candidate, respectively. Each voter has a utility function, with two components, a policy component, and a candidate image component.[4] The policy component is characterized by an ideal point in the policy space $\wp$, with utility of alternatives in the policy space a strictly decreasing function of the Euclidean distance between the ideal point and the location of the policy, symmetric around the ideal point. We assume there exists a unique median voter ideal point, denoted by x_m. Candidates do not know x_m, but share a common prior belief about it, which is symmetric around C. We denote by $\alpha \in [0, 1/2]$ the probability that $x_m = L$, which also equals the probability that $x_m = R$. Hence the probability that $x_m = C$ equals $1 - 2\alpha$.

The quality advantage of A is captured by an additive constant to the utility a voter obtains if A wins the election. That is, the utility to a voter i with ideal point x_i if A wins the election is $U_i(x_A) = \delta - |x_i - x_A|$ and

[4]There could be either a finite number of voters or a continuum.

the utility to i if candidate D wins is $U_i(x_D) = -|x_i - x_D|$, where candidates' policy positions are denoted by x_A and x_D and the magnitude of A's advantage is $0 < \delta < 1/2$.[5]

2.1 Candidates' Objective Functions

Candidates have ideal points, just like voters. The ideal point of candidate j is denoted y_j. Candidates know their own ideal point. They do not know the ideal point of the other candidate, but do know that the other candidate's ideal point is equally likely to be L or R. The game takes place in two stages. In the first stage, candidates simultaneously choose positions in $\wp$. As in the standard Downsian model, candidates implement their announced positions if they win the election. In the second stage, each voter votes for the preferred candidate (taking account of the quality advantage). In case of indifference, a voter is assumed to vote for each candidate with probability equal to 1/2.

Since the behavior of the voters is unambiguous in this model, we define an equilibrium of the game only in terms of the location strategies of the two candidates in the first round. Given a pair of candidate locations, (x_A, x_D) we denote by $\pi_A(x_A, x_D)$ and $\pi_D(x_A, x_D)$ the probability of winning for candidate A and for candidate D, respectively, as a function of (x_A, x_D), where $\pi_A(x_A, x_D) + \pi_D(x_A, x_D) = 1$.

Each candidate maximizes an objective function that is a linear combination of the probability of winning and a second component corresponding to the candidate's privately known policy preferences. Formally, the objective function of candidate A and D are given, respectively, by:

$$\begin{aligned} U_A(x_A, x_D|y_A, \lambda_A) &= \lambda_A \pi_A(x_A, x_D) \\ &\quad -(1-\lambda_A)\{\pi_A(x_A, x_D)\,|y_A - x_A| + \pi_D(x_A, x_D)\,|y_A - x_D|\} \\ U_D(x_A, x_D|y_D, \lambda_D) &= \lambda_D \pi_D(x_A, x_D) \\ &\quad -(1-\lambda_D)\{\pi_A(x_A, x_D)\,|y_D - x_A| + \pi_D(x_A, x_D)\,|y_D - x_D|\} \end{aligned}$$

Thus, λ_j is the weight candidate j places on holding office. This weight is private information. That is, candidate j knows λ_j but does not know the other candidate's value of holding office. Each λ_j is independently drawn

[5] Two further generalizations of this model would be: (1) to allow different candidates to have different beliefs about x; or (2) to allow different voters to have different image terms.

from a commonly known distribution, with cdf F_j over $[0, 1]$. We assume, for each j, $F_j(0) = 0$, $F_j(1) = 1$, and F_j is continuously increasing on $[0, 1]$, and refer to this as the *regularity assumption.* To summarize, each candidate has a two-dimensional type (y_j, λ_j) which is private information. The types are drawn independently and the distribution of types is common knowledge.

3 Derivation of Unique Equilibrium

The first thing to notice is that if candidate D's ideal point is 0, then locating at 1 is never a weak best response for all $\lambda_D \in [0, 1)$. Similarly, if candidate D's ideal point is 1, then locating at 0 is never a weak best response for all $\lambda_D \in [0, 1)$. Therefore, in equilibrium, the probability that D locates at 0 is bounded above by .5 and the probability that D locates at 1 is also bounded above by .5. Iterating this never a weak best response elimination for A implies that if candidate A's ideal point is 0, then locating at 1 is never a weak best response for all $\lambda_A \in [0, 1)$. Similarly, if candidate A's ideal point is 1, then locating at 0 is never a weak best response for all $\lambda_A \in [0, 1)$.

Therefore, given candidate j's ideal point, and given any strategy of the other player, we only need to consider two possibilities for j's best response. Either j's best response is to locate at his ideal point, or to locate at .5. Which is optimal will depend not only on the opponent's strategy, but also on λ_j. Specifically, there will exist a *cutpoint,* $\lambda_j^* \in [0, 1]$ such that locating at .5 is strictly optimal for j if and only if $\lambda_j \geq \lambda_j^*$.

Hence equilibrium strategies take a very simple form, where candidate j chooses to moderate or not, depending only on the value of λ_j. Thus, an equilibrium will consist of a pair, $(\lambda_A^*, \lambda_D^*)$ such λ_A^* is an optimal response to λ_D^*, and λ_D^* is an optimal response to λ_A^*. Given $(\lambda_A^*, \lambda_D^*)$, this determines the probability candidate j locates at .5, which is simply $prob\{\lambda_j \in [\lambda_j^*, 1]\}$. We denote

$$p_{\lambda_A^*} = prob\{\lambda_A \in [\lambda_A^*, 1]\} = 1 - F_A(\lambda_A^*)$$
$$q_{\lambda_D^*} = prob\{\lambda_D \in [\lambda_D^*, 1]\} = 1 - F_D(\lambda_D^*)$$

and, dropping the dependence on λ, we refer to p (or q) as the *induced mixed strategy of candidate* A (or D).

Finally, by symmetry, this implies that the induced mixed strategy for A is $(\frac{1-p}{2}, p, \frac{1-p}{2})$ and the induced mixed strategy for D is $(\frac{1-q}{2}, q, \frac{1-q}{2})$. Given any symmetric induced mixed strategy for A, $(\frac{1-p}{2}, p, \frac{1-p}{2})$, we can derive the optimal λ-cutpoint for D, from which we can derive the induced mixed strategy for D, from which we can derive the optimal λ-cutpoint for A, from which we can derive the induced mixed strategy for A. A Bayesian Nash equilibrium is a fixed point of this composed mapping. Formally, one calculates the equilibrium by the equality conditions that must hold at each of the cutpoints. That is, at a candidate's (interior)[6] cutpoint, the candidates are exactly indifferent between locating at their ideal point or locating at .5.

