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UNIVERSITY OF CALIFORNIA,
IRVINE

The Economic Concerns of Legislative and Regulatory Governance

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Economics

by

Brent Lutes

Dissertation Committee:
Professor Linda Cohen, Chair
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Associate Professor Ivan Jeliazkov

2015

DEDICATION

To

Andrea, for her endless patience,
Sydney, for her jovial good-nature,
and my parents, for always allowing
me to find my own path

*The real price of everything, what everything really costs to the man who wants to acquire
it, is the toil and trouble of acquiring it.*

Adam Smith
The Wealth of Nations

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ACKNOWLEDGMENTS

I would like to express my deepest appreciation to my committee chair, Professor Linda Cohen, whose vast knowledge and understanding of economics has my unreserved respect. My research has benefited significantly from her extensive resources. Without Linda's guidance and mentorship, this dissertation would not have been possible. I am truly grateful for the generosity that she has shown with her time and attention.

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I thank Professor Dan Bogart who has worked tirelessly to keep my research grounded in fundamental economics. His ability to challenge my ideas has taught me how to seek out relevant evidence and helped me conduct more effective research. I have thoroughly enjoyed Dan's classes and our discussions.

I would like to thank my family. My wife, Andrea, has shown a superhuman amount of patience, managing both her successful career and our household, allowing me to pursue my interests. She has also been an extraordinary editor; this dissertation has benefited significantly from her work. My daughter, Sydney, has been especially inspirational. Her endless ability to spread joy has always been able to counterbalance the demands of research. Additionally, I would like to thank my mother, Debra, who has unconditionally supported my decisions—even when I made the wrong ones. Her willingness to let me find my own way has given me the confidence necessary to pursue my passions.

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ABSTRACT OF THE DISSERTATION

The Economic Concerns of Legislative and Regulatory Governance

By

Brent Lutes

Doctor of Philosophy in Economics

University of California, Irvine, 2015

Professor Linda Cohen, Chair

The research presented in this dissertation addresses some of the econometric, theoretical, and empirical concerns in the field of public choice economics. The first chapter presents empirical evidence of a significant and likely causal link between the influence asserted by land-use interest groups and subsequent regulatory action. That relationship is uncovered by measuring the effects of political participation and interest group competition on economic outcomes. These results reveal that campaign contributions can be an effective rent seeking activity, but it is also the case that interest group competition greatly reduces the potential gains from political participation. Moreover, it is shown that competition often leads to a prisoners' dilemma for opposing interest groups. Those findings are in contrast to previous work. Additionally, this research illuminates the nuanced role of campaign finance restrictions and compares the marginal effects of political donations between jurisdictions with and without campaign contribution limits. The second chapter of this dissertation develops an algorithm for determining vote-trade equilibria in a simulated legislative environment in order to examine the welfare and equity effects of vote-trading. The results are then compared to two prominent theories regarding such effects. The third chapter of this dissertation uses a Markov chain Monte Carlo approach to develop and test a new method for simultaneously estimating ideal points and proposal locations in a multidimensional spa-

tial voting model. The method developed is different from other approaches in that it allows the researcher to directly evaluate the joint-distributional qualities of voters' ideal points and proposal location parameters in the same space. Also addressed in this chapter are the identification issues associated with estimating proposal location parameters. The presented estimators are found to be consistent and have a high degree of predictive power. Although the three works described in the following chapters cover diverse subject matters within the field of public choice, they are linked by a common goal to further our understanding of the economic concerns of legislative and regulatory governance.

Chapter 1

The Non-Market Competition for Land-Use: Special Interests, Influence, and Regulation

Introduction

This article explores the empirical characteristics of non-market competition and strategy through the use of a novel, disaggregated data set. The findings presented below show a significant and likely causal link between the influence asserted by land-use interest groups and favorable regulatory action. That relationship is uncovered by measuring the effects of political participation and interest group competition on economic outcomes. These results reveal that campaign contributions can be an effective rent seeking activity, but it is also the case that interest group competition greatly reduces the potential gains from political participation. Moreover, it is shown that competition often leads to a prisoners' dilemma for opposing interest groups. The evidence supports a hypothesis of investment-motivated political contributors; such results are in contrast to many previous studies. Furthermore, this research uncovers suggestive evidence regarding the efficacy of campaign finance regulation

by comparing the marginal effects of political donations in jurisdictions with and without contribution limits. Additionally, within the context of a regulatory signaling model, this research casts light on the mechanism by which regulators observe firm signals. In a more specific context, this article explores the effects of political contributions from competing land-use interest groups on the issuance of building permits. The data comes from the financial disclosures of 65 elected officials in 11 permit-issuing jurisdictions within Los Angeles County, over a 15-year time period.

The findings of this research add to the existing literature on campaign finance and nonmarket competition[1] along several important dimensions. First, the results presented here underscore the economic relevance of political influence. As Getz (1997) points out, we have a good understanding of which interest groups engage politically; however, we have little evidence with regard to the efficacy of such efforts. That lack of understanding stems from our prevailing inability to consistently link political participation to changes in political outcomes, as is poignantly illustrated by Ansolabehere, De Figueiredo, and Snyder (2003). De Figueiredo and Edwards (2007) attribute this inability to a lack of sufficient variation within previous research designs, which has inhibited researchers from properly accounting for counterfactual outcomes. Whereas many previous studies are confined to examining a cross section of legislative outcomes from a single legislative body, this research examines repeated outcomes over multiple time periods and jurisdictions. Such an approach allows for the necessary variation in treatment and provides the consistency of a common dependent variable. Consequently, a clear link between political influence and regulatory outcomes is established, thereby allowing for an effectual analysis of interest group participation and competition.

Second, this research examines the conditions under which a prisoner's dilemma exists in the common agency model of interest group competition, and shows that such an outcome is a theoretically common occurrence. Moreover, the prisoner's dilemma is also found to

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[1]The findings of this analysis are highly relevant to a third body of literature within urban economics; however, in order to fully explore that avenue, the relevant results will be presented in a separate analysis.

be a common empirical outcome when opposing interest groups compete. Evidence to that effect is revealed by measuring the economic value of political influence in comparison to the associated costs. These findings validate previously untested aspects of Grossman and Helpman's (1992) interest group competition model.

Third, this research has uncovered suggestive evidence with regard to the complex effects of campaign finance restrictions. It is clear from the data that special interest groups are more influential in those jurisdictions without contribution limits than they are in those jurisdictions with contribution limits. In contrast to current theory and previous indirect empirical findings (see e.g. Stratmann 2006, Coate 2004a, Prat 2002 and Drazen, Limão, and Stratmann 2007), the evidence presented here suggests that contribution limits may, in fact, reduce the influence of special interests.

Finally, the results of this research bring assumptions about the role of individual political donors into question. Previous studies have mainly focused on donations from formally organized political action committees (PACs) or donations from firms; however, as Ansolabehere, De Figueiredo, and Snyder (2003) point out, the majority of contributions come from individual donors. The practical hypothesis has been that because individuals are not giving through PACs, they are unorganized and, therefore, too small to warrant any attention from the recipients of their funds. This may be a problematic assumption if individual donors are connected through informal networks. For example, the employees of a politically motivated firm or the members of a trade association may be encouraged to support sympathetic candidates. It is likely that the contributing habits of individuals are influenced by the groups to which they belong. Furthermore, It is entirely plausible that the combined contributions of an informal network could be influential, even if the members of that group are not individually persuasive. By collecting disaggregated donor data and classifying individual donors by their occupation and employer, this research is able to control for the likely existence of those informal interest groups.

The remainder of the article proceeds as follows: Section 1.1 discusses the relevant theory and previous work. Section 1.2 provides an overview of the data and methods used for this research. Section 1.3 presents the empirical results and relates those results to previous findings and theoretical predictions. Section 1.4 discusses the implications of the empirical evidence and concludes.

1.1 Theory

This section discusses the theory and literature relating to the ability of interest groups to affect policy outcomes, the mechanisms by which outcomes are affected, and the interaction of opposing interests. While this research is unique in its approach, the underlying theory and results are most closely related to the works of Grossman and Helpman (1994), Baron (2001), and De Figueiredo and Edwards (2007).

1.1.1 Do interest groups affect political outcomes?

Two prominent and opposing theories exist regarding the motivations of political donors. The first school of thought postulates that donors give in order to buy political favor, which then enters the utility function of the donor through subsequent financial or ideological gains; donations are an investment in future utility. [2] Contrarily, the second school of thought theorizes that donations are given by donors who value political participation in and of itself; participation is a normal good and donations are the price of consumption. The theory of investment-motivated donors, given any semblance of rational expectations, implies a measurable expected response to donations in the form of policy outcomes. The consumption theory has no such implications.

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[2]It is also possible that donations are given out of a reciprocity after the issuance of political favor. The evidence gleaned from this research suggests that donation precede political favors; however, the results presented in this article are not dependent on such a distinction.

The existence of these two competing theories is indicative of the general discord with regard to the role or efficacy of political donations, a matter acutely illustrated by Ansolabehere, De Figueiredo, and Snyder (2003). In their survey, Ansolabehere et al. review a number of studies that have attempted to measure the effects of campaign contributions on roll call votes, and find that 75% of those studies either fail to establish a significant link, or produce coefficients with the 'wrong' sign. They go on to show that the majority of contributions originate with individuals instead of PACs and argue that because any single individual has essentially zero probability of swaying legislative outcomes, contributions are likely given for a consumption motive rather than an investment motive. Furthermore, they argue that the consumption motivation behind contributions explains our inability to consistently link those contributions to outcomes.

While the consumption theory would certainly explain the inconsistent relationship between donations and political outcomes evident in the literature, Ansolabehere et al.'s findings might also be explained by the methodological and strategic limitations faced by many studies. For instance, Stratmann (2005) implies that the lack of findings may be a function of sample size. To test this, he employs the meta-analysis methodology proposed by Djankov and Murrell (2002). Stratmann is then able to show that when data from all of the studies reviewed by Ansolabehere et al. is combined in a heuristic way, a highly significant relationship emerges between campaign contributions and roll call votes.

Snyder (1993), on the other hand, implies that the reason for the lack of findings may be a sample selection issue. He argues that there exists a subset of donors who are, in fact, investment-motivated and others who are consumption-motivated. To show this, Snyder classifies PACs by their likely motivations, separating groups with financial incentives from those with ideological incentives. Then, when financially motivated PACs are isolated, he is able to show a significant relationship between donations and roll call votes. Snyder's findings support the notion that at least a subset of donors are investment-motivated.

Perhaps a more compelling explanation for our general inability to support the theory of investment-motivated donors is the focus of previous studies on potentially obscured variables. Roll call votes, the primary dependent variable used by the vast majority of studies on this subject, are problematic along several dimensions. First, it is difficult to account for the counterfactual outcomes of a political process. A decision by a specific group of legislators on a specific piece of legislation is typically a singularity. While some attempts have been made to circumvent this problem, our inability to control for the complex system-fluidity of a legislative body continues to confound measurements. Secondly, as De Figueiredo and Richter (2013) point out, a great deal of lobbying is done in a defensive effort to protect the status quo, e.g. blocking bills from ever leaving (or even reaching) committee. In such cases, political favor has clearly been given in response to lobbying efforts; however, roll call votes will not reflect the results of those efforts. Furthermore, both donors and recipients have a strong incentive to obfuscate the effects of political contributions in the face of electoral accountability. Legislators have a myriad of other avenues by which they can issue political favor. When compared to explicit quid pro quo voting, almost all of those alternatives are less susceptible to public scrutiny. Finally, explicit legislative outcomes are not the primary concern of investment-minded donors. Of primary interest are the economic returns that can be had as a result of political favor. While it is true that political decisions are the genesis of, and thereby a proxy for, the resulting economic outcomes, using roll call votes as such a proxy leaves the researcher with the potentially confounding task of predicting the economic implications of complex and nuanced legislation.

Another potential explanation for our inability to establish a consistent and significant relationship between donations and outcomes is the focus of previous studies on PAC donations. Such focus is a practical necessity in large-scale politics; with millions of individual donors, classifying the interests of those individuals is likely an insurmountable task, as the inconsistency of reporting practices disallows programmatic classification schemes. As mentioned earlier, the working assumption has been that, because individual donors are not

formally organized by the framework of a PAC, their individual donations are too insignificant to affect the behavior of recipients. This assumption may be problematic if individual donors are informally associated with one another and contribute in concert with such association. The assumption may be especially problematic in light of the fact that vast majority of donations come from individuals (Ansolabehere, De Figueiredo, and Snyder 2003).

The research presented in this article was designed to address the empirical hurdles discussed above. First, the use of a direct economic outcome (permitted development activity) as a dependent variable allows for the measurement of otherwise latent political favor and eliminates the need to parse nuanced and linguistically cryptic legislation. Further, such a variable, put into a panel framework, reveals the effects of repeated and varying treatments under quasi-controlled conditions. Second, the issue of sample size identified by Stratmann (2005) is overcome by utilizing building and donation data over 11 jurisdictions and 15 years. Third, examining the relatively small venues of local politics, as opposed to national or state legislative bodies, reduces the number of individual donors present in the data to a manageable 40,000. The relatively low number of donors facilitates a non-programmatic approach to the classification of individual and organizational donors alike, thereby eliminating potentially problematic assumptions about individual donors. Moreover, through an analysis of the individual and organizational information provided by each donor in the data set, it is possible, in the fashion of Snyder (1993), to isolate those donors with feasible investment motives, filtering out much of the confounding ideological noise and addressing sample selection issues. Finally, the level of detail provided in the data allows donors to be classified by their proclivities for the advancement or hindrance of real estate development, thereby controlling for defensive contributing.

Economic effects of political participation

In a similar spirit to the research presented here, several previous works have sought to measure the economic effects of political participation. De Figueiredo and Edwards (2007)

examine the variation in telecommunication network access costs as explained by political donations from opposing interests. In their competitive setting, state regulators set fees for new firms to access the existing networks of incumbent firms. Incumbents are obligated to allow entrant firms access to their networks, given the state-set fee schedule; entrants lobby for low fees, while incumbents lobby for high fees. De Figueiredo and Edwards are able to establish a significant correlation between access fees and the mix of donations from incumbent and entrant firms. Furthermore, they present convincing evidence that at least part of this relationship is causal. The research presented in this article both corroborates and helps to generalize the findings of De Figueiredo and Edwards.

Jayachandran (2006) cleverly exploits a natural experiment in order to measure the stock market losses of Republican-aligned firms when the U.S. Senate unexpectedly and instantaneously switched from Republican to Democrat control. By examining firm-level donations to the Republican Party relative to those made to members of the Democratic Party, Jayachandran is able to construct a measure of party allegiance for each firm in her study. She then compares the varying levels of allegiance to changes in the stock market performance of each firm to show that Republican-aligned firms suffer significant losses directly after the switch. While Jayachandran examines a somewhat less direct relationship than De Figueiredo and Edwards, the results are still implicative of a relationship between political giving and economic outcomes, which supports the investment theory of political participation.

Cooper, Gulen, and Ovtchinnikov (2010) examine the relationship between firm-level political donations and future, abnormal stock returns with data spanning 25 years and 50 states. Instead of using donation levels, Cooper et al. use the number of candidates to which a firm donates as an explanatory variable. The measure is meant to be an accounting of the political connectedness of firms, with the hypothesis being that more connected firms will realize greater financial reward. While they are able to establish a robust and significant link

between the number of candidates supported by a firm and future returns, they are unable to conclusively establish the causal nature of that link.

1.1.2 How do interest groups affect outcomes?

Several assumptions are necessary before discussing the mechanisms by which political donations from land-use interests may affect the level of permitted development in a jurisdiction. The first assumption is that politicians value contributions enough to offset the negative outcomes that may result from the issuance of political favors in an environment of (at least some) electoral accountability. Politicians may derive value from donations in several ways. Donations, to a limited extent, can be converted into votes through advertising or other sorts of campaigning, which increases the probability of (re)election (Bombardini and Trebbi 2011). Large coffers of resources also act as a signal, discouraging otherwise viable challengers from running and transmitting a candidate's legitimacy to undecided voters (Goldenberg, Traugott, and Baumgartner 1986; Coate 2004b). Moreover, the ability to raise funds may result in intra-party power; unused funds are often donated to a political party or other party candidates, resulting in political capital.[3] This research does not necessitate any assumptions with regard to the specific motivations of politicians, only that they value monetary contributions enough to issue some limited political favor in return.