3.1 Candidate A's Best Responses

Without loss of generality, assume that A's ideal point is L.[7] We derive best responses for A, by identifying conditions on α, λ_A, and q, such that choosing C is a best response. With this in mind, fix α and λ_A and suppose that D is using some type-contingent (possibly mixed) strategy that implies an induced mixed strategy of $q \in (0, 1)$. Then the expected payoff to A for locating at L when his office holding weight is equal to λ_A is given by:

$$
\begin{aligned}
V_L^A &= \alpha\left(\frac{1-q}{2}\lambda_A + q\lambda_A + \frac{1-q}{2}\lambda_A\right) \\
&\quad + (1-2\alpha)\left(\frac{1-q}{2}\lambda_A - q\frac{1-\lambda_A}{2} + \frac{1-q}{2}\lambda_A\right) \\
&\quad + \alpha\left(\frac{1-q}{2}\lambda_A - q\frac{1-\lambda_A}{2} - \left(\frac{1-q}{2}\right)(1-\lambda_A)\right) \\
&= \frac{\lambda_A}{2}[2 - q + q\alpha] - \frac{1}{2}[(1-2\alpha)q + \alpha]
\end{aligned}
$$

Similarly, the expected payoff to A for locating at C when his office-holding weight is equal to λ_A is given by:

[6] If the cutpoint is at $\lambda = 0$ or $\lambda = 1$ then we have an inequality condition.

[7] By symmetry, the payoffs and strategy calculations are the same when candidate A's ideal point is R.

$$\begin{aligned} V_C^A &= \alpha\left(\frac{1-q}{2}0+q\frac{3\lambda_A-1}{2}+\left(\frac{1-q}{2}\right)\left(\frac{3\lambda_A-1}{2}\right)\right)+ \\ &+(1-2\alpha)\left(\left(\frac{1-q}{2}\right)\left(\frac{3\lambda_A-1}{2}\right)-q\frac{3\lambda_A-1}{2}+\left(\frac{1-q}{2}\right)\left(\frac{3\lambda_A-1}{2}\right)\right) \\ &+\alpha\left(\left(\frac{1-q}{2}\right)\left(\frac{3\lambda_A-1}{2}\right)-q\frac{3\lambda_A-1}{2}-\left(\frac{1-q}{2}\right)(1-\lambda_A)\right) \\ &= \frac{\lambda_A}{2}[2q\alpha-2\alpha+3)]-\frac{1}{2} \end{aligned}$$

Comparing payoffs for A:

$$\begin{aligned} V_L^A(\alpha,\lambda_A,q) &\leq V_C^A(\alpha,\lambda_A,q) \Leftrightarrow \\ \lambda_A(2-q+q\alpha)+2q\alpha-\alpha-q &\leq \lambda_A(2q\alpha-2\alpha+3)-1 \Leftrightarrow \\ \lambda_A &\geq \frac{1-\alpha-q(1-2\alpha)}{1-2\alpha+q(1+\alpha)} \equiv \lambda_A^*(q) \end{aligned}$$

If $0 \leq q \leq \frac{\alpha}{2-\alpha}$ then $\lambda_A^*(q) \geq 1$, so the best response is to locate at her ideal point. Thus, $p=0$ for all values of $\lambda_A < 1$, for this range of q.

If $\frac{\alpha}{2-\alpha} < q \leq 1$ then $\lambda_A^*(q) \in (0,1)$. In fact, over this range, we get $\frac{\partial \lambda_A^*(q)}{\partial q} < 0$. That is, A's λ-cutoff is strictly decreasing in q over this range of q, from a maximum of $\lambda_A^*(\frac{\alpha}{2-\alpha}) = 1$ to a minimum of $\lambda_A^*(1) = \frac{\alpha}{2-\alpha}$. Similarly, suppressing the dependence of the reaction function of α, we can write $\mathbf{P}(q) = 1-F_A[\lambda_A^*(q)]$, and we have $\frac{\partial \mathbf{P}(q)}{\partial q} > 0$ when $q \in (\frac{\alpha}{2-\alpha}, 1]$, ranging from a minimum of $\mathbf{P}(\frac{\alpha}{2-\alpha}) = 0$ to a maximum of $\mathbf{P}(1) = 1-F_A[\frac{\alpha}{2-\alpha}]$. Thus, the reaction function of candidate A is

$$\mathbf{P}(q) = \begin{cases} 0 & if\ 0 \leq q \leq \frac{\alpha}{2-\alpha} \\ 1-F_A[\lambda_A^*(q)] & if\ \frac{\alpha}{2-\alpha} < q \leq 1 \end{cases}$$

This is illustrated by the solid upward sloping curve[8] in figure 1.

FIGURE 1 ABOUT HERE

3.2 Candidate D's Best Responses

Next consider candidate D. Without loss of generality, assume that D's ideal point is R.[9] Fix α and λ_D. Suppose A is using a strategy that implies an induced mixed strategy $p \in (0,1)$. Then the expected payoff to D for locating at R when his office holding weight is equal to λ_D is given by:

$$\begin{aligned} V_R^D(\alpha, \lambda_D, p) &= \alpha\left(-\left(\frac{1-p}{2}\right)(1-\lambda_D) - p\frac{1-\lambda_D}{2} + \frac{1-p}{2}0\right) \\ &\quad + (1-2\alpha)\left(-\left(\frac{1-p}{2}\right)(1-\lambda_D) - p\frac{1-\lambda_D}{2} + \frac{1-p}{2}0\right) \\ &\quad + \alpha\left(\frac{1-p}{2}\lambda_D + p\lambda_D + \frac{1-p}{2}0\right) \\ &= \lambda_D\frac{1+p\alpha}{2} - \frac{1-\alpha}{2} \end{aligned}$$

Similarly, the expected payoff to D for locating at C when his office-holding weight is equal to λ_D is given by:

[8] The curve represents $\mathbf{P}(q)$ as a concave function. This is done because in a sense this is the typical case when the distributions of λ converge to 1. A necessary and sufficient condition for $\mathbf{P}$ to be a concave function of q is:

$$F_A^{''} \geq -F_A^{'}\frac{2(1-2\alpha+q(1+\alpha))(1+\alpha)}{(1-2\alpha)^2+(1-\alpha^2)}.$$

[9] By symmetry, the payoffs and strategy calculations are the same when candidate D's ideal point is L.

$$
\begin{aligned}
V_C^D(\alpha,\lambda_D,p) &= \alpha\left(-\left(\frac{1-p}{2}\right)(1-\lambda_D)-p\frac{1-\lambda_D}{2}+\left(\frac{1-p}{2}\right)\left(\frac{3\lambda_D-1}{2}\right)\right)\\
&\quad+(1-2\alpha)\left(\left(\frac{1-p}{2}\right)\left(\frac{3\lambda_D-1}{2}\right)-p\frac{1-\lambda_D}{2}+\left(\frac{1-p}{2}\right)\left(\frac{3\lambda_D-1}{2}\right)\right)\\
&\quad+\alpha\left(\left(\frac{1-p}{2}\right)\left(\frac{3\lambda_D-1}{2}\right)-p\frac{1-\lambda_D}{2}+\frac{1-p}{2}0\right)\\
&= \lambda_D\frac{2p\alpha-2p-2\alpha+3}{2}-\frac{1}{2}
\end{aligned}
$$

To compute best replies for D, we simply compare $V_R^D(\alpha,\lambda_D,p)$ and $V_C^D(\alpha,\lambda_D,p)$:

$$
\begin{aligned}
V_R^D(\alpha,\lambda_D,p) &\geq (\alpha,\lambda_D,p)V_C^D \Leftrightarrow\\
\lambda_D(1+p\alpha)-1-\alpha &\geq \lambda_D(2p\alpha-2p-2\alpha+3)-1 \Leftrightarrow\\
\alpha &\geq (2(1-\alpha)-p(2-\alpha))\lambda_D
\end{aligned}
$$

If $\frac{2-3\alpha}{2-\alpha}\leq p\leq 1$ then $\alpha\geq(2(1-\alpha)-p(2-\alpha))$, so the best response for D is to locate at his ideal point. Thus, $q=0$ for all values of λ_D, for this range of p.

If $0\leq p<\frac{2-3\alpha}{2-\alpha}$ then $\frac{\alpha}{2(1-\alpha)-p(2-\alpha)}\equiv\lambda_D^*(p)\in(0,1)$. In fact, over this range, we get $\frac{\partial\lambda_D^*(p)}{\partial p}>0$. That is, D's λ-cutoff is strictly increasing in p over this range of p, from a minimum of $\lambda_D^*(0)=\frac{\alpha}{2-2\alpha}$ to a maximum of $\lambda_A^*(\frac{2-3\alpha}{2-\alpha})=1$. Similarly, we can write $\mathbf{Q}(p)=1-F_D[\lambda_D^*(p)]$, and we have $\frac{\partial\mathbf{Q}(p)}{\partial p}<0$ when $p\in[0,\frac{2-3\alpha}{2-\alpha})$, ranging from a maximum of $\mathbf{Q}(0)=\frac{\alpha}{2-2\alpha}$ to a minimum of $\mathbf{Q}(\frac{2-3\alpha}{2-\alpha})=0$. Thus, the reaction function of candidate D is

$$
\mathbf{Q}(p)=\begin{cases}0 & if\ \frac{2-3\alpha}{2-\alpha}\leq p\leq 1\\ 1-F_D[\lambda_D^*(p)] & if\ 0\leq p<\frac{2-3\alpha}{2-\alpha}\end{cases}
$$

This is illustrated by the solid downward sloping curve[10] in figure 1. It is

[10] The curve represents $\mathbf{Q}(p)$ as a concave function. This is in some sense a typical case, particularly when the distributions of λ converge to 1. A necessary and sufficient condition for $\mathbf{Q}$ to be a concave function of p is:

$$
F_D^{''}\geq -2F_D^{'}/\lambda_D^*(p).
$$

evident from the figure that there is a unique equilibrium in pure strategies, which we state and prove formally below.

Theorem 1: There is a unique equilibrium in pure strategies for all values of α, and for all F_D and F_A satisfying the regularity assumption.

Proof: There are two cases.

Case 1: $\frac{\alpha}{2-\alpha} < 1 - F_D[\frac{\alpha}{2-2\alpha}]$. This case is illustrated in the Figure 1. At $p = 0$, candidate D's cutoff value, $\lambda_D^*(p)$ equals $\frac{\alpha}{2-2\alpha}$ and increases continuously to 1, which occurs when $p = \frac{2-3\alpha}{2-\alpha} < 1$. Hence, D's induced mixed strategy response, $\mathbf{Q}(p)$, is equal to $1 - F_D[\frac{\alpha}{2-2\alpha}]$ if $p = 0$, and decreases continuously (by the regularity assumption) to 0 for $\frac{2-3\alpha}{2-\alpha} \leq p$. For candidate A, $\lambda_A^*(q) = 1$ for all values of $q \in [0, \frac{\alpha}{2-\alpha}]$. Then $\lambda_A^*(q)$ is strictly and continuously decreasing until $q = 1$, at which point, $\lambda_A^*(q) = \frac{\alpha}{2-\alpha}$. Therefore A's induced mixed strategy response, $\mathbf{P}(q)$, is equal to 0 if $q \in [0, \frac{\alpha}{2-\alpha}]$, and increases continuously (by the regularity assumption) to $\frac{\alpha}{2-\alpha}$ when $q = 1$. Since $\frac{\alpha}{2-2\alpha} < 1 - F_D[\frac{\alpha}{2-2\alpha}]$ there is exactly one intersection between $\mathbf{Q}(p)$ and $\mathbf{P}(q)$. This intersection point is in the interior of $[0, 1]^2$ and takes on values $q^* \in (\frac{\alpha}{2-\alpha}, 1 - F_D[\frac{\alpha}{2-2\alpha}])$ and $p^* \in (0, \frac{2-3\alpha}{2-\alpha})$.

Case 2: $\frac{\alpha}{2-\alpha} \geq 1 - F_D[\frac{\alpha}{2-2\alpha}]$. There is again a single intersection, but it is not interior, since the intersection occurs at $p^* = 0$, $q^* = 1 - F_D[\frac{\alpha}{2-2\alpha}] \leq \frac{\alpha}{2-\alpha}$. ■

4 Properties of the Equilibrium Mapping

Here we study several properties of the equilibrium mapping. First, we look at how the equilibrium changes when α, the index of voter polarization (or uncertainty about the median voter), changes. Then, we study the effects of changing the distribution of weights that candidates place on their policy preferences.

4.1 The Effects of Changing α

It is straightforward to show that $\mathbf{P}(q)$ is weakly decreasing in α (strictly decreasing for $q > \frac{\alpha}{2-\alpha}$). This is illustrated in Figure 1, with the dotted upward sloping curve to the upper left of the solid $\mathbf{P}(q)$ curve. As α increases the q-intercept of $\mathbf{P}(q)$, which equals $\frac{\alpha}{2-\alpha}$, increases and the p-intercept of $\mathbf{P}(q)$, which equals $1 - F_A(\frac{\alpha}{2-\alpha})$, decreases.

Similarly, $\mathbf{Q}(p)$ is also weakly decreasing in α (strictly decreasing for $p < \frac{2-3\alpha}{2-\alpha}$). This is shown in Figure 1, by the dotted downward sloping curve to the lower left of the solid $\mathbf{Q}(p)$ curve. As α increases the q-intercept of $\mathbf{Q}(p)$ which equals $1 - F_D(\frac{\alpha}{2-2\alpha})$, decreases as does the p-intercept of $\mathbf{Q}(p)$, which equals $\frac{2-3\alpha}{2-\alpha}$. These two results are stated and proved below in Proposition 1.

Proposition 1: (comparative statics with respect to α)
a) $\frac{d\mathbf{Q}(p)}{d\alpha} \leq 0$ for all p and $\frac{d\mathbf{Q}(p)}{d\alpha} < 0$ for $p < \frac{2-3\alpha}{2-\alpha}$.
b) $\frac{d\mathbf{P}(q)}{d\alpha} \leq 0$ for all q and $\frac{d\mathbf{P}(q)}{d\alpha} < 0$ for $q > \frac{\alpha}{2-\alpha}$.