The second assumption has to do with the general strategies employed by investment-minded donors, about which there are several competing theories. The first school of thought postulates that donors give in order to ensure the election of allies. The hypothesis is that donors are not buying political favor, but simply putting like-minded candidates in office. While this is a feasible hypothesis for broad, sweeping issues, it is somewhat unlikely for the more nuanced policy that may pertain to a regulatory environment (Grossman and

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[3] An additional motivation for collecting donations, which is particularly endemic to the office of Los Angeles County Supervisor, is legacy. An interesting characteristic of some political offices is the existence of office holder accounts, which are separate from campaign funds. Donors can contribute directly to these accounts and office holders can use those funds at their limited discretion. The result is often a public works project bearing the name of the office holder.

Helpman 1992). The second general theory of giving is that donors donate on a service basis. Politicians seek political support (in many forms) from interest groups and then set policy as to maximize that support. This study, like previous studies (see e.g. Stigler 1971, Hillman 1982, or Grossman and Helpman 1992), assumes donations are given for services rather than electoral competition. The assumption is supported by the quick response to donations seen in the data and the fact that elections in the jurisdictions under examination are relatively uncompetitive.

It is now appropriate to discuss the mechanisms by which political donations might affect the level of permitted development in a jurisdiction. To embark on a new real estate development project, a developer must ensure that a proposed project is consistent with the general plan of the jurisdiction (or lobby for a change in the general plan). Then they must obtain the necessary (re)zoning and subdivision approvals, and finally they must obtain a building permit. Additionally, they will need to pay development, application, and processing fees. The agencies endowed with the power to grant the necessary permissions are typically the Planning Commission and the Department of Building and Safety. These institutions are overseen by a commission or commissioner appointed by the city council.[4] Applicants whose plans have been denied by either agency are able to appeal to the city council; the city council has the power to overturn the decisions of the regulatory agencies.

The institutional structure governing the allowance of development provides at least three theoretical paths through which donations can influence the decisions of regulatory agencies. First, recipients of donations can apply explicit or implicit pressure on agency leadership to approve or deny applications. Second, office holders can simply vote to overturn a decision made by an agency after receiving donations. These two methods are the most direct, but also the most politically risky in an environment of electoral accountability, as they produce an observable (perhaps implicit) quid pro quo agreement. The third method by which interest groups may affect agency decisions is through a signaling game described

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[4]For the unincorporated areas of Los Angeles County included in the data, the role of city council is played by the Board of Supervisors

by Gordon and Hafer (2005). They argue that an agency receives utility from the proper administration of regulation. Those regulatory duties also impose a cost on an agency in the form of expended effort and resources. When an interest group makes large donations to office holders, it is signaling a willingness to fight the decision of a regulatory authority. Such conflict would be costly to an agency, causing it to reconsider unfavorable decisions in light of the contentious predilections signaled by political donations. Gordon and Hafer argue that officeholders calibrate the budget and authority structure of regulatory and bureaucratic agencies so as to maximize political contributions. Both Gordon and Hafer (2005) and De Figueiredo and Edwards (2007) further argue that a mechanism by which rents can be extracted from a regulatory agency by interest groups and then remitted to office holders would be valuable to those office holders insofar as it insulates them from any nefarious quid pro quo transactions.[5] An open question in this realm of thought is whether contributions are themselves the signal, or if contributions are a proxy for the signal. Section 1.3.4 exploits timing discrepancies in the data in order to address this question.

While the specific mechanisms by which influence is asserted over agencies is interesting, the main results of this study are not dependent on the existence of one mechanism over another. All that is necessary is an assumption of feasibility; i.e. the institutional and competitive structures that exist allow for the possibility of influence flowing from political office holders to agencies. Such a relationship is clearly feasible.

1.1.3   How do opposing interests interact?

As Baron (2001) describes, there are two contexts in which interest groups affect policy choices. In the first context (client politics), a single interest group attempts to sway a policy outcome through asserted influence. However, opposing interests (if they exist) do not attempt to assert counter influence; there is no competition other than that between an office holder's separable preferences for a policy outcome and the utility she derives from

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[5]It could be reasonably argued that this is the sort of relational obfuscation that has inhibited researchers from finding consistent relationships between donations and political outcomes.

donations. The second context (interest group competition) is one in which interests compete through asserted influence, in the hopes of achieving necessarily opposing objectives. Baron also distinguishes two institutional types in which interests attempt to influence policy: majority-rule legislative bodies and administrative agencies. Competition differs between the two settings in both the optimal strategy and the predicted equilibrium outcome. The latter is a more appropriate context for the empirical setting of this study. Although donations are being given to members of a legislative body, they are given in an attempt to influence the decisions of an administrative agency.

The strategies pertaining to the lobbying of administrative bodies by competing interests can be modeled in one of two frameworks. The first type of model is an all-pay auction within the traditional rent-seeking context. While the basic all-pay auction has been extended to include various asymmetries, multiple prizes, and sequential allocations (see, e.g. Clark and Riis 1998, Siegel 2009, Hillman and Riley 1989, and Nitzan 1994), all variations share a common characteristic, which is the prize or prizes offered are indivisible; contests are winner-take-all.[6] While this is a good model for some political contests, it is not appropriate for interest group competition where the set of feasible policy outcomes is continuous. Such is the case in the competition for land-use. The choice faced by adjudicating agencies is not between developing all useable land, and developing no additional land; the choice is how much new development to allow. Therefore, when the competitors are anti- and pro-development interests, the prize (the right to either develop land or leave land undeveloped) is very much divisible, making the set of all-pay auction models inappropriate.

The second (and more contextually appropriate) type of model is the menu auction within a common agency context. In a common agency setting, two or more principals contract a single agent to act on each of their behalf. When the interests of the principals are contradicting, the result is modeled by a menu auction, as first described by Bernheim

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[6]In the case of multiple prizes allocated simultaneously, the winner can be thought of as the group of contestants who win. Then the outcome is still winner-take-all in the sense that members of the winning group each receive a single indivisible prize and nonmembers receive nothing. In the case of multiple prizes in a sequential allocation, each allocation round breaks down to a winner-take-all sub-game.

and Whinston (1986) and extended by Grossman and Helpman (1992) and Baron (2001). Bidders in a menu auction offer a list of prices they are willing to pay for different portions of the divisible prize. The decision maker then decides on an allocation so as to maximize total payments. The basic menu auction becomes somewhat more complex when the decision maker has preferences regarding the prize allocation which are separate from her impulse to maximize total payments. Such is the case in interest group competition; while opposing interests compete with one another by offering political donations implicitly contingent on policy outcomes (prize allocations), they also compete with the separable preferences of the donation recipients. Therefore, the degree to which an interest can sway policy outcomes depends crucially on their preferred policy, the preferred policy of their opposition, and the preferred policy of the decision maker. For an informal sketch of the menu auction model as it applies to interest group competition, see appendix A.1. For a formal and complete treatment of the model, see Grossman and Helpman (1992) or Baron (2001).

The application of the menu auction model to interest group competition has some interesting and testable predictions, the first of which is that both sides of an issue will participate in the game. One potential problem with this prediction is that it assumes both sides of an issue have the ability to organize and overcome their respective collective action problem. The results discussed in Section 1.3 show that the coincidence of participation by opposing interests is relatively high, but not perfect. The second, and perhaps more interesting prediction is that in equilibrium, both sides of an issue may be worse off by donating than they would have been if neither had donated, but better off than they would have been if they did not donate and the other side did donate; i.e. a prisoners' dilemma is theoretically possible.

Baron (2001) presents a numerical example in which a prisoners' dilemma clearly occurs. While this corroborates the theoretical prediction of Grossman and Helpman (1992), it does not speak to the theoretical or empirical frequency with which such an outcome would occur. Appendix A.2 explores the conditions under which a prisoners' dilemma will occur to show that such an outcome is not a theoretically rare manifestation. For instance, if the opposing

interests and the decision maker have a roughly similar salience, the preferences of one interest group would have to be more than twice as extreme as those of the opposing interest group in order to avoid the prisoners' dilemma.[7] The same is true for relative salience when ideal points are equally extreme; one interest must have more than twice the salience of their opposition for the prisoners' dilemma to be avoided. This suggests that a winner (aside from the recipient of donations) is only likely to exist when relative preferences are highly skewed. The empirical frequency of the prisoners' dilemma is examined in Section 1.3.2.

1.1.4 Which interest groups participate?

When considering a set of interest groups through which to study the theories discussed above, it is useful to select groups that are highly engaged in political activity, and whose economic objectives can be easily measured. As for the latter, land-use interests clearly have a measurable objective, i.e. the amount of development permitted in a jurisdiction. As for the former, Mathur and Singh (2011) characterize firm attributes that lead to their willingness and ability to engage politically. Although they analyze these attributes at the firm level, parts of their analysis can easily be extrapolated to interest groups comprised of relatively homogeneous firms.

The first attribute identified Mathur and Singh (2011) is firm size. Schuler and Rehbein (1997) and Cooper, Gulen, and Ovtchinnikov (2010) both show that larger firms engage more often and to a higher degree. While there may be free riders within interest groups, we still expect larger interest groups (in terms of numbers and potential profits) to be more involved than smaller interest groups, given a constant dispersion of gains.[8] However, larger interest groups may lead to a larger dispersion, thereby increasing the collective action problem. After firm size, the characteristic that can best predict an interest group's political involvement

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[7]The analysis assumes the same functional form as the example developed by Baron (2001), i.e. quadratic utility.

[8]While we certainly expect larger groups to be more involved than smaller groups, ceteris paribus, the methods in which larger groups engage may be different than the methods employed by smaller groups. Larger groups have more tools at their disposal, such as rent-chain manipulation. See Bombardini and Trebbi (2011) for a good empirical analysis of this phenomenon or Baron (2001) for a theoretical treatment.

is the level of risk faced by the industry or firms of which the group is comprised. Myers (2007) finds that industries with a lower returns volatility are more politically active. The proffered intuition for such findings is that firms with greater volatility have a less certain future, which reduces the expected return on any investment. Investments with mid-to-long time horizons, such as the typical political investment, are particularly sensitive to volatility. The result is less political engagement by firms that face higher returns volatility. The third characteristic that may lead to political engagement is the leverage profile of a firm. Empirical evidence shows that firms who are primarily debt-financed are more likely to engage in political activity (see e.g. Cooper, Gulen, and Ovtchinnikov 2010 or Faccio, Masulis, and McConnell 2006).

Considering the determinants of interest group participation described above, the expected political participation rate of development interest groups is high. Real estate investment–at least on an institutional level–is relatively low risk, with a returns volatility characterized as greater than that of bonds, but significantly less than that of stocks (Ciochetti, Fisher, and Gao 2003). Moreover, real estate investment (both in terms of developing land and owning developed property) tends to be more heavily debt-financed than firms in other industries; the industry's foundation of durable and stable assets decreases the cost of debt in relation to equity-financing. Finally, development interests are arguably the largest interest groups that exist at a local level. The union of anti- and pro-development interests essentially includes the entire constituency of a jurisdiction (with varying degrees of salience) as well as a number of interested parties from outside of the jurisdiction. While this fact on its own is non-informative, when considered in conjunction with the concentrated dispersion of rents and the relatively large firm size within the development sector, it predicts a high level of political participation.[9] Empirical observations confirm the high level of political activity predicted by the industrial characteristics of development interests. At the municipal level, roughly 22% of all donations come from the real estate sector, making it

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[9]The concentrated dispersion of rents and large firm size refers pro-development interests. Rents are more dispersed and firms are smaller within the anti-development interest group.

not only the largest contributing group, but also twice the size of the second largest group, in terms of quantity and frequency of donation. More than one-third of those donations can be identified as explicitly anti- or pro-development.

1.2   Data and Methods

This research examines the effects of anti- and pro-development political contributions on the issuance of building permits in the jurisdictions over which contribution recipients preside. Data covers the developmental and political activities of 11 jurisdictions from the Los Angeles-Long Beach metropolitan statistical area between 1999 and 2013. The 11 jurisdictions consist of the unincorporated areas of the five supervisorial districts of Los Angeles County, as well as the cities of Alhambra, Lancaster, Norwalk, Pasadena, Torrance, and Santa Clarita. Data on the issuance of building permits was compiled as part of a joint effort with the various departments of building and safety. Building permits, measured in square feet, are the primary dependent variable of the model discussed below; they are restricted to only those permits for new structures. Permits for projects other than new structures are used as a control variable and will be further discussed later in this section.

All data on political donations comes from campaign finance disclosures (CA Form 460 Schedule-A & CA form 497) filed with city and county clerks' offices. Hard copies of the financial disclosures (roughly 60,000 pages) were obtained directly from the jurisdictional agencies and then digitized using optical character reading software. In addition to the dollar-amount and the timing of donations, the documents contained information about an individual donor's occupation and employer. For institutional donors, the documents contained organizational information. Using various web sources,[10] the industries of employers and organizations were identified. Donors were then classified by the industry in which they primarily operate. When specific employer information was not disclosed, the occupation of

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[10]Web sources include commercial business databases such as Dun & Bradstreet, as well as company-specific websites.

a donor is used for classification. In cases where a donor's industry was ambiguous or undisclosed (2.3% of the data), donors were left unclassified. Those unidentified donors represent a form of measurement error; however, the diagnostics performed in Section 1.3.1 suggests that the effect of such measurement error is negligible.

Data pertaining to the five supervisorial districts of Los Angeles County is restricted to the unincorporated areas of each district, as the county does not issue building permits for incorporated cities—incorporated municipal governments are responsible for their own local planning and regulation. Contrarily, unincorporated cities have no formal municipal government with which to handle such tasks. The Los Angeles County charter, therefore, mandates that the county government handle the municipal regulatory duties of unincorporated areas, where the county district supervisor acts as mayor and city council of that area.[11] Consequently, for the intent and purpose of the analysis at hand, it is appropriate to treat the unincorporated area within a county district as a municipality. When controlling for other characteristics, no significant structural differences are observed between county districts and the incorporated cities included in the study, which supports the common treatment of all 11 jurisdictions.

The jurisdictions included in this analysis were selected on several criteria. The first was the availability and quality of the necessary records. Campaign finance records are mandated and regulated by the state of California. Any candidate running for or holding an elected position must submit a CA Form 460 (along with other supplemental forms), which discloses an itemized list of every donation, as well as the identifying information about donors discussed above. Although the state mandates these disclosures be filed at given intervals and publicly disclosed upon request, compliance and the quality of filings are somewhat inconsistent between jurisdictions. While cities are legally obligated to turn over campaign finance records upon request, the same is not necessarily true for building

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[11]Each of the five county districts elects a single supervisor. The board of supervisors plays a mostly legislative role in county-wide issues. However, each supervisor is considered the executive of the unincorporated areas within the district (s)he was elected to represent. They have control over the district field offices which issue building permits, and they have abundant power to influence the general plan of the county.

permit records. Despite the lack of legal imperative, many jurisdictions that had records were willing to share them; however, because of the lack of legal imperative, many cities do not archive permit information beyond a couple of years.[12] The lack of detailed building permit records was the main limiting factor in the selection of jurisdictions.

The second consideration when selecting jurisdictions was attributional variety. The jurisdictions selected exhibit a mix of campaign contribution limits, population density, size, voter apathy, election timing, and electoral structure, all of which help to enrich and deepen the analysis. The attributional variety also helps to establish the external validity and generalizability of the present analysis. Table 1.1 lists the relevant jurisdictional attributes.

Table 1.1: Jurisdictional characteristics

Jurisdiction	Pop.	Population Density per Sq. Mile	# Elected Officials	Districted	Campaign Contribution Limit	Election Cycle	Term Limits	Voter Turn-Out as % of Population	Number of Voters
L.A.C. Dist-1	196,703	8,100	1	Yes	Yes	Even; with state	no	4	7,963
L.A.C. Dist-2	197,735	12,387	1	Yes	Yes	Even; with state	no	8	14,944
L.A.C. Dist-3	195,645	4,590	1	Yes	Yes	Even; with state	no	8	14,928
L.A.C. Dist-4	197,164	6,132	1	Yes	Yes	Even; with state	no	7	13,573
L.A.C. Dist-5	194,614	700	1	Yes	Yes	Even; with state	no	7	14,451
Alhambra	83,089	10,773	5	No	No	Even; with state	3	17	13,972
Lancaster	156,633	1,810	5	No	No	Even; stand alone	no	14	21,681
Norwalk	105,549	10,986	5	No	No	Odd; stand alone	no	14	15,189
Pasadena	137,122	6,021	8	Yes	No	Odd; stand alone	no	9	12,002
Torrance	145,438	7,212	7	No	Yes	Even; with state	2	33	48,433
Santa Clarita	176,320	2,999	5	No	Yes	Even; stand alone	no	22	39,509

The number of elected officials indicates the number of officials for whom records were collected, i.e. every council member, mayor, and county supervisor in a jurisdiction. Peripheral elected officials are not considered. The column for 'Districted' refers to the structure of elected representation. Officials are either districted, whereby they are elected by only the members of the district that they represent, or they are elected at large, whereby they are beholden to the entire jurisdiction. Campaign contribution limits, where they exist, range from $1,000 to $1,500. Jurisdictions choose the election cycle that they wish to follow. They may choose elections in even or odd years and the may choose to align their elections with statewide elections as a cost savings measure, or to have stand alone elections in which the ballot contains only candidates for local elections. The result of the latter is a low voter turnout which reduces the level of campaigning necessary to obtain votes.