Proof: An informal argument is given in the paragraph above. The formal argument simply requires partial differentiation of $\mathbf{P}(q)$ and $\mathbf{Q}(p)$ with respect α. For $\mathbf{Q}(p)$ when $p < \frac{2-3\alpha}{2-\alpha}$, we get

$$\begin{aligned}
\frac{\partial \mathbf{Q}(p)}{\partial \alpha} &= -\frac{\partial F_D}{\partial \lambda}\frac{\partial \lambda_D^*}{\partial \alpha} \\
&= -\frac{\partial F_D}{\partial \lambda}\frac{\partial \frac{\alpha}{2(1-\alpha)-p(2-\alpha)}}{\partial \alpha} \\
&= -\frac{\partial F_D}{\partial \lambda}\frac{2(1-\alpha)-p(2-\alpha)+\alpha(2-p)}{[2(1-\alpha)-p(2-\alpha)]^2} \\
&= -\frac{\partial F_D}{\partial \lambda}\frac{2(1-p)}{[2(1-\alpha)-p(2-\alpha)]^2} \\
&< 0
\end{aligned}$$

since $\frac{\partial F_D}{\partial \lambda} \geq 0$ and $\frac{2(1-p)}{[2(1-\alpha)-p(2-\alpha)]^2} > 0$. When $\frac{2-3\alpha}{2-\alpha} \leq p \leq 1$ we always have that $\frac{\partial \mathbf{Q}(p)}{\partial \alpha} = 0$.

Similarly, for $\mathbf{P}(q)$ when $\frac{\alpha}{2-\alpha} < q$, we get

$$\begin{aligned}
\frac{\partial \mathbf{P}(q)}{\partial \alpha} &= -\frac{\partial F_A}{\partial \lambda}\frac{\partial \lambda_A^*}{\partial \alpha} \\
&= -\frac{\partial F_A}{\partial \lambda}\frac{\partial \frac{1-\alpha-q(1-2\alpha)}{1-2\alpha+q(1+\alpha)}}{\partial \alpha} \\
&= -\frac{\partial F_A}{\partial \lambda}\frac{(-1+2q)(1-2\alpha+q(1-\alpha))+(2-q)(1-\alpha-q(1-2\alpha))}{[1-2\alpha+q(1+\alpha)]^2} \\
&= -\frac{\partial F_A}{\partial \lambda}\frac{2q^2+(q-1)^2}{[1-2\alpha+q(1+\alpha)]^2} \\
&< 0
\end{aligned}$$

since $\frac{\partial F_A}{\partial \lambda} \geq 0$ and $2q^2 + (q-1)^2 > 0$. When $q \leq \frac{\alpha}{2-\alpha}$ we always have that $\frac{\partial \mathbf{P}(q)}{\partial \alpha} = 0.$■

Both of these effects, which lead candidates to adopt less moderate positions when α increases, are intuitive, since they are direct effects. As α increases, the median voter's ideal point is more likely to be at one of the two extremes, either L or R. Therefore all types of both candidates find it less advantageous to locate in the center, holding constant the strategy of the other player. Hence either player's cutoff value increases, given any induced mixed strategy of the other player.

The *equilibrium* effect of this shift reflects the same intuition as discussed in Aragones and Palfrey (2002). In order to increase the chance of winning, candidate A wants to locate close to the median voter, *and* also wants to locate close to D. Since the direct effect on D is to move in the direction of the median voter (i.e. $\lambda_D^*(p)$ decreases when α increases), both of these effects on A go in the same direction. Hence $\frac{dp^*}{d\alpha} < 0$. The effect on D is more complicated. While the direct effect on D is to follow the median voter (suggesting that q^* should decrease), the indirect effect on D goes in the opposite direction, since D wants to distance himself from A. Since these effects go in opposite directions, we cannot sign $\frac{dq^*}{d\alpha}$. The sign can be either positive or negative. Figure 1 shows a case in which $\frac{dq^*}{d\alpha} > 0$, but it could easily go the other way.

Proposition 2: (equilibrium comparative statics with respect to α)
i) $\frac{dp^*}{d\alpha} \leq 0$
ii) $\frac{dq^*}{d\alpha} \leq 0$ iff $\frac{-2(1-p^*)}{\alpha(2-\alpha)} \leq \frac{dp^*}{d\alpha}$

Proof: An informal argument is given in the paragraph above.

(i) The formal argument that $\frac{dp^*}{d\alpha} < 0$ is straightforward. Consider $(p^*(\alpha), q^*(\alpha))$ and $(p^*(\alpha'), q^*(\alpha'))$ and suppose that $\alpha < \alpha'$. We will show that $p^*(\alpha') \leq p^*(\alpha)$.

If $q^*(\alpha') \geq q^*(\alpha)$, we have that $q^*(\alpha') = \mathbf{Q}(\alpha', p^*(\alpha')) \leq \mathbf{Q}(\alpha, p^*(\alpha'))$ since $\alpha < \alpha'$ and $\frac{\partial \mathbf{Q}(p)}{\partial \alpha} < 0$. Therefore, since $q^*(\alpha') \geq q^*(\alpha)$, we have that $q^*(\alpha) = \mathbf{Q}(\alpha, p^*(\alpha)) \leq \mathbf{Q}(\alpha, p^*(\alpha'))$. Since $\frac{\partial \mathbf{Q}(p)}{\partial p} \leq 0$, this implies that $p^*(\alpha') \leq p^*(\alpha)$.

If $q^*(\alpha') < q^*(\alpha)$, we have that $p^*(\alpha') = \mathbf{P}(\alpha', q^*(\alpha')) \leq \mathbf{P}(\alpha', q^*(\alpha))$ because $q^*(\alpha') < q^*(\alpha)$ and $\frac{\partial \mathbf{P}(q)}{\partial q} \geq 0$. And $\mathbf{P}(\alpha', q^*(\alpha)) \leq \mathbf{P}(\alpha, q^*(\alpha)) = p^*(\alpha)$ since $\frac{\partial \mathbf{P}(q)}{\partial \alpha} < 0$ and $\alpha < \alpha'$. Therefore, we have that $p^*(\alpha') \leq p^*(\alpha)$.

(ii) To prove that $\frac{dq^*}{d\alpha} \leq 0$ iff $\frac{-2(1-p^*)}{\alpha(2-\alpha)} \leq \frac{dp^*}{d\alpha}$ notice that

$$\begin{aligned} \frac{dq^*}{d\alpha} &= \frac{d\left(1 - F_D\left(\lambda_D^*\left(p^*\left(\alpha\right)\right)\right)\right)}{d\alpha} = -\left(\frac{\partial F_D\left(\lambda_D^*\left(p^*\left(\alpha\right)\right)\right)}{\partial \lambda}\right)\left(\frac{d\left(\lambda_D^*\left(\alpha, p^*\left(\alpha\right)\right)\right)}{d\alpha}\right) \leq 0 \\ &\Longleftrightarrow \frac{d\left(\lambda_D^*\left(\alpha, p^*\left(\alpha\right)\right)\right)}{d\alpha} \geq 0 \end{aligned}$$

since $\frac{\partial F_D(\lambda)}{\partial \lambda} \geq 0$.