It is conceivable that sample selection based on the availability and quality of data may lead to some estimation bias. In the case of campaign finance disclosures, the quality and availability of records is largely a function of the competence of city and county clerks. Clerks are individually elected and not necessarily beholden to city councils, mayors, or county supervisors. Hence, it is unlikely that a systematic relationship exists between pertinent data characteristics and the selection of jurisdictions based on the quality and availability of

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[12]Annual residential permit data for most cities is available through the census bureau; however, omitting commercial construction and aggregating to the annual level would greatly reduce the depth of analysis possible.

Table 1.2: Intra-jurisdiction activity

Jurisdiction	Square feet permitted	Value of permitted structures	All Donations	Donations from All Real Estate Sectors	Donations from Anti-Development Interests	Donations from Pro-Development Interests
L.A.C. Dist-1	453,816	$170,955,720	$746,340	$189,849	$4,750	$54,300
L.A.C. Dist-2	251,666	$96,280,368	$3,912,115	$707,509	$36,809	$229,400
L.A.C. Dist-3	269,886	$94,296,320	$3,076,464	$682,881	$52,900	$177,850
L.A.C. Dist-4	202,620	$66,184,082	$2,825,346	$638,911	$37,875	$198,316
L.A.C. Dist-5	4,072,306	$1,308,673,756	$3,801,053	$884,999	$52,525	$276,189
Alhambra	623,946	$32,109,088	$1,172,905	$219,867	$9,835	$56,208
Lancaster	3,333,360	$164,834,978	$855,461	$255,416	$13,100	$137,247
Norwalk	168,013	$47,883,583	$430,297	$73,618	$0	$15,150
Pasadena	1,169,204	$174,922,329	$654,890	$78,180	$6,300	$14,025
Torrance	136,719	$54,687,716	$1,272,766	$301,263	$16,450	$105,872
Santa Clarita	2,220,248	$156,730,575	$1,006,573	$341,838	$1,350	$149,758
Total	**12,901,784**	**$2,367,558,515**	**$19,754,210**	**$4,374,331**	**$231,894**	**$1,414,315**

campaign finance records. If, on the other hand, city and county clerks are systematically incentivized to obfuscate the relationships that might be borne out by a careful analysis of the records, the relationships discussed in Section 1.3 would likely be larger in magnitude than the model estimates imply.[13] It is, perhaps, more likely that the record keeping practices of building departments are indicative of wider institutional practices. That is, the quick disposal of permitting records or an unwillingness to share records, may lead to, or be caused by, a greater willingness to exercise influence in the realm of development. If this is the case, we would expect those jurisdictions with unavailable or lower quality records (those cities not selected) to exhibit a stronger relationship between political influence and the issuance of building permits than those jurisdictions that were selected. The bias in that case would, again, be towards zero. Therefore, if the selection process introduces some estimation bias, the elimination of that bias would not negate the results presented in Section 1.3, but likely strengthen them.

In the analysis that follows, pro-development interests are represented by donations from real estate developers, while anti-development interests are represented by donations from property managers. Property managers may own the properties under their management,

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[13]It is unclear how the recent corruption scandals and ensuing publicity of other Los Angeles jurisdictions affected the selection process. On one hand, the state has ramped up enforcement efforts in regards to public records requests. On the other hand, jurisdictions with less than virtuous practices have a greater incentive for concealment. On an anecdotal level, several city clerks acknowledged a quickening of their pace as a result the castigation of their peers; however, several of those jurisdictions most reputed for overt malfeasance simply ignored my records requests.

but ownership is not a necessary condition. If a property manager does not own the property under her management, she earns a percentage of the rental revenue, hence her incentives are aligned with those of the property owner. Property managers wish to restrict land development in order to maintain high rental rates, while real estate developers, clearly wish to develop land. There is, however, an asymmetry in this measure of interest group participation. While measuring the donations from real estate developers likely captures a large portion of the pro-development interest group's activity, the same may not be true for property managers. Information on any given donor is limited to the name, address, occupation, and employer of that donor. There are likely some donors who contribute in an effort to protect property value, while listing an occupation outside of the real estate industry, e.g. homeowners who hold non-real estate employment, but wish to maintain the value of their homes. Such donors would clearly be contributing in support of anti-development interests, yet their donations remain unclassified. If we assume that those donations are positively correlated with the donations given by property managers, the analysis that follows is unaffected by this asymmetry. If we further assume that recipients of donations equally value donations from either side, parameter estimates can be used to account for the observational asymmetry.

Several additional controls for permitting activity and political activity are employed, including population, election timing, donations from non-development interests, campaign contribution limits, and building permits for projects other than new construction. Population changes over time within jurisdictions and would likely drive both permits and donations. Population is, therefore, a necessary and significant control. Election timing is a variable that measures the number of months until the next election within a jurisdiction. The variable controls for any building activity that may be driven by the electoral cycle. For instance, it is feasible that when an election is eminent, politicians may want to issue more (or fewer) permits in order to gain favor with a portion of the electorate.[14] Donations from

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[14]While some jurisdictions have the same elections cycle, most do not.

non-development interests[15] control for some idiosyncratic shocks (e.g. an income shock) that might affect both permits and donations. Campaign contribution limits are roughly the same across those jurisdictions that employ them, therefore, an indicator is used for the presence of limits. The presence of contribution limits is a significant determinant of the relationship between donations and new-structure building permits. Building permits for projects other than new structures are meant to control for time-variant, district-specific institutional changes that may lead to changes in the issuance of new-structure permits. For example, the permit issuing agency may have a change in policy, budget, or labor capital that affects its ability or willingness to process permits.

The empirical model used for estimation is a dynamic fixed effects model which regresses square feet permitted in time t by jurisdiction i on square feet permitted in time t-1, anti-development interest donations, pro-development interest donations, and non-development interest donations made to political office holders in jurisdiction i in time t-1, as well as the additional controls described above. For the majority of the analysis that follows, data is aggregated at the four-month level; however, some additional results will be examined in Section 1.3 which use monthly aggregated data within an autoregressive distributed lag framework. The lag lengths were chosen according to the Akaike information criterion (AIC), which suggests a one-period lag for the data aggregated at the four-month level and a nine-period series of lags for the one-month aggregated data. Lags were tested in both directions; however, no effects were found when permits precede donations. The effects of donations differ between jurisdictions with contribution limits and jurisdictions without contribution limits. To capture that difference, an indicator for the presence of limits was constructed and interacted with donations from the various groups. The full model is listed below.

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[15]These are donations from everyone who is not directly affected by development

Empirical model:

$$y_{it}^{\text{permits}} = \alpha_i + y_{it\text{-}1}^{\text{permits}} + \boldsymbol{\beta} \boldsymbol{X}_{(i,t\text{-}1)}^{\text{anti}} + \boldsymbol{\eta} \boldsymbol{X}_{(i,t\text{-}1)}^{\text{pro}} + \boldsymbol{\psi} \boldsymbol{Z}_{(i,t\text{-}1)}^{\text{other}} + \boldsymbol{\delta} \boldsymbol{W}_{(i,t)} + \gamma_t + e_{it} \qquad (1.1)$$

$$\boldsymbol{\lambda} = \begin{bmatrix} \lambda_t^1 & \lambda_t^2 I_i^{lim} \end{bmatrix} \qquad for\ \boldsymbol{\lambda} = \boldsymbol{\beta},\ \boldsymbol{\eta},\ and\ \boldsymbol{\psi}$$

where,

$$
\begin{aligned}
y_{it}^{\text{permits}} &= \text{sq. ft. permitted in jurisdiction } i \text{ in time } t, \\
X_{(i,t)}^{\text{anti}} &= \text{donations from anti-development interests in jurisdiction } i \text{ in time } t, \\
X_{(i,t)}^{\text{pro}} &= \text{donations from pro-development interests in jurisdiction } i \text{ in time } t, \\
Z_{it}^{\text{other}} &= \text{donations from non-development interests in jurisdiction } i \text{ in time } t, \\
W &= \text{Vector of control variables}, \\
\boldsymbol{\beta} &= \text{coefficient vector on } X_{(i,t)}^{\text{anti}}, \\
\boldsymbol{\eta} &= \text{coefficient vector on } X_{(i,t)}^{\text{pro}}, \\
\boldsymbol{\psi} &= \text{coefficient vector on } Z_{(i,t)}^{\text{other}}, \\
\boldsymbol{\delta} &= \text{coefficient on } W_{(i,t)}^{\text{ratio}}, \\
I_i^{lim} &= \text{indicates the existence of campaign contribution limits in jurisdiction } i, \\
\alpha_i &= \text{time-invariant characteristics of jurisdiction } i, \\
\gamma_t &= \text{jurisdiction-invariant characteristics of time } t.
\end{aligned}
$$

1.3   Results

The following sections present an empirical analysis of the data described in Section 1.2, as well as a discussion of the relevant theoretical implications. Section 1.3.1 presents evidence of a significant relationship between donations from development interests and the allowance of development activity, followed by a discussion of the likely causal nature of that relationship. Section 1.3.2 explores the relationship between the opposing interest groups and attempts to control for reactive contributing. Through that effort, the winners and losers of interest group competition are identified, and the frequency with which a prisoners' dilemma occurs is determined. Section 1.3.3 will explore the role and efficacy of campaign contribution limits.

Finally, Section 1.3.4 discusses some insight into the signaling mechanisms of Gordon and Hafer's (2007) regulatory signaling model.

1.3.1 The effects of contributions

Subsequent questions of nonmarket strategies are conditional on the existence and nature of the relationship between political giving and economic outcomes. The generalized existence of such a relationship is a contentious notion in light of the inconsistent results discussed in Section 1.1. This section will, therefore, examine the evidence supporting the existence of a relationship between interest group political donations and the issuance of building permits, followed by an exploration of the (likely causal) nature of that relationship. To that end, Table 1.3 presents estimates of Equation 1.1 using several different estimation techniques. The coefficients on donations represent the effect of a one dollar donation on permits measured in square feet, holding all else constant. The coefficients on the interaction terms represent how effects change in jurisdictions with campaign contribution limits. Those results will be discussed in Section 1.3.3.

Column (1) of Table 1.3 shows the results of the two-way fixed effects model (FE) estimated with ordinary least squares (OLS). In dynamic panel models, it is well-known that the OLS estimator may be inconsistent due to the endogeneity of the lagged dependent variable, although this is less of a concern in panels with a long time-dimension. To control for that inherent endogeneity, Column (2) shows the results of the Arellano-Bond (AB) approach which uses first-differenced data and instruments for the lagged dependent variable. The coefficient estimates in column (1) and column (2) are not statistically different from one another and the Hausman test implies that OLS is the preferred estimator. Column (3) presents the results of an instrumental variable approach, estimated by the generalized method of moments (IV-GMM). Additional lags of the regressors are used to instrument for the potentially endogenous variables (donations from anti-development and pro-development interest) within the Arellano-Bond framework. Table 1.4 presents the relevant IV diagnostics. The first-stage

Table 1.3: Regression results

Variables	(1) FE	(2) AB	(3) IV-GMM	(4) ARDL[†]
Lagged Permits	0.73***	0.75***	0.76***	0.47***
	(0.03)	(0.03)	(0.03)	(0.02)
Anti-Dev.	-144**	-160**	-165**	-131*
	(54)	(56)	(57)	(61)
Anti-Dev#CCLim	103	115	123	25
	(61)	(63)	(63)	(82)
Pro-Dev.	31**	31**	32**	53*
	(9)	(9.3)	(9.4)	(23)
Pro-Dev#CCLim	-27**	-24*	-25*	-62*
	(10)	(11)	(11)	(26)
Population	-16	-335*	-236*	2.32
	(157)	(133)	(118)	(39)
mths Until Elct.	508	868	671	-113
	(1306)	(1334)	(1325)	(282)
Other Permits	0.23	0.46	0.34	0.4
	(0.55)	(0.6)	(0.56)	(0.5)
Other Dontions	-1.36	-1.47	-1.47	-6.27
	(0.88)	(0.91)	(0.92)	(4.52)
Oth Don#CCLim	1.9	1.88	1.87	5.92***
	(1.03)	(1.07)	(1.07)	(1.55)
Constant (in 10,000s)	18	215*	153*	0.98
	(98)	(83)	(74)	(31)
N	484	473	473	1625
Differenced	no	yes	yes	no
District FE	yes	yes	yes	yes
Time FE	no	yes	yes	no
Aggregation Level	4-mth	4-mth	4-mth	1-mth

(***) → α = .001;   (**) → α = .01;   (*) → α = .05;
† Values in column (4) represent the sum of the estimated lag weights. They can be interpreted as the cumulative effects of covariates over all the lags.

Table 1.4: IV diagnostics

First-Stage F-Statistics			Sargan test of overidentifying restrictions
	F(10,409)	P-val	H_0: over identifying restrictions are valid
Anti-Dev	20	0.00	H_a: instruments are correlated with the error
Anti-Dev.#CCLim	20	0.00	chi2(450) = 410.8419
Pro-Dev.	21	0.00	Prob> chi2 = 0.9070
Pro-Dev.#CCLim	21	0.00	

Endogeneity test of endogenous regressors	Arellano-Bond test for zero autocorrelation in first-differenced errors		
FE vs. IV-GMM	H_0: no autocorrelation exists		
H_0: regressors should be treated as exogenous	H_a: order i autocorrelation exists		
H_a: OLS is inconsistant	Order	Z	P-val
Chi2(10)=2.81	1	-2.12	0.04
P-val=.99	2	0.27	0.78

F-statistics suggest that the instruments are relevant, while the overidentification restrictions suggest that the instruments are excludable. Moreover, there is no evidence of second order autocorrelation in the dynamic panel. The IV-GMM coefficient estimates are slightly larger in magnitude than the FE and the AB estimates; however, the Hausman test finds no evidence of a systematic difference, again indicating that OLS is the preferred estimator. The first three columns of Table 1.3 are based on data aggregated to the four-month level and donations are lagged by one time period. Alternate lag structures were tested going in both directions. Models in which donations lead permits produce no significant results.