From above,

$$\frac{d\left(\lambda_D^*\left(\alpha, p^*\left(\alpha\right)\right)\right)}{d\alpha} = \frac{2\left(1-p^*\right) + \alpha\left(2-\alpha\right)\frac{dp^*(\alpha)}{d\alpha}}{\left[2\left(1-\alpha\right) - p^*\left(2-\alpha\right)\right]^2}$$

and hence

$$\begin{aligned} \frac{d\left(\lambda_D^*\left(\alpha, p^*\left(\alpha\right)\right)\right)}{d\alpha} &\geq 0 \\ &\Longleftrightarrow \\ 2\left(1-p^*\right) + \alpha\left(2-\alpha\right)\frac{dp^*\left(\alpha\right)}{d\alpha} &\geq 0 \end{aligned}$$

Therefore,

$$\begin{aligned} \frac{dq^*}{d\alpha} &\leq 0 \\ &\Longleftrightarrow \\ \frac{-2\left(1-p^*\right)}{\alpha\left(2-\alpha\right)} &\leq \frac{dp^*}{d\alpha}. \blacksquare \end{aligned}$$

4.2 The Effects of Changing the Distribution of Office-holding Weights, F_A and F_D

4.2.1 Converging to Complete Information about λ

In this subsection we study the effects of changing the distribution of λ_A and λ_D. When either distribution function shifts to the right, the value of the corresponding λ is more likely to be higher, in the sense of stochastic dominance.[11] This implies that the reaction function of the candidate whose

[11] Formally, given two distribution functions F and G defined on $[0,1]$, F *stochastically dominates* G if $F(\lambda) \leq G(\lambda)$ for all $\lambda \in [0,1]$.

distribution function has shifted will also shift in the same direction. That is, the candidate's best response is more likely to locate in the center since the candidate is more likely to place a higher weight on winning. This in turn implies unambiguous comparative statics results for p^* and q^*, which are summarized in the next proposition.

Proposition 3: Let $F_D(\lambda_D) < G_D(\lambda_D)$ for all λ_D, and $F_A(\lambda_A) < G_A(\lambda_A)$ for all λ_D, where F_D, G_D, F_A, and G_A each satisfy the regularity assumption. Then

$$\begin{aligned} p^*(F_A, F_D) &\leq p^*(G_A, F_D) \\ p^*(F_A, F_D) &\leq p^*(F_A, G_D) \\ q^*(F_A, F_D) &\leq q^*(F_A, G_D) \\ q^*(F_A, F_D) &\geq q^*(G_A, F_D) \end{aligned}$$

Proof: Since $F_D(\lambda_D) < G_D(\lambda_D)$ for all λ_D we obtain $\mathbf{P}(F_A, q) \geq \mathbf{P}(G_A, q)$ for all q. Similarly, if $F_D(\lambda_D) < G_D(\lambda_D)$ for all λ_D, then $\mathbf{Q}(F_D, p) \geq \mathbf{Q}(G_D, p)$ for all p. This implies that the equilibrium values for p^* will be larger when either distribution function shifts to the right. That is, if F_j first order stochastically dominates G_j $(j = A, D)$ we will have that $p^*(F_A, F_D) \leq p^*(G_A, F_D)$ and $p^*(F_A, F_D) \leq p^*(F_A, G_D)$, because $\mathbf{Q}(p)$ is decreasing and $\mathbf{P}(q)$ is increasing. The equilibrium values for q^* will be greater when F_D shifts to the right, that is, if F_D first order stochastically dominates G_D we will have that $q^*(F_A, F_D) \leq q^*(F_A, G_D)$, because $\mathbf{P}(q)$ is increasing. Finally, q^* decreases when F_A shifts to the right. That is, if F_A first order stochastically dominates G_A we will have that $q^*(F_A, F_D) \geq q^*(G_A, F_D)$, because $\mathbf{Q}(p)$ is decreasing. Therefore, we have that on the equilibrium path as both distribution functions shift to the right p^* increases and q^* could either increase or decrease.■

As we continue to shift these distributions to the right (keeping the support at $[0, 1]$) in the limit the distributions become concentrated at $\lambda_A = \lambda_D = 1$. This is illustrated in figure 2. The solid curves show the same reaction functions as in figure 1. The dotted curves show the reaction functions when the distributions are very close to degenerate on $\lambda_A = \lambda_D = 1$. We have also marked the limit equilibrium, for $\lambda_A = \lambda_D = 1$:

$$\begin{aligned} p^* &= \frac{2 - 3\alpha}{2 - \alpha} \\ q^* &= \frac{\alpha}{2 - \alpha} \end{aligned}$$

which is the same equilibrium point as in Aragones and Palfrey (2002). Thus, the mixed strategy equilibrium in that paper can be approximated arbitrarily closely as a pure strategy equilibrium when players have private information about policy preferences. That is, this limiting case gives identical mixed strategies[12] as in Aragones and Palfrey (2002), except here the candidates have policy preferences that are private information.

FIGURE 2 ABOUT HERE

It is also worth remarking on the direction of convergence as the distributions approach $\lambda_A = \lambda_D = 1$. Candidate A converges to $p^* = \frac{2-3\alpha}{2-\alpha}$ from below while candidate D converges to $q^* = \frac{\alpha}{2-\alpha}$ from above. That is, for any distributions F_A and F_D that satisfy the regularity condition, the effect of policy preferences on the two candidates is for A to be more extreme that she would be without policy preferences, while D is more moderate than the case of no policy preferences. Recall that when candidates only care about holding office, then D tends to hold extremist views (even though he does not prefer them) and A tends toward the moderate location (even though she does not prefer a moderate policy). The effect of incomplete information and policy preferences is to dampen this extremist/moderate distinction between D and A. The effect is especially interesting for D, since (stochastically) increased preferences by D for extreme policies lead him to adopt equilibrium strategies that are actually *less* extreme.

4.2.2 The Boundary Case of Complete Information about λ

We next examine the properties of the equilibrium correspondence in the boundary case where F_A and F_D converge to *any* degenerate pair of weights for holding office, $(\lambda_A, \lambda_D) \in [0,1]^2$. This is illustrated in figure 3, which shows the equilibrium limit points for all values in the unit square.

FIGURE 3 ABOUT HERE

First consider the diagonal of this figure, corresponding to limiting distributions where at the limit $\lambda_A = \lambda_D = \lambda$. As a reference point, the point of the upper left, W, corresponds to both candidates only caring about winning,

[12] However, the players actually mix only *at* the limit. For any distributions of λ_A and λ_D satisfying the regularity assumption, no matter how concentrated around $\lambda_A = 1$ and $\lambda_D = 1$, there is a unique pure strategy equilibrium in type-contingent strategies.

where we know from above that the unique equilibrium has mixed strategies, $p^* = q^* = \frac{\alpha}{2-\alpha}$. For almost all values of λ the equilibrium is unique.