Column (4) of Table 1.3 shows the results for an autoregressive distributed lag model (ARDL). The model uses data aggregated to the one-month level and includes lags on donations between zero and nine months, as determined by the AIC. The estimates in column (4) represent the sum of the lag weights. The distributed lag approach allows us to better examine the timing of effects, which are illustrated in Figure 1.1. The plots in the left column of Figure 1.1 show the monthly effects of donations, while the plots in the right column show the cumulative effects of donations. From the ARDL model, we can deduce that most of the effects of pro-development donations occur in the first three months after a donation
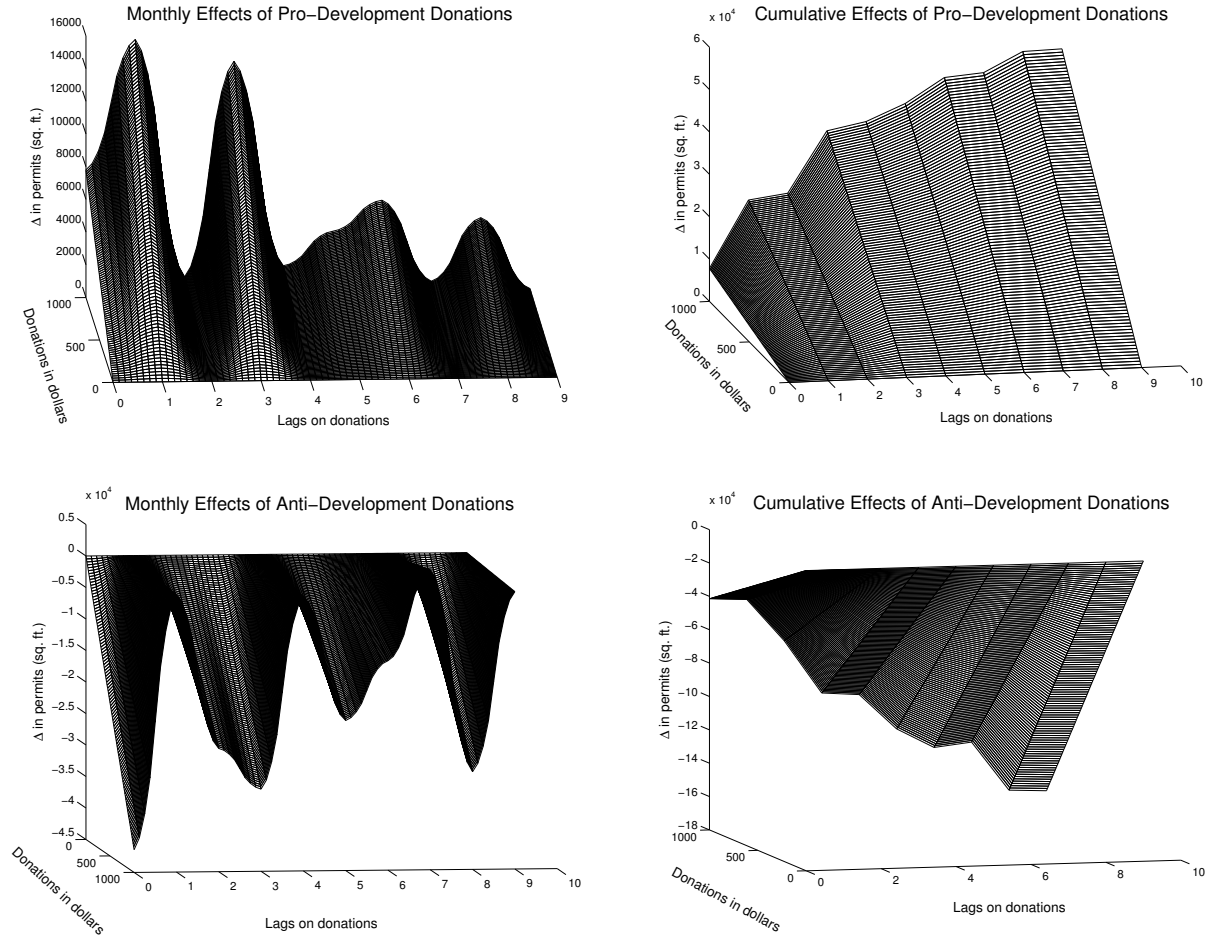
Figure 1.1: Distribution of effects zero to nine months after donation

The above plots show the effects of donations on permits zero to nine months after the donations are received. The plots on the left show the monthly effects, while the plots on the right show the cumulative effects. The x-axis show the number of months since a donation was received (lags on donations are measured in months). The y-axis gives the dollar amount of donations. The z-axis shows the effects on permits of y dollars after x months.

is received, with some residual effects stretching out to the nine-month mark. The effects of anti-development donations are more evenly spread over the ten month period. The average time for building permit processing is between four and six weeks after an application has been submitted. The implication then, is that developers are giving donations in the zoning and planning stages of development, directly before permit applications are being submitted. Anti-development interests are giving donations throughout the planning, zoning, and permitting stages.

Table 1.5: Normalized effects of donations

Variables	FE ($\sigma_{permits}$)	AB ($\sigma_{permits}$)	IV-GMM ($\sigma_{permits}$)	ARDL ($\sigma_{permits}$)
Jurisdictions without limits				
Anti-Dev. $\Delta\sigma_{anti}$	-0.14	-0.16	-0.17	-0.13
Pro-Dev. $\Delta\sigma_{pro}$	0.21	0.21	0.22	0.36
Jurisdictions with limits				
Anti-Dev. $\Delta\sigma_{anti}$	-0.1	-0.11	-0.11	-0.27
Pro-Dev. $\Delta\sigma_{pro}$	0.05	0.08	0.08	-0.10

The table shows the effects of a one-standard deviation shift in donations (σ_{anti} & σ_{pro}) on permits, measured in standard deviations ($\sigma_{permits}$). Results are divided into jurisdictions with campaign contribution limits and jurisdictions without contribution limits.

The coefficient estimates in Table 1.3 represent the partial effects of donations, e.g. a one dollar increase in donations from pro-development interests will lead to an increase in permits issued by 31 square feet, holding all else constant. To put these measures in perspective, Table 1.5 shows the average change in permits (measured in standard deviations) that results from a one standard deviation change in donations. For example, a one standard deviation increase in donations from pro-development interests will increase building permits in the next time period by 0.21 standard deviations. It should be noted that if we think that donations from one group may induce donations from the other group, the net effect of donations will be smaller. Such relationships are explored in Sections 1.3.2.

The coefficient estimates of anti- and pro-development donations in Table 1.3 are significant and of the expected sign for every estimation approach; the important implications of these findings will be discussed at the end of this section. Another noteworthy characteristic of the estimates is the relative size of the effects. The effects of anti-development donations are significantly larger in magnitude than the effects of pro-development donations. There are several possible explanations for this difference. The first of which is that anti-development money may be more influential than pro-development money. Anti-development interests tend to be well-established in the community; in addition to being voters, they are continuing sources of revenue for local office holders. Real estate developers, conversely, may be

more transient; after the completion of a project, they will likely move on to a new community. The second possible explanation for the difference in effects stems from the way in which interest groups are identified (i.e. the industry in which a donor works). It may be the case that a portion of the anti-development interest group does not work in the real estate industry and is, therefore, unidentified in the data. The positive correlation between the donations given by those unidentified anti-development interests and the donations from identified anti-development interests may be causing the effect (per dollar donated) to appear larger than it is.

Before discussing the implications of the empirical results, it is useful to examine the likely causal nature of the relationship that exists between donations and building permits. The panel design of this research controls for jurisdiction-specific, time-variant as well as time-specific, jurisdiction-variant characteristics, thereby greatly reducing the likelihood of omitted variable bias. Furthermore, the controls included in the model account for much of the idiosyncratic variation that may simultaneously affect donations and building activity. For instance, it is feasible that an influx of new residents in a jurisdiction could affect both permits and donations; however, measuring changes in population directly accounts for such effects. It is also possible that economic or political shocks specific to a jurisdiction could drive permits and donations. This possibility is controlled for by measuring changes in the general level of donations. Furthermore, by measuring building permits that are issued for projects other than new structures, we can control for institutional changes that could affect permits and donations. It may also be the case that politicians wish to issue more (or fewer) permits when an election is imminent, in order to gain the support of a set of constituents. This sort of strategy would clearly coincide with increases in donations. However, such possibilities are accounted for through a measure of temporal proximity to an election. By examining the partial and semipartial correlations listed in Table 1.6, it is clear that donations from development interests are significantly correlated with the issuance of building permits, even when controlling for time fixed effects, jurisdiction fixed effects, and

idiosyncratic economic, political, electoral, and institutional variation. Additionally, the use of lagged independent variables reduces the likelihood of simultaneity or reverse causation. Finally, comparing the IV-GMM and FE estimates listed in Table 1.3 via the Hausman test implies that donations can be treated as exogenous, conditioned on the model controls. In light of the evidence, it is reasonable to conclude that the relationship between development interest donations and the issuance of building permits is, at least in part, causal.

Table 1.6: Partial & semipartial correlations

Variable	Partial Corr.	Semipartial Corr.	Partial Corr^2	Semipartial Corr^2
Anti-Dev.	-0.124**	-0.055**	0.015**	0.009**
Anti-Dev.#CCLim	0.080	0.035	0.006	0.001
Pro-Dev.	0.163***	0.073***	0.026***	0.005***
Pro-Dev.#CCLim	-0.127**	-0.057**	0.016**	0.003**

The values given are for the partial and semipartial correlation between the listed variable and sq. ft. permitted per period, controlling for all other variables in the model, as well as time and district fixed effects.

This initial analysis has several implications, the first and most important of which is that special interests can, and do, affect government action. Much of the previous work done in this area has focused on measuring the relationship between political contributions and certain political outcomes. Such an approach poses a number of challenges which have ostensibly hindered our ability to establish the existence of a significant and consistent link. By examining economic outcomes, as opposed to political outcomes, this research has produced evidence that a link between special interest influence and government action exists and that the relationship is likely causal, thereby adding weight to one side of a long–open question.

Second, the vast majority of donations in this data come from individuals,[16] and those donations appear to have a direct effect on economic outcomes. When omitting institutional donors from the data and retaining only individuals, significant results similar to those in Table 1.3 are obtained. This implies that either individual donors can affect political outcomes on their own or that individual donors, who have previously been viewed as acting

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[16]Roughly 85% of donations come from individuals, 15% come from firms, and ≪ 1% come from PACs.

alone, are in fact, part of an informal network, acting in loose concert. The fact that many of the individual donors in the data are employed by a relatively small set of firms, combined with the ostensible circumvention of the collective action problem supports the latter over the former. In either case, these findings suggest that a research design that ignores individual donors may produce flawed results.

Third, regardless of which revised view on the importance of individual donors is taken, the data strongly supports the theory of an investment-motivated donor, at least for some subset of donors. The evidence causally linking donations from interest groups to changes in economic outcomes directly implies that donors are contributing in order to achieve some economic benefit–i.e. an investment motive. The crux of Ansolabehere et al.'s (2003) argument supporting the consumption treatment of political contributions is the fact that most contributions come from individuals, and individuals, they argue, are too small to affect political outcomes. In light of the data, it seems that individuals can be impactful (either on their own or through their informal networks), making such an argument problematic, at least in the context of small-scale politics.

The results do, however, strongly corroborate the general findings of De Figueiredo and Edwards (2007) insofar as political contributions can affect economic outcomes. Furthermore, the opposing effects of anti-development and pro-development interests imply that interest group competition does exist—a fact that can potentially account for Tullock's Puzzle (Tullock 1972), since competition drives down expected returns. This competition will be further explored in Section 1.3.2.

Robustness

As mentioned in Section 1.2, there is a relatively small number of donors who cannot be identified. Specifically, 915 donors remain unclassified, which accounts for about 2.3% of all donations. Because donations are aggregated, the inability to classify some donors amounts to measurement error. It is useful to evaluate the potential effects of that measurement error.

The persistent anonymity of those 915 donors stems from two obstacles. First, because the data goes back to 1999, some small businesses have ceased to operate and do not have the residual web-presence necessary to identify the industry in which they once existed. This accounts for the majority of unidentified donors. The remaining are due to incomplete or incoherent paperwork; the financial disclosures filed by politicians occasionally omitted crucial identifying information or were otherwise illegible.

It is reasonable to assume that the inability to classify donors is not correlated with the group to which donor's belong, after conditioning on time, district and the other model controls. In that case, we can use a multinomial logit model to predict the probability of a donor belonging to the anti-development group, the pro-development group, or the non-development group. Assigning unidentified donors to the categories in which they most likely exist and then reanalyzing the data produces coefficient estimates that are statistically indistinguishable from those in Table 1.3.

Based on the source of the measurement error, it is unlikely that the missing information is correlated with the group to which the donor belongs; however, if there is some sort of systematic relationship, we can evaluate the potential effects on the coefficient estimates. Figure 1.2 presents the results of a simple Monte Carlo exercise. The unclassified donors are randomly assigned to one of three groups: anti-development, pro-development, or non-development.[17] Then the data is re-aggregated and the model is estimated on the new data set. The exercise is repeated 10,000 times. Figure 1.2 presents a histogram of the coefficient estimates. The sign of the coefficients does not change in any of the 10,000 trials, and it is clear that estimates are not overly sensitive to the potential measurement error.

In order to determine whether the observed effects of donations are being driven by a single jurisdiction, each jurisdiction was individually dropped from the data. Estimating the model with the censored data set did not significantly change the results in any case; however,

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[17]This is a purposely naive approach, which assumes that the probability of a donor belonging to any of the three groups is $1/3$. This exercise is meant to simulate the range of possible outcomes as a function of variation in the data.
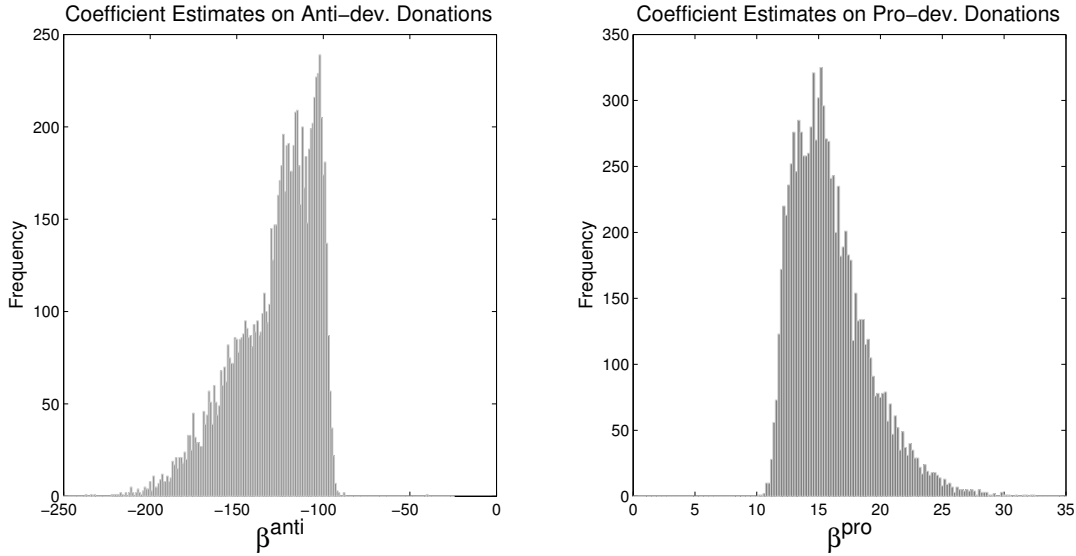
Figure 1.2: Coefficient estimates as function of measurement error

Donors within the dataset who could not be identified are randomly assigned to one of three groups: anti-development interests, pro-development interests, or non-development interests. The adjusted data is then used to estimate the model and the coefficient estimates for anti- and pro-development donations are recorded. The above histograms represent frequency and range of estimates based on 10,000 random assignments.

dropping the city of Lancaster or L.A. County District 5 does reduce the precision of the estimates. Outlier analysis was also performed. The largest 5% of donations within each jurisdiction were dropped before aggregating the data. Model estimates on the winsorized data were similar to those in Table 1.3, although with less precision. Additionally, changes in the efficacy of donations over time were examined. Splitting the data into two groups, pre-2008 and post-2008, suggests that the effects of donations became smaller after 2008 (presumably because of the sharp downturn in the housing market). Lastly, control variables are individually dropped with no notable changes in coefficient estimates.

The observed effects of donations are also not sensitive to the way in which donations enter the model. Models in which donations from anti- and pro-development interests enter as a ratio produce marginal effects that are similar in sign and magnitude to those reported in Table 1.3. Additionally, transformations of the dependent variable were examined. Using logged permits as the dependent variable produces significant coefficient estimates of the expected sign, although with slightly less precision.

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As reported in Table 1.4 the dynamic model errors are first-order serially correlated (by construction); however, there is no second-order serial correlation. Additionally, four unit-root tests appropriate for panel data are applied to the data to test for stationarity. The results are listed in Table-1.7. The Levin-Lin-Chu unit-root test and the Harris-Tzavalis unit-root test are both appropriate for moderate sized panels (with slightly different asymptotic assumptions). Both tests strongly reject the null hypothesis that all panels contain unit roots. Likewise, the Breitung unit-root test, which is robust to cross-sectional correlation, rejects the null hypothesis that panels contain unit roots. Finally, the Hadri LM test examines the hypothesis that all panels are stationary. We fail to reject this hypothesis, which further confirms the stationarity of the data.

Because donations from the two interest groups are strongly correlated with one another and strongly correlated to the general level of donations, multicollinearity is a potential problem. To assess the sensitivity of the estimated coefficients to the multicollinearity issues, the model is estimated using random subsets of the data. This results in coefficient estimates of the same sign, similar magnitude, and expectedly lower significance. The results do not exhibit over-sensitivity to changes in the data.

1.3.2 Winners, losers, and the prisoners' dilemma

The previous section evaluated the individual partial effects of political participation by anti- and pro-development interests on the rate of development. However, the greater concern, as has been stressed throughout this article, is the economic impact of such political participation. In order to evaluate the true economic implications, it is necessary to account for the net effect of the opposing interest groups on development and the gross individual cost of participation. Although it is clear that an interest group can significantly affect the allowance of building activity when holding the actions of an opposing group constant, the effect is not immediately obvious once reactive participation is considered. Anti- and pro-development interests have a strong coincidence of participation, suggesting interdependence, i.e. partic-

Table 1.7: Nonstationarity tests

Levin-Lin-Chu unit-root test	
H_o: Panels contain unit roots	AR parameter: Common
H_a: Panels are stationary	Panel means: Included
Asymptotics: N/T $\rightarrow$ 0	Time trend: Not included

	Statistic	p-value
Unadjusted t	-27.3	
Adjusted t	-26.2	0.000

Harris-Tzavalis unit-root test	
H_o: Panels contain unit roots	AR parameter: Common
H_a: Panels are stationary	Panel means: Included
Asymptotics: N $\rightarrow \infty$, T fixed	Time trend: Not included

	Statistic	p-value
ρ	-0.51	0.000

Breitung unit-root test	
H_o: Panels contain unit roots	AR parameter: Common
H_a: Panels are stationary	Panel means: Included
Asymptotics:T, N $\rightarrow \infty$ sequentially	Time trend: Not included
Lambda robust to cross-sectional correlation	Prewhitening: Not performed

	Statistic	p-value
λ	-13.2	0.000

Hadri LM test	
H_o: All panels are stationary	Time trend: Not included
H_a: Some panels contain unit roots	Heteroskedasticity: Robust
Asymptotics:T, N $\rightarrow \infty$ sequentially	

	Statistic	p-value
z	-2.33	0.99

ipation by one group may incite opposition, thereby mitigating the efficacy of that group's efforts. This section will consider the relationship between the opposing interest groups and take a heuristic approach to estimate the net returns on contributions in an effort to identify the winners and losers of competition, and to evaluate the frequency with which a prisoners' dilemma occurs.

As a first step to understanding the net effects of the opposing interest groups, we can explicitly model the relationship between them as follows:

$$\boldsymbol{X}^{\text{anti}}_{(i,t)} = \boldsymbol{\pi}^1 \boldsymbol{X}^{\text{pro}}_{(i,t)} + \boldsymbol{\phi}^1 \boldsymbol{H}^1_{(i,t)} + \gamma^1_t + e^1_{it} \tag{1.2}$$

$$\boldsymbol{X}^{\text{pro}}_{(i,t)} = \boldsymbol{\pi}^2 \boldsymbol{X}^{\text{anti}}_{(i,t)} + \boldsymbol{\phi}^2 \boldsymbol{H}^2_{(i,t)} + \gamma^2_t + e^2_{it} \tag{1.3}$$

Where X^{anti} and X^{pro} are donations from anti- and pro-development interest groups, H^g is a vector of exogenous variables, γ^g_t are jurisdiction-invariant factors, and π^g represents the conditional relationship between the two opposing interest groups ($for\ g = \{1,2\}$). The exogenous variables in H^2 used to identify the system are supply-side measures of real estate development.[18] Two-stage least squares Estimation results for equations (2) and (3) are presented in the first two columns of Table 1.8. In each case, donations from a group's opposition are a significant explanatory variable, even after controlling for the general level of donations, electoral timing, and changes in population. Again, effects are different in jurisdictions with campaign contribution limits, an issue that will be explored in Section 1.3.3.

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[18]A measure of construction cost per square foot is produced using census data on construction related capital expenditures and completed new structures. Additionally an index of historical construction prices provided by The Gordian Group is utilized. Construction cost affect the profit margin on new development and therefore affect the ultimate value of building permits to developers, without directly affecting the value of permits to anti-development groups. Finally, a measure of city level construction subsidies is constructed using data from the Department of Housing and Urban Development. Subsidized construction increases the value of permits to developers without directly affecting the value of permits to anti-development groups.

Table 1.8: Total effects of contributions

Dependent Variable:	(1) Anti-Dev. Donations	(2) Pro-Dev. Donations	(3) Permits	(4) Permits
Regressors				
Lagged Permits	~	~	0.76*** (0.03)	0.73*** (0.03)
Anti-Dev.	~	3.30*** (0.79)	-1.28 (37)	~
Anti-Dev#CCLim	~	-3.27*** (1.10)	-38 (46)	~
Pro-Dev.	0.07*** (0.02)	~	~	13* (6)
Pro-Dev#CCLim	-0.06*** (0.01)	~	~	-9.6 (7.8)
Population	-0.43 (0.32)	-0.34 (1.65)	-7.7 (158)	11 (158)
mths Until Elct.	3.00 (2.74)	-25 (14)	40 (1314)	224 (1313)
Other Permits	~	~	0.23 (0.55)	0.17 (0.55)
Other Dontions	0 (0.002)	0.02* (0.008)	-0.06 (0.8)	-1.1 (0.88)
Oth Don#CCLim	0.02*** (0.002)	0.02* (0.01)	0.82 (0.92)	1.07 (0.95)
Constant in (10,000's)	.11 (.12)	.23 (1)	11 (8.1)	-.45 (98)
N	495	495	484	484
Time FE	yes	yes	yes	yes
Jurisdiction FE	yes	yes	yes	yes

(***) → α = .001; (**) → α = .01; (*) → α = .05;

Because donations from one group have a positive influence on donations from the opposing group and donations from the two groups have opposite effects on the issuance of building permits, we would expect the net effect of donations to be smaller in magnitude once we allow for reactive contributing. In order to estimate the net effect of pro-development contributions, combine Equation 1.2 and Equation 1.3, solve for X^{anti}, and substitute into Equation 1.1 (the general model from Section 1.2). The coefficient on X^{pro} then becomes $\left(\frac{\beta\pi^1-\beta+\eta-\eta\pi^2}{1-\pi^2}\right)$, which represents the net effect of donations from pro-development interests on the issuance of building permits, after accounting for the reaction of anti-development interests. Likewise, the combination of Equation 1.2 and Equation 1.3 can be solved for X^{pro} before substituting into Equation 1.1 in order to estimate the net effect of anti-development donations on the issuance of permits, after accounting for the reaction of pro-development interests. Those estimates are presented in Columns (3) and (4) of Table 1.8.

An interesting result of this analysis is that pro-development donations continue to have a significant impact on the issuance of building permits after allowing for the relationship between the two groups. The same is not true for anti-development donations. It is likely the case that anti-development interests donate on a purely reactionary basis in order to offset the influence of pro-development donations. Alternatively, it could be the case that any donation from an anti-development interest induces an exactly offsetting reaction from pro-development interests.

With some understanding of the competitive relationship between the two groups, we can now evaluate the costs and benefits of political participation, in order to explore the existence of winners and losers in the competitive game. First define a game to be the interaction that takes place between opposing interests within a given jurisdiction and time period.[19] For simplicity, each game is treated as independent. Define a winner as the interest group which realizes a positive net change in profit after both groups have contributed. Define the loser to be the interest group (or groups) that realize a net negative change in profit

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[19]The analysis presented here uses four-month time periods; however, analysis was also conducted with data aggregated to three and six months with similar results.

after both groups have participated. Note that, while at least one loser will exist in any game where both groups participate, a winner need not exist; although revenue must be nonnegative for exactly one group,[20] it is theoretically possible (and empirically likely) that the cost of participation fully negates that revenue. Calculations of costs and revenue are discussed below. Measurements of the change in building permit issuance attributable to contributions are made using the FE estimation results from Table 1.3.

The cost to anti-development interests is only partially captured by donations from property managers. Many unclassified donors are likely donating in an effort to protect property values (as discussed in Section 1.2). If we assume that contribution recipients assign a similar value to a dollar from either interest group, then the parameter estimates of the model imply that donations from property managers only capture about one-fourth of donations from anti-development interests. Furthermore, it is well known that political contributions are only one of the tools used by interest groups who wish to assert influence. Previous studies have found that lobbying expenditures are typically five times larger than contribution expenditures (De Figueiredo and Richter 2013). The ratio in Los Angeles County is slightly higher at six-to-one.[21] Therefore, we can assume the participation costs of anti-development interests are roughly 28 times the contributions from property managers. Likewise, costs to pro-development interests are roughly seven times donations given by real estate developers.

Using data on average prices, average returns, completion rates and price elasticities, the change in gross profit as a function of permits issued is estimated to be $\Delta \pi^{anti} \approx$ -$0.27\Delta permits$ (sq. ft.) for anti-development interests and $\Delta \pi^{pro} \approx \$9.5 \Delta permits$ (sq. ft.) for pro-development interests (see Appendix B for full derivations). The revenue of pro-development interests is clearly more sensitive to changes in building permits than is the revenue of anti-development interests—a characteristic that is strongly supported by the data developers contributed six times as much as property managers and five times more

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[20]The revenue of anti-development interests is a negative function of permits, while the revenue pro-development interests is a positive function of permits. Since permits must increase, decrease, or remain unchanged, revenue must be either positive for one group or zero for both groups.

[21]This is calculated at the county level and does not include in-house lobbying expenditures.

frequently. Additionally, the average donation from a developer is 10% greater than the average donation from property managers. Developers also participate in about twice as many district-time-periods as property managers, which suggests that developers often have an incentive to contribute even in the absence of competition from property managers. The same is not true for property managers.[22] Participation by property managers almost always coincides with participation by developers, although it is not clear from the data which prefigures the other.

As can be seen in Table 1.9, of the 474 games covered by the data, 123 saw participation by both groups. Of those 123 dual-participant games, 34 were won by pro-development interests; 14 of those were significant at $\alpha = .05$.[23] Anti-development interests won 43 of the 123 games, with 23 of those cases being significant at $\alpha = .05$. The remaining 46 dual-participant games resulted in both interests realizing negative net profits, which satisfies the first condition for a prisoners' dilemma. The second condition for the existence of a prisoners' dilemma is that each group would be incentivized to donate in the absence of donations from the other group. To test that condition, it is necessary to construct the hypothetical change in permits that would have occurred if one interest donated zero. In 35 of the 46 dual-loser cases, the net profit for each interest would have been significantly positive at $\alpha = .001$ if the other interest had not donated. The remaining 11 cases would not have resulted in statistically significant profits for one or both interest groups in the absence of donations from the opposing group. Therefore, 35 games can be classified as a prisoners' dilemma. Additionally, there were 108 games in which only one of the interest groups participated. In all of those 108 cases, the participating interest group realized net positive gains from participation at $\alpha = .01$. The implication of this analysis is that, in the absence of competition, the rent-seeking activities

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[22]This disparity may also be partly explained by the relative magnitude of the collective action problem that exists in each interest group. We would expect anti-development interests to suffer more from collective action problems because of the wide dispersion of potential gains.

[23]The net change in profit for pro-development interests was positive in 34 games; however, considering the variance of the coefficient estimates used to calculate changes is revenue, the net revenue was significantly different from zero in only 14 of those games.

of interest groups can be highly profitable.[24] However, when interest group competition exists, those rent-seeking activities are typically not successful and often leave both groups worse-off.

Table 1.9: Winners & losers with four month aggregated data

	Time periods in the data	Pro-development interests participate	Anti-development interests participate	Both participated (number of competitions)	Competitions won by pro-development interests	Competitions won by pro-development interests ($\alpha = 0.05$)	Competitions won by anti-development interests	Competitions won by anti-development interests ($\alpha = 0.05$)	Both lose	Prisoners' dilemma ($\alpha = .001$)
L.A.C. Dist 1	45	12	5	4	2	1	1	0	1	0
L.A.C. Dist 2	45	27	18	18	7	0	3	0	8	0
L.A.C. Dist 3	45	12	12	10	0	0	4	4	6	6
L.A.C. Dist 4	45	30	25	25	0	0	16	11	9	9
L.A.C. Dist 5	45	34	23	22	0	0	6	6	16	16
Alhambra	43	24	13	12	6	4	6	0	0	0
Lancaster	40	14	7	7	5	5	2	2	0	0
Norwalk	36	11	0	0	0	0	0	0	0	0
Pasadena	45	11	5	5	0	0	2	0	3	0
Torrance	40	21	20	15	10	4	3	0	2	3
Santa Clarita	45	25	5	5	4	0	0	0	1	1
Total	474	221	133	123	34	14	43	23	46	35

Winners and losers are determined using the regression results of Model-4 combined with heuristic measures of expected revenue and cost, as discussed in Section 1.3.

Additionally, the evidence suggests that politicians are better-off when interest groups compete with one another. Donations from anti-development and pro-development interests are five times greater in those competitive time-periods, compared to their donations in time-periods when only one group contributed (controlling for electoral timing). This may be a selection issue, insofar as competition may exist because there is greater value at stake in those time-periods, which also leads to more donations; however, the implication is that politicians prefer the conditions that lead to interest group competition and have a clear incentive to promote those conditions.

The results of the analysis in this section strongly support Baron's (2001) theoretical analysis of interest group competition in a regulatory framework. Moreover, the occurrence of the prisoners' dilemma, in addition to being a theoretically common occurrence, is also an empirically common occurrence; the prisoners' dilemma appears to be the most likely outcome when both groups participate. The results also lend some insight to Tullock's

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[24]This point should be interpreted with care. There are a number of instances in which neither group participates; interests may be choosing to participate only in those instances where the likelihood of success is high or they are induced to participate by their opposition.

puzzle, which postulates that the amount of money in politics is incommensurate with the potentially large returns from political investment (Tullock 1972). The explanation, in part, may be that the potentially large rents associated with political investments are not so easy to capture. Political participation by an interest group may compel defensive participation by an opposition group, thereby shifting bargaining power away from donors. The result can be (and in this context, often is) a negative return on investment.

1.3.3 Effect of contribution limits

Several previous studies have argued or implied that special interest groups (SIG's) become more influential in the face of campaign contribution limits (see e.g. Stratmann 2006, Coate 2004a, Prat 2002 and Drazen, Limão, and Stratmann 2007). Such a hypothesis is the logical conclusion of several schools of thought. For instance, we can put campaign contributions into the framework of a competitive market, where contributions are a normal good supplied by SIG's and consumed by politicians. The "price" of contributions is, then, political favor; i.e. politicians promise future political favors in return for contributions. Such a market is illustrated in Figure 1.3. While contribution limits only explicitly control the amount each donor can give, they often have the practical effect of reducing aggregate donations supplied, thereby shifting the supply curve to the left. This effectively raises the market price of contributions such that a politician must promise more favors to a SIG for any given level of contributions. Note that although the result is fewer contributions given, because more favors are being offered for those contributions, the effect on total political favor issued is ambiguous.

If we think that politicians or donors have some degree of market power (which is a reasonable assumption) then the problem can be illustrated as a bargaining game. The contract curve representing the possible bargaining outcomes is illustrated by an Edgeworth box in Figure 1.4. Taking initial endowments of money and political favors (the commodities being traded) as given, the ultimate bargaining outcome will lay on the contract curve; however,

the exact point on the curve (β) will depend on the bargaining power of the SIG relative to that of the politician (λ). Let λ be a random variable; then β, a function of λ, is a random variable within the domain of the contract curve. When a campaign contribution limit (α) exists within the domain of the contract curve, the limit effectively truncates the distribution of β such that:

$$\beta = \begin{cases} f(\lambda), & \text{if } f(\lambda) \leq \alpha \\ \alpha, & \text{otherwise.} \end{cases}$$

In this case, $\mu^\beta < \mu^{\beta|\alpha}$, hence, the distribution of the bargaining outcome is skewed in favor of the SIG, who can now, on average, receive more political favor in return for donations. The distribution of outcomes is illustrated in the bottom panel of Figure 1.4. By restricting the domain of the contract curve in the top panel, α truncates the conditional distribution of β on the left, thereby shifting the mean to the right.[25]

Stratmann (2006) provides indirect empirical evidence that contribution limits increase the bargaining power of SIG's. He is able to establish a positive relationship between the existence of contribution limits and the number of lobbies formed across U.S. states. The argument is that limits increase the average outcome of the bargaining game that exists between lobbies and politicians, thereby increasing the average rate at which contributions can be converted into political favor. The increased efficacy of contributions induces more lobbies to form. While Stratmann's approach is clever and the theories of Coate (2004a) and Prat (2002) are well-formulated, there has not been much in the way of direct empirical evidence to support the idea that limits increase the marginal effect of contributions. However, because the data used for the current research produces a clear measure of the efficacy of contributions, it can provide some insight into the role of campaign contribution limits.