If $\lambda < \frac{\alpha}{2-2\alpha}$, the unique equilibrium is pure, with $p^* = 0$ and $q^* = 0$. That is, if the candidates place enough weight on policy preferences, they locate at their ideal points and never in the center.

If $\lambda > \frac{\alpha}{2-2\alpha}$, there is a unique equilibrium in mixed strategies with:

$$\begin{aligned} p^* &= \frac{2(1-\alpha)\lambda - \alpha}{\lambda(2-\alpha)} \\ q^* &= \frac{1-\alpha-(1-2\alpha)\lambda}{\lambda(1+\alpha)+1-2\alpha} \end{aligned}$$

If $\lambda = \frac{\alpha}{2-2\alpha}$, there is a continuum of equilibria. In all of these equilibria, A plays $p^* = 0$. When $p^* = 0$ and $\lambda = \frac{\alpha}{2-2\alpha}$, D is indifferent between locating at the center and at his ideal point. As long as D chooses C with probability no greater than $\frac{2+2\alpha^2-\alpha}{2-5\alpha+5\alpha^2}$, A's best response is her ideal point, so the set of equilibria are $p^* = 0$, $q^* \in [0, \frac{2+2\alpha^2-\alpha}{2-5\alpha+5\alpha^2}]$.

The comparative statics of (p^*, q^*) when λ is increased along the diagonal is qualitatively the same as the comparative statics of stochastically increasing λ_A and λ_D. That is, $\frac{dp^*}{d\lambda} > 0$ and $\frac{dq^*}{d\lambda} < 0$. The intuition is exactly the same. This is formally proved below.

Proposition 4: (comparative statics with respect to λ, when λ is common knowledge) $\frac{dp^*}{d\lambda} > 0$ and $\frac{dq^*}{d\lambda} < 0$.

Proof: The formal argument simply requires partial differentiation of p^* and q^* with respect λ. For q^*, we get

$$\frac{\partial q^*}{\partial \lambda} = \frac{-(1-2\alpha)^2-(1-\alpha^2)}{[\lambda(1+\alpha)+1-2\alpha]^2} < 0$$

For p^*, we get

$$\frac{\partial p^*}{\partial \lambda} = \frac{\alpha}{\lambda^2(2-\alpha)} > 0 \qquad \blacksquare$$

Next, we consider the case where λ_A and λ_D are common knowledge, but $\lambda_A \neq \lambda_D$. These correspond to the off-diagonal points in figure 3. There are three regions to consider. First, if $\lambda_D < \frac{\alpha}{2-2\alpha}$, then D cares enough about policy that there is a unique pure strategy equilibrium with $p^* = q^* = 0$. That is, both candidates locate at their ideal points. If $\lambda_D > \frac{\alpha}{2-2\alpha}$ and $\lambda_A < \frac{\alpha}{2-\alpha}$, there is a unique pure strategy equilibrium with $p^* = 0$ and $q^* = 1$. In this region, policy matters much more to A than to D. If $\lambda_D > \frac{\alpha}{2-2\alpha}$ and $\lambda_A > \frac{\alpha}{2-\alpha}$, Then both care enough about winning that a pure strategy equilibrium cannot exist, and we are in the region with a unique mixed strategy equilibrium. On the boundaries between the mixed and pure strategy regions, multiple equilibria typically exist, with one player indifferent (with a continuum of possible equilibrium mixing strategies) and the other player adopting a pure strategy.

Finally, we consider the comparative statics results with respect to α, in the mixing region.[13] Straightforward derivations give:

$$\frac{\partial q^*}{\partial \alpha} = \frac{3\lambda^2 - 2\lambda + 1}{[\lambda(1+\alpha) + 1 - 2\alpha]^2} > 0$$

and

$$\frac{\partial p^*}{\partial \alpha} = \frac{-2(1+\lambda)\alpha}{\lambda(2-\alpha)^2} < 0$$

These comparative statics are qualitatively the same as the case studied in Aragones and Palfrey (2002), with $\lambda_A = \lambda_D = 1$.

5 Conclusions

This paper examined an equilibrium model of candidate competition, combining the effects of five variables that are important factors shaping voter and candidate behavior in competitive elections: candidate quality, candidate policy preferences, the value of holding office, asymmetric information between candidates, and the uncertainty that candidates face about the distribution of voter preferences. It extends in a significant way the results of earlier models of candidate quality by Aragones and Palfrey (2002) and Groseclose (2001), and shows how results in those papers are special cases in the framework of this paper.

Asymmetric information arises naturally because candidates do no know the other candidate's value of holding office and do not know precisely the

[13] The comparative statics with respect to α are flat in the other regions. However, the boundaries between regions will change as a function of α.

policy preferences of the other candidate. This asymmetric information not only makes the model more realistic, but actually simplifies the analysis as well. In particular, we show that even if candidates have very little private information, a unique pure strategy equilibrium always exists. Furthermore, due to the approximation result of Harsanyi (1973), this implies that the mixed strategy equilibria identified in Aragones and Palfrey (2002) are limit points of the pure strategy equilibria in this paper. In other words, the mixed equilibria, which are difficult to interpret empirically, can be viewed as an artifact of the complete information in the basic model. Even a tiny amount of asymmetry will convert these mixed equilibria into pure equilibria that share similar qualitative properties.

With asymmetric information, we show that an increase in uncertainty about the median voter leads both candidates to be less likely to adopt the moderate platform. An alternative interpretation is that as the electorate becomes more polarized (i.e. the probability the median voter is moderate decreases) the candidates also become more polarized.

In equilibrium we find that A's platform becomes more polarized when the electorate becomes more polarized (α increases), but that is not the case for candidate D. In fact, for D there are two effects that go in opposite directions, so the total effect is ambiguous.

With complete information about λ, we show that there is a unique mixed strategy equilibrium if and only if the value of holding office is high enough for both candidates. In this case, we obtain the same main comparative static results of Aragones and Palfrey (2002). The case of complete information also allows comparisons to the model of Groseclose (2001), although he considers a continuous policy space with known candidate ideal points and does not look at mixed equilibria. The two similar findings are that A moves to the center as λ increases, and that only mixed equilibria exist if the value of holding office is sufficiently high.

Our theoretical findings complement the wealth of empirical evidence about the importance of candidate quality in competitive elections, evidence that has for the most part been gathered and studied without the guidance of formal theoretical models.[14] Dating back at least to the seminal work of Stokes (1963) on the "valence dimension" of politics, numerous studies

[14] A notable exception is the work of Banks and Kiewiet (1989) which investigates the effect of candidate quality and asymmetric information on entry decisions by challengers in congressional elections.

have identified a wide variety of effects of quality and other valence factor. This paper combines several essential features of candidate competition in a simple model that has clear and interesting implications about the nature of *equilibrium* platforms. Among the most interesting is the interactive effects of candidate quality, the degree of polarization (or uncertainty) in the electorate, and the information candidates have about each other. There is a strong interaction between quality and these information variables. That is, the effects of polarization on candidate behavior go in opposite directions depending on candidate quality. This suggests a role for empirical studies to explore these theoretical hypotheses. Experimental research (Aragones and Palfrey 2004) has verified all of the qualitative implications of the model, but it would be very useful to obtain field data and see if the conjectures also hold up in mass elections.