In light of the above theory, we would expect to see a significant difference in the marginal effects of donations between jurisdictions with limits and jurisdictions without limits. More

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[25]This is a synthesis of the theory described in Stratmann 2006, Coate 2004a, Prat 2002 and Drazen, Limão, and Stratmann 2007.
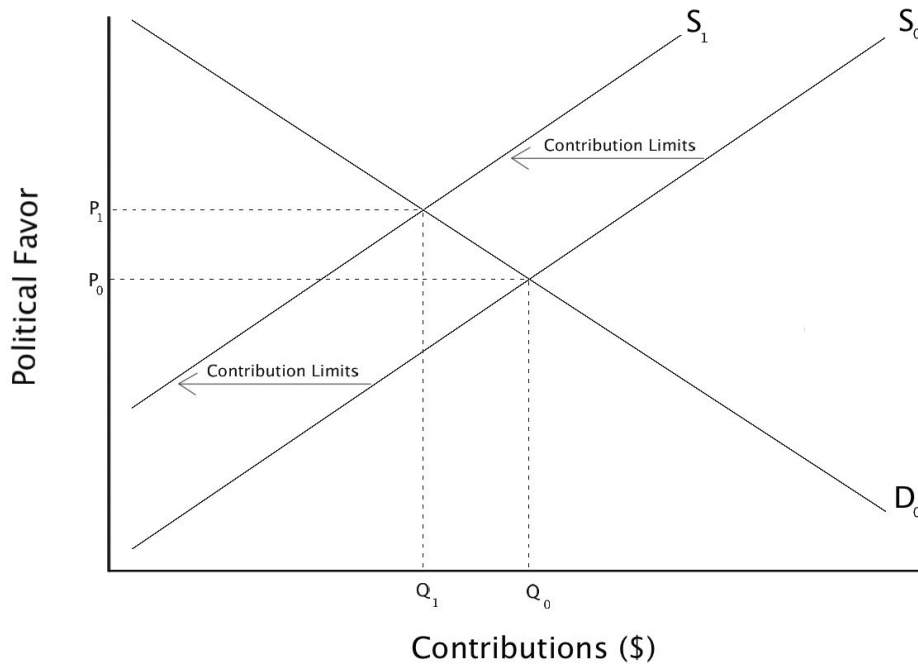
Figure 1.3: The market for contributions

specifically, we would expect those marginal effects to be larger in magnitude in those jurisdictions with limits. However, the opposite seems to be true. Table 1.10 shows the relevant results by splitting the marginal effects up by jurisdictional type (jurisdictions with contributions limits, and jurisdictions without contributions limits). The marginal effects of donations from all donors are consistently and significantly smaller in magnitude when faced with contribution limits. Additionally, as is evident in Table 1.8, the two interest groups seem to be less reactive to one another in those jurisdictions with contributions limits. Such results may be reflective of some transactional frictions associated with limits. When faced with contribution limits, interest groups must adopt some sort of decentralized donation strategy. While, in principle, an interest group can deliver the same amount of funding to a recipient regardless of contribution limits, the strategy necessary to circumvent limits may impose a significant transactional cost. Moreover, a decentralized donation strategy may
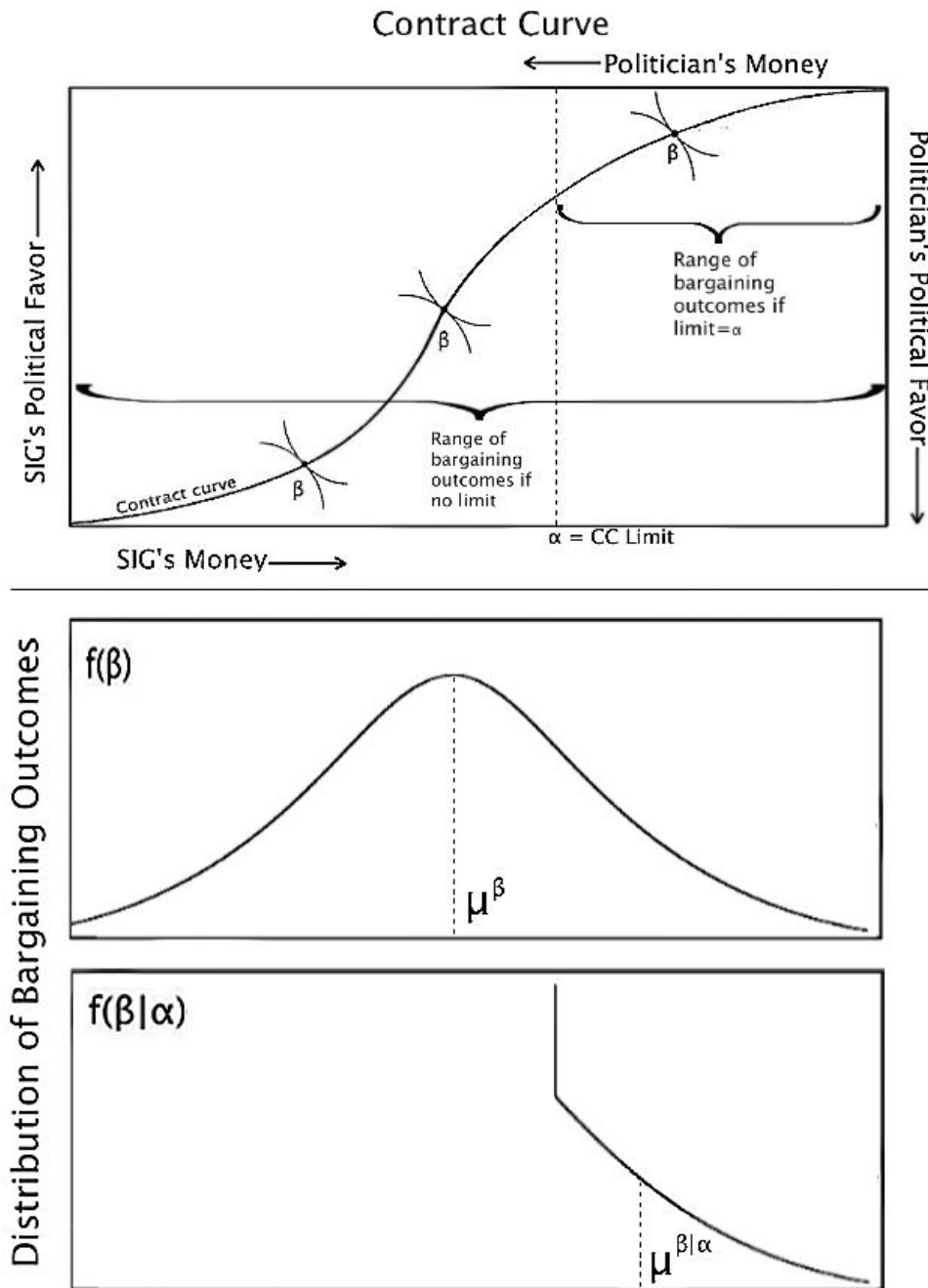
Contract Curve

Figure 1.4: Bargaining outcome

The Edgeworth box diagram in the top panel depicts the contract curve given some initial endowment of the two commodities: political favor and money. Each player attempts to bargain for a position on the contract curve furthest from his or her origin; i.e. the SIG prefers a point moving up and to the right. The politicians prefer a point moving down and to the left. The SIG moving up along the y-axis indicates that she gets more favors, while a movement to the right along the x-axis indicates that she gets (or keeps) more money. Likewise, the politician moving down along the y-axis indicates that she keeps more political favors (which she could sell to other interest groups), while a movement to the left along the x-axis indicates that the politician gets more money. The outcome of the bargaining game will be some point on the contract curve. That point, β, represents the rate at which money can be converted into political favor and is a random variable. A contributions limit at α will truncate the distribution of β. The full and truncated distributions are represented in the bottom panel.

Table 1.10: Marginal effects with and without contribution limits

Variables	(1) FE	(2) AB	(3) IV-GMM	(4) ARDL[†]
No Contribution Limits				
Anti-Dev.	-144**	-160**	-165**	-131*
	(54)	(56)	(57)	(61)
Pro-Dev.	31**	31**	32**	53*
	(9)	(9.3)	(9.4)	(23)
Contribution Limits				
Anti-Dev.	-41	-45	-42	-106
	(25)	(26)	(26)	(32)
Pro-Dev.	4	7	7	-9
	(4.5)	(4.6)	(4.6)	(15)
N	484	473	473	1625
Differenced	no	yes	yes	no
District FE	yes	yes	yes	yes
Time FE	no	yes	yes	no
Aggregation Level	4-mth	4-mth	4-mth	1-mth

(***) → $\alpha = .001$; (**) → $\alpha = .01$; (*) → $\alpha = .05$;
† Values in column (4) represent the sum of the estimated lag weights. They can be interpreted as the cumulative effects of covariates over all the lags.

decrease the visibility of an interest group to the recipient of their funds, thereby reducing the efficacy of donations.

While this evidence contradicts the indirect empirical findings of Stratmann (2006), the results should be interpreted with some care. It is not possible to produce a random or exogenously determined distribution of policies across districts; it is therefore feasible that the implementation of contribution limits is driven by some other jurisdictional characteristic, which also determines the ability of special interests to assert influence. The results do, however, provides some suggestive evidence that campaign contribution limits are having the intended effect. The results also highlight the need for further research in the area.

1.3.4   Signaling mechanism

In the model of Gordon and Hafer (2007), discussed in Section 1.1, the mechanism by which signals of regulated firms are observed by regulatory agencies is an open question. It is not clear whether donations themselves act as a signal or whether donations are a proxy for

some measure of political connectedness. The former relies crucially on the public disclosure of donations while the latter should be temporally aligned with the receipt of donations. Assuming the appropriateness of Gordon and Hafer's model, the data used for this research provides some insight into the question of signaling mechanisms. By exploiting the non-linear relationship between the date on which donations are received and the date on which those donations are first publicly disclosed,[26] we can evaluate the relative importance of those dates. In order to conduct such analysis, donations from the relevant interest groups are first aggregated according to the receipt date (as was the case in the preceding analysis) to create one set of variables and then aggregated by the discloser date to create a second set of variables. Those two sets of variables are subjected to several tests, the results of which are reported in Table 1.11.

Table 1.11: Relative importance of contribution receipt date vs. report date

	F-test for report dates, given receipt dates	F-test for receipt dates, given report dates	AIC	Probability relative to model 2	BIC	Δ BIC vs. model 2	PMVD receipt dates	PMVD report dates	AMVD receipt dates	AMVD report dates
Model 1	~	~	43453	<.0001	45853	1305	30%	0%	29.2%	0.8%
Model 2	~	p=.001	43281	~	44549	~	~	~	~	~
Model 3	P=0.75	~	474341	<.0001	48723	4174	~	~	~	~

Model 1 includes the set of variables aggregated by the receipt-date of donations and the set of variables aggregated by the report-date of donations. Model 2 includes only the receipt-date variables and Model 3 includes only the report-date variables.

As a preliminary evaluation, three model variations (Models 1, 2, and 3) are compared via the standard f-test of nested models. All three models are variations of Equation 1.1 with donation data either aggregated by the date on which donations where received, the date on which donations where made public, or both. Model 1 includes both sets of variables,[27] Model 2 includes only the receipt-date variables and Model 3 includes only the report-date variables. As is seen in Table 1.11, the inclusion of the receipt-date variables, given the inclusion of report-date variables, significantly decreases the model sum of squared errors with a p-value of 0.001. However, the inclusion of the report-date variables, given the

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[26]Time between receipt and disclosure ranges from zero to 12 months

[27]The imperfect correlation between the corresponding variables in the two sets ($0.1 < \rho < 0.3$) allows for a model which include both sets of variables.

inclusion of the receipt-date variable does not significantly reduce the sum of squared errors (p-value=.75). This suggests that the report-date variables have no significant explanatory power beyond their correlation with the receipt date variables.

Next, the three models are simultaneously compared with one another. The AIC and Bayesian information criterion (BIC) both provide strong evidence to support the use of Model 2 (receipt-date variables) over Models 1 and 3. This suggests that all of the relevant information that is contained in the report-date variables is a proper subset of the information contained in the receipt-date variables.

Finally, by examining Model 1, which includes both variables, a measure of the relative explanatory power of the two sets of variables can be obtained. This is done by using either a proportional marginal variance decomposition or an average marginal variance decomposition (see Grömping 2007 for a discussion and comparison of methodology).[28] The resulting statistics of this sort of analysis provide a measure of the fraction of dependent variable variance that can be attributed to each set of regressors. Both methodologies suggest that the set of receipt-date regressors explain about 30% of the variation in building permits, while the set of report-date regressors explain between 0% and 1% of the variation in permits.

All of the evidence taken together strongly suggests that the date on which a donation is received matters far more than the date on which that donation becomes public knowledge. In the context of a signaling model, these results imply that donations themselves are not the signal observed by the regulatory agency, but a proxy for the signal observed by a regulatory agency. An alternative explanation for these results is that donors are soliciting legislative interventions in a more pure quid pro quo framework. That is, donation recipients are directly intervening in the regulatory process in order to distribute political favor. In such a scenario, the date on which donations are publicly disclosed has little bearing on the timing of political favors.

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[28]Note that partial R^2 is not a valid approach to measuring the relative importance of correlated regressors.

1.4 Conclusion

The research presented in this article undertakes an effort to more broadly understand the strategic and democratic characteristics of non-market competition. Utilizing a unique data set, we have examined the effects of political contributions from competing land-use interests on the allowance of development activity in 11 jurisdictions over 15 years. By using a measurable and repeated economic outcome and a full distribution of treatments across multiple jurisdictions and time-periods, this research has been able to avoid many of the complications faced by previous work. The analysis shows that, when controlling for confounding factors, a significant relationship between political contributions and *economic* outcomes emerges. This is in stark contrast to the findings of many previous studies, which fail to produce significant links between political contributions and *political* outcomes. The evidence presented in this paper shows that an interest group can significantly affect government action through political contributions; however, when we consider the relationship between opposing interest groups and account for reactionary contributing, the ability to assert influence, though still significant, is greatly reduced.

This research has extended the ideas of Grossman and Helpman (1992) and Baron (2001) to show that interest group competition regularly results in a prisoners' dilemma. From a strategic point of view, such findings should inform the decisions of interest groups as to where and how they compete through political participation. If a commitment mechanism exists by which competing interests can negotiate a cooperative outcome, such a strategy should be pursued when the likelihood of mutual loss is high. From a democratic point of view, the results show that, although a market for political favor can be democratically distorting, competition within that market can act as a mitigating force in a single-dimensional setting. The true distortion comes from interest group participation in the absence of competition, suggesting that a policy which encourages competitive participation may be as effective as prohibitive policies, in certain contexts.

Additionally, the results of this research have uncovered some suggestive evidence with regard to the complex effects of campaign finance restrictions. It is clear from the data that special interest groups are more influential in those jurisdictions without contribution limits than they are in those jurisdictions with contribution limits. In contrast to current theory and previous indirect empirical findings, the evidence presented here suggests that contribution limits may, in fact, limit the distorting influence of special interests. In light of these findings, a fruitful research agenda may be one aimed at separating the effects of contribution limits from those of other (possibly confounding) jurisdictional characteristics.

On a more general level, the findings of this research further our understanding of the efficacy of political participation. Political engagement can be a profitable venture for interest groups; however, in the face of competition profitability is not a necessary condition for an assumption of rational behavior. The findings also suggest that individual donors can affect policy outcomes, likely through informal interest group networks. While previous studies assume that individual contributors have little impact on government action, the results of the current analysis suggest that such an assumption may be inappropriate. Furthermore, this research strongly supports the investment motive of political participation, and within that context, it supports the theory of service based contributions over the theory of electoral competition.

Chapter 2

Logrolling Over Welfare: The Effects of Vote-Trading on Welfare and Equity

Introduction

A reality of collective decision making mechanisms, such as voting, is that strategic behavior tends to trump sincere behavior in repeated games once players become sophisticated. What this means in the context of a legislative body is that logrolling and vote-trading [1] not only exist, but are increasingly prevalent (see e.g. Stratmann 1995). Scholars have consistently found that vote-trading is commonplace in legislative bodies and is a major determinant of legislative outcomes (see e.g. Crombez 2000, Kau and Rubin 1979, Stratmann 1992). Although the existence and prevalence of vote-trading is well understood, the welfare effects of such behavior are not. The reason for our lack of understanding is an inability to observe the counterfactual, i.e. vote outcomes in the absence of trading. What we can observe

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[1]Although 'logrolling' and 'vote-trading' are often used interchangeably, there are subtle, but important differences. For a detailed explanation of the types and characteristics of logrolling and vote-trading, see Russell 1979

empirically is a vote outcome which results from all voters considering all actual and potential sets of vote-trades, however, without some knowledge of voters' sincere preferences, the welfare effects of vote-trading cannot be identified.

In order to circumvent these empirical roadblocks and to give some insight into the effects of vote-trading, this article develops a method for finding vote-trade equilibria, given the true preferences of voters over a set of bills and applies that method to data on 10,000 sets of simulated voters. The results are then compared to the theories put forth by Buchanan and Tullock (1965) as well as those by Riker and Brams (1973). This article also outlines the voter and bill conditions that affect the magnitude of change in welfare once vote-trading is allowed.

The article proceeds as follows: Section 2 outlines the previous work done on the welfare effects of vote-trading, Section 3 describes the underlying model used, Section 4 describes the results, and Section 5 concludes. For a description of the algorithm used for determining trade-equilibria, see Appendix A.