REFERENCES

Ansolabehere, Stephen and James M. Snyder, Jr. 2000. "Valence Politics and Equilibrium in Spatial Election Models," *Public Choice*. **103**: 327–336.

Aragones, Enriqueta and Thomas Palfrey. 2002. Mixed Equilibrium in a Downsian Model with a Favored Candidate. *Journal of Economic Theory*. **103**: 131-161.

Aragones, Enriqueta and Thomas Palfrey. 2004. The Effect of Candidate Quality on Electoral Equilibrium: An Experimental Study. *American Political Science Review*. In press.

Banks, Jeffrey S. and D. Roderick Kiewiet. 1989. "Explaining Patterns of Candidate Competition in Congressional Elections," *American Journal of Political Science*. **33**: 997–1015.

Berger, Mark. M., Michael C. Munger, and Richard F. Potthoff. 2000. "With Uncertainty, the Downsian Model Predicts Divergence," *Journal of Theoretical Politics*. **12**: 262–268.

Calvert, Randall. 1985. Robustness of the Multidimensional Voting Model: Candidate Motivations, Uncertainty, and Convergence. *American Journal of Political Science*. **28**: 127-47.

Groseclose, Tim. 2001. A Model of Candidate Location When One Candidate has a Valence Advantage. *American Journal of Political Science*. **45**:862-86.

Harsanyi, John. 1973. Games with Randomly Disturbed Payoffs: A New Rationale for Mixed Strategy Equilibrium Points. *International Journal of Game Theory*. **2**:1-23.

Stokes, Donald E. 1963. Spatial Models of Party Competition. *American Political Science Review*. **57**: 368-77.

Wittman, Donald. 1977. Candidates with Policy Preferences. *Journal of Economic Theory*. **14**:180-9.

Wittman, Donald. 1983. Candidates Motivation: A Synthesis of Alternatives. *American Political Science Review*. **77**:142-57.

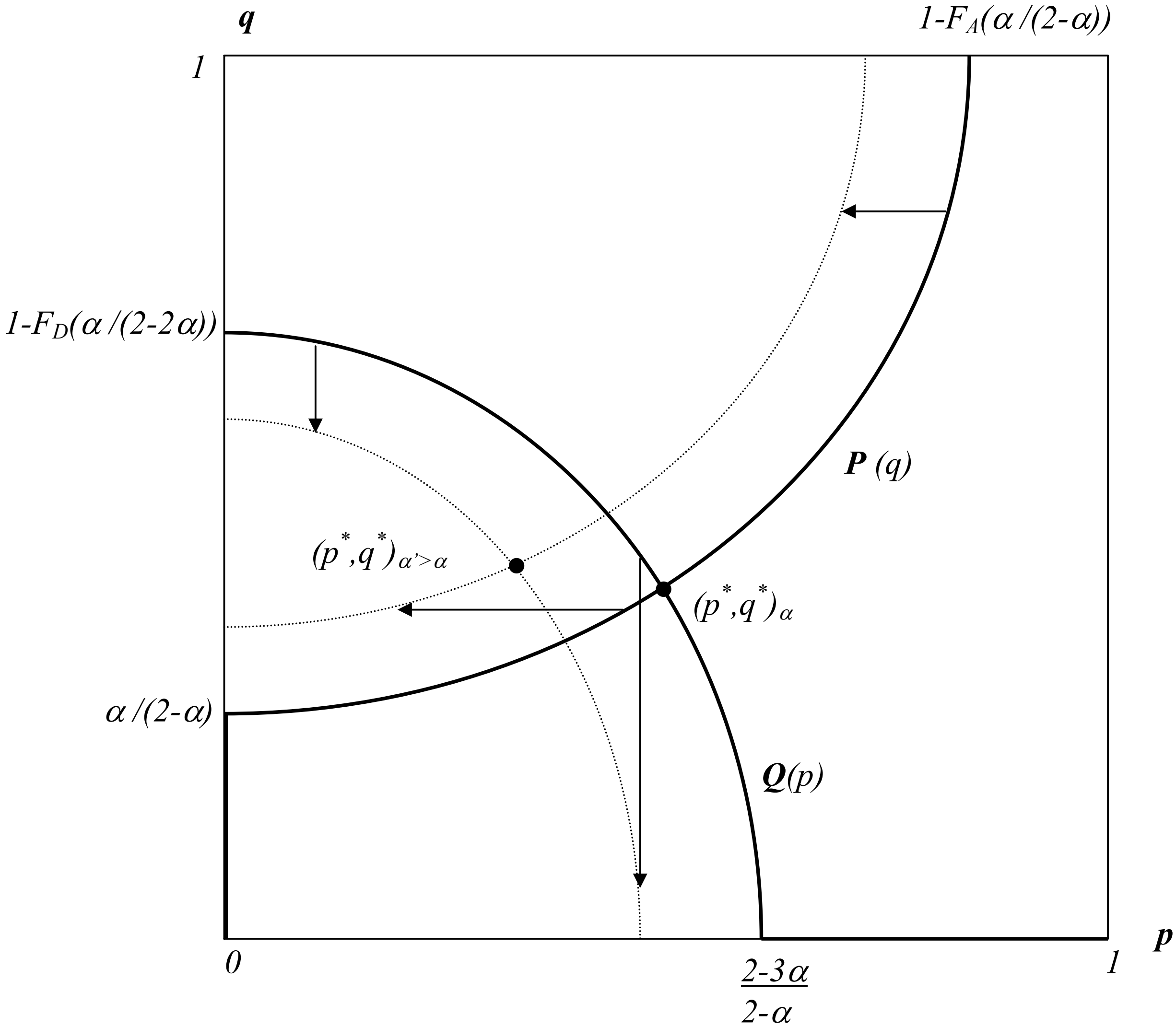

Figure 1: Unique Equilibrium and Comparative Statics in α.