2.1   Previous Work

The dichotomized intuition of the public choice theorist manifests itself poignantly on the subject of vote-trading. On one hand, the intuition of the inner economist tells us that there exist potential gains from exchange to be captured in the trading of votes, whereas the inner political scientist tells us that such a rudimentary undermining of the democratic process is sure to be destructive. It was this latter view that dominated the field, as well as public perception, up until the early works of James Buchanan and Gordon Tullock (1965).

Buchanan and Tullock's seminal work used a simple example to illustrate the potential gains from exchange in vote-trading. In their example, there exist three districts, each with a single representative. The three representatives are to decide on three issues with varying degrees of salience to each representative. The issues are public works bills, each meant to

benefit only the constituents of a single district, but are to be financed by the collective of districts. Each bill would provide a benefit of $1 to the beneficiary district and impose a cost of $\frac{1}{6}$ on each district. Without vote-trading it is clear that none of the three bills will pass. Each representative will vote in favor of the bill that helps his district, but will be opposed to the other bills on account of the cost to his district without direct benefits; the net social welfare change is $0. If, however, two of the representatives trade votes on two of the issues, those two bills will pass and the third will fail, bringing a net welfare gain of $1.

Inspired by the ideas of Buchanan and Tullock, Mueller et al. (1972) tested the theory of social welfare gains through vote-trading in a primitive simulation environment. Mueller et al. model vote-trading as a commodity market where votes can be bought and sold for some enumerary, and voters are ignorant of preferences of other voters. Mueller et al. go on to find what they believe to be overwhelming evidence supporting the virtues of vote-trading and even allude to the idea that some explicit vote-trading market should be established.

The methodology used by Mueller et al., although advanced for its time, raises some issues, as does the underlying theory. First, modeling vote-trading as a perfectly competitive, blind auction-type market will lead to unrealistic trade equilibria (Weingast and Marshall 1988). Vote-trading is a barter market where side payments are prohibited, supply is limited, and the identity of one's trading partner is of great consequence. Second, the theory of gains from exchange is based on the fact that trades are only entered into when they increase the utility of the parties involved over that of the no-trade scenario. This is not necessarily the case for vote-trading because voters may enter into trades knowing that their utility will decrease from the no-vote scenario in order to block or counter a trade between other voters which would result in even lower utility. The false assumption that trades will only occur in the presence of increased expected utility over the no-trade scenario is likely the driving force behind the findings of Mueller et al (1972).

Furthermore, voters do have some (albeit imperfect) knowledge of the positions of other voters. Such knowledge changes the expected trade outcome. Also, the model of Mueller

et al. (1972) does not allow for the fact that a voter incurs a negative externality by not buying a vote and allowing his opposition to buy the vote. Allowing vote-trading to occur brings their model beyond that of sincere voting, but it does not fully account for the level of sophistication that is thought to exist in legislative bodies.

Riker and Brams (1973) articulate the role of externalities in vote-trading in their criticism of Buchanan and Tullock's theory. Riker and Brams provide a simple example where the Nash trade equilibrium results in a utility loss for all voters, including those who make the trades. The result is essentially an n-dimensional prisoners' dilemma. In their example, three voters participate in a set of three trades. In each given trade, two voters are active participants and one is not, but he experiences a negative external cost as a result of the trade. In all three trades the two active participants realize a gain from exchange, making the action rational. However, the externality experienced by each voter in the one trade to which he was not party completely wipes out the gains from the two trades in which he was an active participant. The net result is a loss in utility for each of the three voters.

There has yet to be an in-depth evaluation of the effects of vote-trading on social welfare in a model that incorporates the critique of Riker and Brams while addressing the methodological issues of Mueller et al. This article presents such an evaluation using a logical, expectations-based trade equilibrium to measure the direction and magnitude of the effects of vote-trading on social welfare and identify the significant distributional factors.

The underlying model of this article takes one key departure from that of Riker and Brams (1973). They assume that vote-trades will only occur between two voters whose switch can change a minority group to a majority group or visa versa. This is a fair assumption if all voters had perfect knowledge of the positions of other voters; however, in reality (and in the model presented below) voters do not necessarily have perfect knowledge. Therefore, a voter can increase the likelihood of a bill passing, and thereby his expected utility,[2] by securing the sure support of any other voter whose vote would otherwise be, to some degree,

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[2]For more on the expected utility approach to logrolling, see Enelow 1986

uncertain. Hence, trade participants need not be pivotal voters in order for a trade to be profitable in expectation. Furthermore, voters need not be on opposing sides of an issue to trade votes; all that must exist is some positive probability that any trade partner would vote in opposition in the absence of trade.

2.2 Model

There exist n voters who vote on a set of m exogenously determined bills. Voters are represented by ideal point parameters in $\mathbf{R}^2$. Each bill is represented by a 'yea' position and a 'nay' position in the same space. Voters are allowed to have elliptical preferences described by the (negative) general form of an ellipse:

$$U_{i,j}^k\left(x_j^k, y_j^k\right) = -\sqrt{\frac{\left(\left(x_j^k - \bar{x}_i\right)\cos\alpha_i + \left(y_j^k - \bar{y}_i\right)\sin\alpha_i\right)^2}{a_i^2} + \frac{\left(\left(x_j^k - \bar{x}_i\right)\sin\alpha_i - \left(y_j^k - \bar{y}_i\right)\cos\alpha_i\right)^2}{b_i^2}}, \qquad (2.1)$$

where $U_{i,j}^k$ is voter i's utility from bill j with position $\left(x_j^k, y_j^k\right)$ for $k = [yea, nay]$. The parameters (a_i, b_i), α_i, and $(\bar{x}_i, \bar{y}_i)$ are the elliptical radii, the angle of rotation, and the centroid (or the ideal point) of voter i's indifference curves respectively. Let $U_{i,j}^{yea} = U_i\left(x_j^{yea}, y_j^{yea}\right)$ be voter i's utility from bill j passing and $U_{i,j}^{nay} = U_i\left(x_j^{nay}, y_j^{nay}\right)$ be voter i's utility from bill j failing. Then $U_{i,j} = U_{i,j}^{yea} - U_{i,j}^{nay}$ is the net utility gain of voter i from bill j passing. Absent vote-trading, voter i will vote in accordance with the sign of $U_{i,j}$. Elliptical utility functions allow for a more generalized description of preferences then strict Euclidean preferences would, by allowing each voter to have a set of unique weightings on the dimensions. Note that Euclidean preferences are a special case of elliptical preferences where the preferences are equally weighted in each dimension.

The bills in this model, although measured on the same scale, are independent and separable, making the utilities gained by the individual bills additive, similar to the model presented by Koford (1982). For example, assume the two dimensions of the preference space represent a fiscal spectrum and a social spectrum, respectively. Further assume that

two separate bills are being considered, the first of which (bill A) has large fiscal implications, but few social implications (e.g. steel tariffs). Conversely, bill B has large social implications but few fiscal implications (e.g. late-term abortion). It is likely that the utility gained by a voter from bill A will not affect the utility gained by that voter from bill B, but since the utility from each bill is derived though its social and fiscal impact, it is appropriate to measure them on the same scale. Then if, for example, both bill A and bill B pass, a voter's total utility is represented by the (negative) elliptical distance from his ideal point to bill A's yea position plus the (negative) elliptical distance to bill B's yea position. While one can think of situations in which bills are dependent and non-separable, for simplicity, this model is restricted to exogenously proposed bills which are independent and separable.

An improvement of this model over past models is the allowance for varying degrees of knowledge of voters' preferences. Voter i may have some (possibly perfect) knowledge of the location of his fellow voters' ideal points and preferences, whereas previous models have assumed either no knowledge or perfect knowledge. Voter i's beliefs about voter j's $(j \neq i)$ utility function parameters $[\bar{x}, \bar{y}, a, b, \alpha]$ follows a normal distribution $N(\mu, \sigma^2)$ where μ is voter j's true parameter value and σ^2 may range from 0 to ∞. For $\sigma_{\bar{x}}^2 = \sigma_{\bar{y}}^2 = \sigma_a^2 = \sigma_b^2 = \sigma_\alpha^2 = 0$ voter i can perfectly predict voter j's $(j \neq i)$ votes on every bill. For $\sigma_{\bar{x}}^2 = \sigma_{\bar{y}}^2 = \sigma_a^2 = \sigma_b^2 = \sigma_\alpha^2 = \infty$ voter i has no predictive power.

Since each voter knows his own preferences but not necessarily the preferences of the other voters, each voter may have a unique set of subjective beliefs about the probability of each bill passing. Voters are assumed to maximize their expected utility given their subjective beliefs about the likely behavior of all other voters.

Voters may trade votes with one another, but no side payments are permitted. Vote-trades are determined by first examining the change in utility from all possible trades over the default utility. In the beginning stage, the default utility is that of the no-trade outcome. Any trade that does not increase the utility of at least two voters is eliminated. The remaining possible trades are then the starting nodes. For each starting node, taking that trade as

given and the resulting utility as the default, all possible secondary (counter) trades are enumerated. Those secondary trades that do not increase the utility of at least two voters (excluding those involved in the first trade) are eliminated. If no such secondary trades exist for a given node, then the trade outcome resulting from that node is recorded as just the first trade with no counter trade. If only one possible secondary trade from a given node exists, the utility resulting from the first and second trades is recorded as the default utility and the voters are allowed to re-optimize based on the new default utility. If no player is able to improve his utility through a counter trade, then the first and second trade are recorded as the trade outcome for that node. This process continues with subsequent trades until no voter is able to counter and improve his utility. Furthermore, all of the trades that occur in a particular outcome are the best response to the other trades in that outcome. To be clear, an 'outcome' may be several coalitions working in opposition, a single coalition working in opposition to the remaining non-aligned voters, or no coalition (which would be the no-trade outcome). Some outcomes may be dominated by other outcomes if there is a majority coalition that exists in both outcomes, and every member of that coalition receives a lower utility from the dominated outcome. Furthermore, some starting nodes may produce the same outcome. Let {C} be the set of unique, un-dominated outcomes. This set of unique, un-dominated outcomes is similar to Xue's (1998) concept of the Largest Consistent Set, and, in practice, can be relatively small. Also similar to Xue's concepts is this model's ability to achieve farsightedness through continued re-optimization.[3]

The set {C} typically contains more than one possible outcome (in practice, two or three is normal), so it becomes necessary to choose the most likely of the possible outcomes. Such a task requires two assumptions, the first of which is that if a coalition is formed, the voters not in that coalition will react according to the best response determined in the previous phase. For example, say outcome 1 is that voters 1, 2, and 3 form a coalition to vote [yea, yea, yea, yea] on bills A though D, and voters 4, 5, 6, and 7 form a counter coalition to vote

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[3]For more on logrolling models and equilibria stability, see Bernholz 1978, Bernholz 1976, Carruba and Volden 2000, Casella, Llorente-Saguer, and Palfrey 2010, Tullock 1970, Miller 1977, and Wilson 1969

[nay, nay, nay, nay] on bills A through D; then given the formation of either of these two coalitions, the other will naturally form to make outcome 1 the realized outcome.

The second assumption is that the likelihood of any given coalition to form is proportional to the bargaining power of the members of that coalition, and the bargaining power of a coalition member is proportional to the relative utility derived from that coalition's associated outcome. Since all coalitions within an outcome are best responses to the other coalitions within that outcome, to determine the most likely outcome, it is only necessary to determine the most likely coalition to form; the voters not in that coalition will act in accordance with their best response to form the outcome that contains the most likely coalition. To find the most likely coalition to form, let Q be the set of all coalitions across all outcomes in $\{C\}$. For example, if there were three outcomes in $\{C\}$, and outcome 1 had two coalitions, outcome 2 had one coalition, and outcome 3 had three coalitions, then Q would be the set of all six of those coalitions.

The bargaining power of voter i to form coalition q is proportional to $\hat{\delta}_q^i = \frac{\delta_q^i}{\sum\limits_{q \in \gamma} \delta_q^i}$, where δ_q^i is the utility of voter i from C_q (the outcome containing coalition q) net of the default utility, and γ is the set of all q's for which voter i is a member. If i is not a member of coalition q, then $\hat{\delta}_q^i$ does not exist, and if voter i realizes a reduction in utility by joining coalition q from his default utility, $\hat{\delta}_q^i = 0$. The value of $\hat{\delta}_q^i$ represents voter i's relative desire for C_q versus C_h $\forall\ h \neq q$. The coalition which is most likely to form (q^*) is the q that maximizes $\prod_\lambda \hat{\delta}_q^\lambda$ where λ is the set of i who are members of coalition q. The outcome is then the set of coalitions C^* that contains q^*. The outcome C^* is not meant to be the deterministic outcome, only the most likely of the possible outcomes given the assumptions of the model.

Maximizing $\prod_\lambda \hat{\delta}_q^\lambda$ has several desirable properties over other possible specifications. First, if a member of a coalition receives zero or a negative change in utility from joining that coalition, it is very unlikely that such a coalition will form. Since $\hat{\delta}_q^i = 0$ for coalition members in such a situation, $\prod_\lambda \hat{\delta}_q^\lambda$ is also zero, eliminating q from contention. Second, if the formation of coalition q would greatly benefit one member, but do little for the other

coalition members, such a coalition would be unlikely to form in reality. By maximizing $\prod_\lambda \hat{\delta}_q^\lambda$, q would not be in contention for the most likely coalition to form, whereas under other specifications, (e.g. $\max_q \sum_\lambda \hat{\delta}_q^\lambda$) q would likely be chosen.

2.3   Results

2.3.1   Environment

For this article 10,000 sets of ideal points and bill locations were used. Each set included seven voters who made decisions on four bills. The preferences of the voters were elliptical as described in Section 2.2.

The ideal point and bill location parameters, $(x_0^i, y_0^i, x_l^j, y_l^j)$, are independently drawn from the uniform distribution $U(-1,1)$. The elliptical radii parameters, (a^i, b^i), are drawn independently from $U(0,2)$, and the ellipse rotational angle, (α^i), is drawn independently from $U(0,360)$.

In the absence of vote-trading, voter i will vote in favor of bill j if and only if $U_{ij}^{yea} \geq U_{ij}^{nay}$. This rule is used to determine the no-trade roll call, which is then summed to determine the outcome of the four bills. The bill pass/fail results are then put into Equation 2.1 in order to determine the 7 x 4 utility matrix for the seven voters over the four bills. The matrix is summed horizontally to derive each voter's total utility for the round and then summed vertically to derive total welfare for the round.

2.3.2   The 'merits' of vote-trading

In the examination of the effects of vote-trading, there are several parameters of interest, the first being the effect on total welfare. This is measured by summing the welfare without vote-trading in each round, as described above, and then subtracting the welfare of the vote-trade equilibrium. Call this parameter ω.

Table 2.1: Changes in welfare

	μ	s	Sample Size	Probability of Significance
ω	3.83	1.12	10,000	.9997
ζ	-7,736	3445	10,000	.9876
τ	-0.3187	.0074	10,000	~1

Table 2.2: Changes in welfare (trimmed data)

	μ	s	Sample Size	Probability of Significance
ω	.469	.0026	9,000	~1
ζ	-2.74	.301	9,000	~1
τ	-0.4093	.0043	9,000	~1

The second parameter of interest is the change in variance per round between the trade and no-trade situations. This is found by calculating the total welfare of each of the seven voters in each round by summing over the four bills and then deriving the variance between the seven voters. This is done for both the trade and no-trade situation, and the difference is ζ, which is a measure of how equitable the distribution of welfare is per round. We tend to find lower variance of welfare distributions desirable, at least normatively.

The third parameter of interest is τ, which represents the number of voters whose welfare increases by allowing vote-trading, less the number of voters whose welfare decreases by allowing vote-trading. Presumably, a positive τ would lend some merit to vote-trading.

The results for the three parameters of interest using the entire data set are listed in Table 2.1. The methodology used in this article allows for occasional extreme outcomes which influence the magnitude and variance of the parameters, but not the sign. Table 2.2 shows the parameter values using data which has been trimmed at 5% above and below, as to more clearly illustrate the stereotypical behavior of the data.

To give the values in Table 2.1 and Table 2.2 context, the average utility per voter per bill without vote-trading was -13.029 and and the average utility per voter, per bill with trading was -16.86. Hence, voters realized a roughly 30% reduction in the average utility per bill per voter once trading was permitted.

The significant positive value found for ω suggests that on average, social welfare under the vote-trade equilibrium is less than that under the no-trade outcome. Similarly, the significant negative value found for ζ indicates that the variance of utility between voters in any given set is higher under the vote-trade equilibrium than the no-trade equilibrium, leading us to believe that vote-trading results in a less equitable distribution of utility. Finally, the significant negative value found for τ suggests that more voters are harmed by vote-trading than are helped.