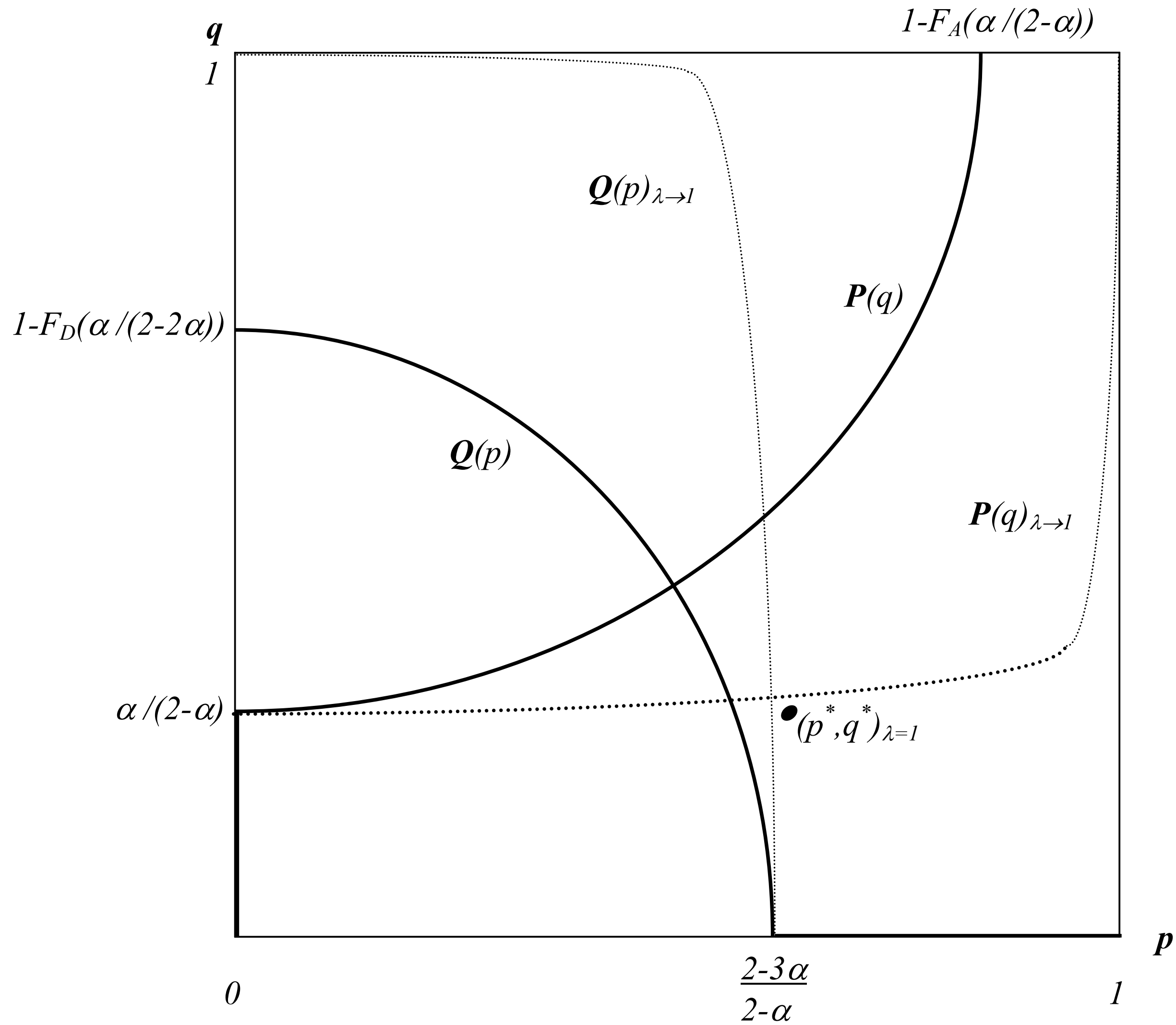

Figure 2: Comparative statics as $F_\lambda \to 1$.

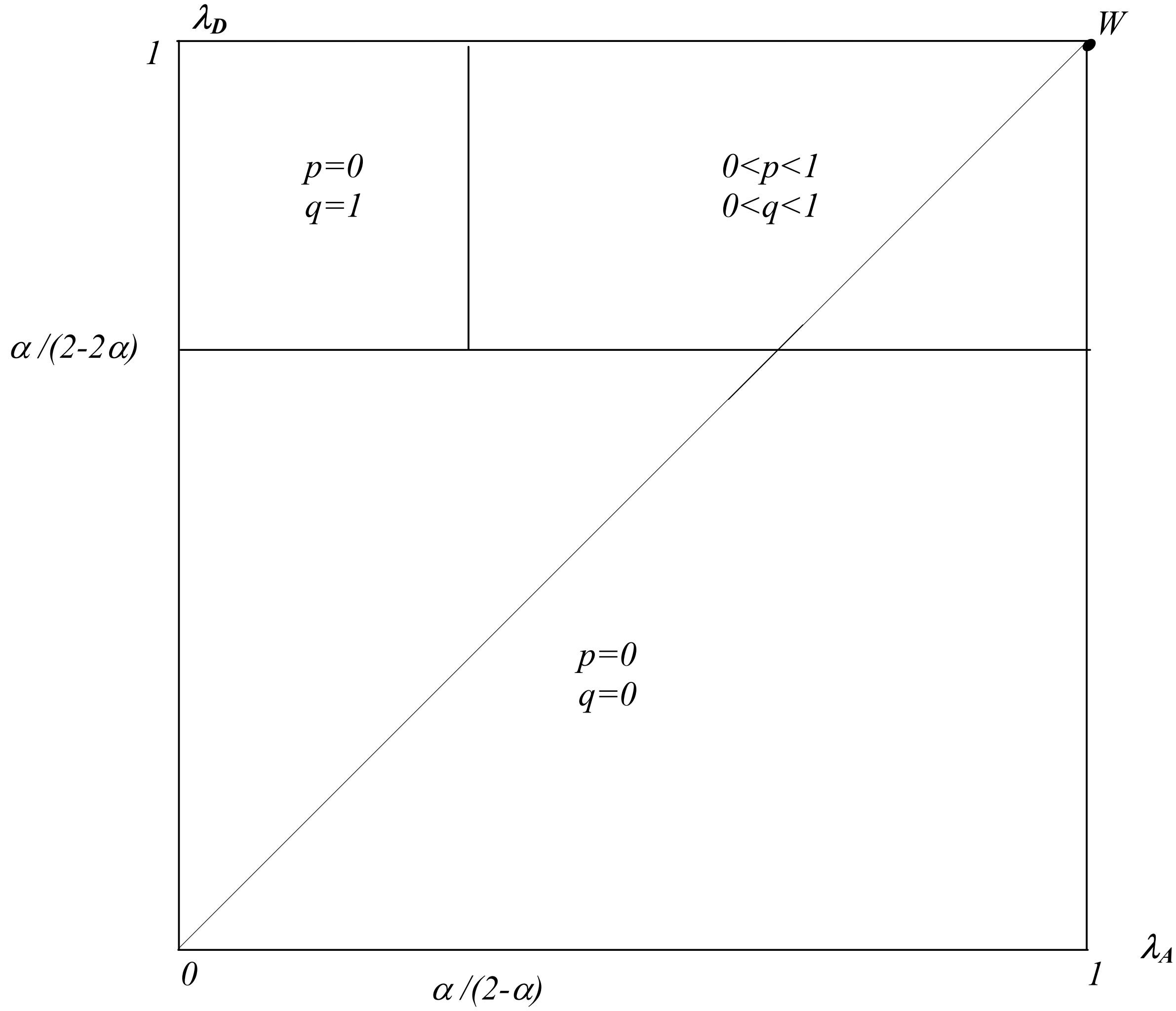

Figure 3: Equilibrium Strategies for λ_A and λ_D.