Under the three general tenets of social desirability tested here, vote-trading has yet to prove meritorious. In fact, by all measures, vote-trading seems to explicitly harm social welfare. These findings seem to support Riker and Brams' n-dimensional prisoners' dilemma theory while raising questions about the theories put forth by Buchanan and Tullock and the test results presented by Mueller et al.

It seems clear from the simulation data that allowing vote-trading typically results in decreased welfare. The next subsection explores the factors that can mitigate or exacerbate the negative effects of such practices.

2.3.3 Compounding and mitigating factors

A number of characteristics of voter preferences and bill locations were examined to determine their effects on the changes between the vote-trade and no-trade welfare levels. Four were found to be significant.

The first significant variable is the eccentricity of voters' elliptical indifference curves. Voters with more eccentric curves tend to have unidimensional preferences, while voters with more circular curves tend to give equal weighting to issues in all dimensions. Eccentric indifference curves tend to facilitate trade between voters more than circular curves. The eccentricity of voter i's preferences is measured using the standard definition: $\frac{\sqrt{[\max(a^i, b^i)]^2 - [\min(a^i, b^i)]^2}}{\max(a^i, b^i)}$ where a^i and b^i are the elliptical radii described in Section 2.2.

The second significant variable is the uncertainty of one voter about the positions of the other voters. This variable was randomly chosen and fed into the simulation algorithm. Uncertainty ranges from 0, for perfect knowledge, to infinity, for no knowledge. The level of uncertainty affects a voter's subjective assessment of his expected utility and can lead to lesser or greater willingness to trade depending on his position relative to his perception of the position of the majority.

The third significant variable is a cluster coefficient that measures how well the set of voters fits into two groups. The cluster coefficient is derived in a manner similar to the k-means method of cluster analysis (Hartigan and Wong 1979): first, all 126 possible combinations of two clusters are enumerated. Then, for each of the two clusters in each of the 126 sets, the point which minimizes the elliptical distance between itself and each voter in the cluster is found. Then the distance from each voter to the centroid of his cluster is summed for each set; let this sum be γ_k for all $k \in (1, 2, ..., 126)$. Then let $\hat{\gamma} = \min(\gamma_1, \gamma_2, ..., \gamma_3)$. The set of clusters corresponding to $\hat{\gamma}$ best describes the clustering behavior of the voters, given two clusters. The cluster coefficient is then $\hat{\gamma}$. Lower cluster coefficients signify the existence of groups with congruent preferences, e.g. party alignment. Low cluster coefficients combined with low uncertainty leads to fewer trades.

The fourth significant variable is the extremity of bill proposals. This variable measures the Euclidian distance between a bill proposal and its corresponding status quo position. Though bill proposals are chosen by an exogenous random process in this simulation, examining the effects of extreme bill proposals can lend some insight into the effects of agenda manipulations on welfare. Extreme bill proposals tend to decrease the frequency of trades.

The four variables described above were regressed on the welfare difference between the no-trade outcome and the vote-trade outcome for each of the 10,000 rounds. The coefficient estimates are listed in Table 2.4. Exclusion tests were run on all variables using the likelihood ratio test. All of the included variables were found to be jointly significant with a probability greater than .9.

Table 2.3: Descriptive statistics

	μ	σ	Min	Max
$Welfare_{notrade} - Welfare_{vote-trade}$	3.8	112.6	-2045.1	4994.6
$Eccentricity$	0.785	0.083	0.392	0.979
$Uncertainty$	0.500	0.289	0	1
$Cluster\ Coefficient$	6.87	2.60	1.44	30.28
$Bill\ Extremity$	1.043	0.248	0.186	1.920

Table 2.4: Compounding and mitigating factors

	$\hat{\beta}$	Standard Error	Probability of Significance
Intercept	-3.38	2.58	0.9049
Eccentricity	8.76	6.23	0.922
Uncertainty	8.82	8.10	0.86
Cluster Coefficient	0.332	0.225	0.9035
Bill Extremity	-8.82	4.63	0.9716

As can be seen in Table 2.4, the coefficient on 'Eccentricity' is positive and of a moderate relative magnitude. Therefore, an increase in the single-mindedness of voters tends to increase the gap between the no-trade and vote-trade outcomes, increasing the damage done to total welfare by the trading of votes. This suggests that voters with more diverse interests or representatives with broader platforms tend to be better for overall welfare.

Similarly, the positive coefficient on 'Uncertainty' suggests that voters who are better informed about the positions of their fellow voters will cause less damage. This is congruent with the idea put forth by Riker and Brams, that in an environment where voters have perfect knowledge of the preferences of other voters, only voters who are pivotal on a given set of bills will be able to exchange votes. We would expect fewer vote-trades to mitigate the aggregate damage done by trading.

The positive coefficient on the cluster coefficient suggests that the formation of groups with similar preferences decreases the damage done by vote-trading (keeping in mind that a lower cluster coefficient represents a higher degree of clustering). This suggests that the formation of disciplined political parties when coupled with the ability to trade votes decreases social welfare.

The negative coefficient on 'Bill Extremity' suggests that more extreme bill proposals tend to mitigate the potential damage done by allowing vote-trading. This is because extreme bill proposals tend to have 'yea' or 'nay' positions that exist outside of the convex hull of voters' ideal points, which causes unanimous support on one side or the other, and unanimity disallows vote-trading.

2.4 Conclusion

This article has developed an algorithm for determining a vote-trade equilibrium in an effort to examine two competing theories of the effects of vote-trading on welfare. The first of those two theories, initially brought to light by Buchanan and Tullock, suggests a sort of gains from exchange takes place in the presence of vote-trading. In contradiction to Buchanan and Tullock (1965), Riker and Brams (1973) theorize that vote-trading can lead to an n-dimensional prisoners' dilemma.

Riker and Brams' general critique of Buchanan and Tullock (1965) is that vote-trades do not take place in a vacuum. One trade (or potential trade) will lead to a counter-trade by other voters, which may lead to a counter-counter-trade, and so on. Furthermore, the effect of any given trade is not limited to the participants of that trade; there are externalities on all other voters who have an interest in the issues being traded.

The results from this article support the ideas of Riker and Brams (1973) over those of Buchanan and Tullock (1965). It is true that a single vote-trade would likely lead to an increase in welfare; however, once all of the reactions to that trade are accounted for, and all of the resulting externalities are tabulated, welfare, on average, decreases. Vote-trading also results in a less equitable distribution of utility. Furthermore, on average, more voters are harmed by the results of vote-trading than are helped.

This article also identified several voter and bill conditions that significantly affect the amount of damage done by vote-trading. Voters with highly eccentric indifference curves

(unidimensional preferences) tend to exacerbate the loss in welfare that results from vote-trading. The same is true with the level of uncertainty of voters with regard to the preferences of their fellow voters and the level of voters clustering (e.g. into political parties).

The intuition of the findings in this article is first that legislators are often in a situation that requires them to actively seek a utility-reducing outcome in order to avoid a potentially larger reduction in utility through the collusion of other voters. Similar to the criminal in the prisoner's dilemma, a voter must often accept a loss in order to avoid a larger loss. The second bit of intuition is that voter single-mindedness tends to facilitate these prisoner's-dilemma-like situations. When a voter's preferences are skewed heavily in one dimension, they are willing to give rather large concessions in the other dimensions to achieve relatively small changes in the dimension of their primary interest. Such concessions can lead to extreme outcomes which only benefit a small number of voters and reduce total welfare.

Chapter 3

Joint Estimation of Ideal Points and Proposal Locations in Spatial Voting

Introduction

This article develops a method for simulating the joint-distribution of ideal points and proposal locations in spatial voting models. While there are other methods for estimating spatial voting models, all either produce invalid variance-covariance estimates or are limited to only estimating ideal points. The estimation methods presented here were developed out of a necessity to draw from the joint distribution of ideal points and proposal locations.

In spatial voting games there are several solution concepts that have theoretical weight, however, they have been subjected to little, if any, empirical testing. The reason is that closed-form solutions to such concepts have yet to be found, causing their properties to remain a mystery. An important advancement on this front came from Bianco, Jeliazkov, and Sened (2004), who developed a brute-force, computationally-intensive method for examining the uncovered set. The limitation of this method, however, is that it treats the ideal points of voters as fixed, when in fact, they are stochastic. Bianco, Jeliazkov, and Sened (2004)

show that the uncovered set is not robust to small changes in the location of ideal points, making the fixed treatment of ideal points problematic in the face of estimation error.

Advancements in computational power and techniques have allowed for the development of estimation methods which treat ideal points and proposal locations as stochastic. However, to employ these methods one must first have access to the joint-distribution of ideal points and proposal locations, not just the estimated values. The intent of this article is to develop such a method and test its validity.

This article adds to the existing spatial voting model research in two significant ways. First, it provides a straightforward method for simulating the joint distribution of ideal points and proposal locations. As mentioned above, this is a necessary first step towards the proper examination of spatial voting solutions. Second, the estimation methods developed here eliminate the need for the restrictive assumption of quadratic utility imposed by previous models. One of the main arguments in favor of quadratic utility has been that almost any other functional form of utility would be computationally intractable in spatial voting models. With this advancement, the researcher will be able to choose the functional form of utility on more scientific criteria. Section 3.4 discusses a new metric for comparing utility function appropriateness.

There is a great deal of literature pertaining to the estimation of voter ideal points in the spatial voting model. However, there is less literature pertaining to the estimation of proposal locations. In fact, many researchers view the proposal locations as nuisance parameters to be eliminated (e.g. see Lewis 2001). As mentioned earlier, there is no literature pertaining to the properties of the joint distribution of ideal points and proposal locations. On a side note, there is large amount of literature regarding the somewhat sensitive subject of spatial model dimensionality. Such arguments are not addressed in this article; the model presented here can be abstracted to any arbitrary dimensionality (although not without computational cost). The model is presented in $\boldsymbol{R}^2$ for simplicity and leave it to the individual researcher to make the case for their dimension of choice.

3.1 Previous Work

The most utilized methods for estimating ideal points and proposal locations are NOMI-NATE and all of its derivatives, developed by Poole and Rosenthal (1985). Descriptions of these methods are easily accessible as are the estimates themselves (e.g. see Poole and Rosenthal 1997). There is widespread criticism of NOMINATE because the distributional properties of the estimates produced by this method are altogether unknown. The reason behind the mystery is the block matrix inversion method (used out of computational necessity) has unknowable and possibly misleading effects on the variance-covariance of the estimates. There is, however, no evidence that the ideal point and proposal location parameter estimates produced by NOMINATE are themselves invalid; on the contrary, NOMINATE is considered to be a useful tool in spatial voting theory. Therefore, the pragmatic researcher not interested in the distributional properties of ideal points and proposal locations should consider using the NOMINATE estimates, which are readily available on Poole and Rosenthals Vote-View website.

The largest competitor to the NOMINATE method is the factor analytical methods developed by Heckman and Snyder. While this method has some attractive features, it too prohibits the researcher from observing the distributional qualities of ideal points and proposal locations.

Clinton, Jackman, and Rivers (CJR) were the first to really address the issue of observing the distributional qualities of ideal points by employing a Markov chain Monte Carlo (MCMC) algorithm to sample from the posterior joint distribution, as outlined in their 2004 article (CJR 2004). CJR also address the issues of identification. In their model, however, they make no explicit attempt to estimate the proposal locations. Their model also focuses on, and is somewhat limited to, the special case of quadratic utility. The methods presented in this article are most similar to those of CJR.

An important advancement in ideal point estimation came from Andrew Martin and Kevin Quinn (2002). They showed that in the case of U.S. Supreme Court justices, ideal

point estimates tend to be time-variant over a justice's tenure. Although the tenure of other voting officials tends to be shorter on average than that of supreme court justices, it is likely that ideal points of legislators also shift over time. The model presented in this article does not address the possibility of shifting ideal points. The model could be adapted to incorporate such complications, but for simplicity, analysis will be restricted to the base-line static model.

Another important argument regarding the estimation of SVM parameters is put forth by Clinton and Meirowitz (2001). They argue that voting outcomes are path-dependent, and as such, the parameters of the SVM should be constrained by the agenda of the voting body, i.e. the time path of voting. Specifically, they contend that the nay position, or the status-quo, of a piece of legislation should be the yea position of the most recent successful piece of legislation. While Clinton and Meirowitz make a compelling argument and subsequent research will incorporate a mechanism to handle the sequential nature of legislative voting, the model presented here will not. The reason is twofold. First, in order to study the SMV solution concepts such as the uncovered set on a basic level, it is necessary to have a simple, baseline model of the parameters. Later research will study how the uncovered set holds up under sequential voting. The second reason for not incorporating sequential voting is that the method presented by Clinton and Meriwitz (2001) is very sensitive to errors in the choice of dimensionality of the model. As Clinton and Meriwitz point out, dimensionality is often misspecified.

3.2 Model

The basic model presented in this section is similar to model presented by CJR (2004) with two key differences: utility is not assumed to be quadratic and the identification method allows for direct estimation of the proposal location parameters. Though the dimensionality of the model is only limited by the number of proposals voted on and one's computing

capabilities, the model is presented in two dimensions for both illustrative and pragmatic reasons.

In a given legislative body, there are n voters $i = 1, 2, \ldots, n$ who have voted yea, nay or abstained on m proposals $j = 1, 2, \ldots, m$. Votes occur simultaneously. Voters and proposals are located in $\boldsymbol{R}^2$. It is instructive (but not necessary) to think of the dimensions as social ideals and economic ideals, ranging from liberal to conservative where left and right represent economically liberal and conservative, respectively, and up and down represent socially liberal and conservative, respectively. The location of any given voter in this political space is his ideal point. The proposals have two locations: one representing the political ramifications of a yea vote and another for the nay vote.

A voter's utility from a yea or nay vote is some function of the relative location of his ideal point and the position of the yea or nay proposal parameters. The voter votes as to maximize utility. A logical choice for the functional form of utility is $U_i = A_i - \|X_i - B_j^k\|$ where, A_i is some constant representing the $i'th$ voter's maximum utility, X_i is the $i'th$ voter's ideal point, B_j^k is the proposal location for $k = yea$ or nay, and $\| * \|$ is the Euclidean norm. For simplicity, this Euclidean distance utility is used in the presentation of the model, but any functional form of utility can easily be substituted into the algorithm, which will allow the researcher to fit the best model, rather than the model whose calculations are the most tractable.

When deciding his vote, voter i considers the difference in utility gained from a nay vote and the utility gained from a yea vote on proposal j. He then makes the utility maximizing decision. In the case of the Euclidean preferences described above, this amounts to subtracting the distance between X_i and B_j^{yea} form the distance between X_i and B_j^{nay}. This measure is referred to as the utility differential, or simply Y_{ij}^*.

In this model, unlike many others, the possibility of abstentions is allowed. Because voters abstain from a large number of votes, such an allowance is necessary if one intends

on doing empirical work. Below, the model is put into more formal terms using Euclidean preferences as the functional form of utility.

$$Y_{ij}^* = \sqrt{(X_{i1} - B_{j1}^{nay})^2 + (X_{i2} - B_{j2}^{nay})^2} - \sqrt{(X_{i1} - B_{j1}^{yea})^2 + (X_{i2} - B_{j2}^{yea})^2} + e_{ij},$$

$$Y_{ij} = \begin{cases} 1 & if \quad Y_{ij}^* > 0 \\ 0 & if \quad Y_{ij}^* = 0 \quad \text{or is missing} \\ -1 & if \quad Y_{ij}^* < 0 \end{cases},$$

where,

$$e_{ij} \sim N(0, \sigma^2),$$

$$\begin{pmatrix} x_{i1} \\ x_{i2} \end{pmatrix} = \text{The ideal point of the } i'th \text{ Congressman in } \boldsymbol{R}^2,$$

$$\begin{pmatrix} B_{j1}^{yea} \\ B_{j2}^{yea} \end{pmatrix} = \text{The location of a yea vote on the } j'th \text{ proposed proposal in } \boldsymbol{R}^2,$$

$$\begin{pmatrix} B_{j1}^{nay} \\ B_{j2}^{nay} \end{pmatrix} = \text{The location of a nay vote on the } j'th \text{ proposed proposal in } \boldsymbol{R}^2,$$

$$Y_{ij} = \begin{cases} 1 & \text{if voter } i \text{ votes yea on proposal } j \\ 0 & \text{if voter } i \text{ abstains on proposal } j \\ -1 & \text{if voter } i \text{ votes nay on proposal } j \end{cases}.$$

3.3 Estimation and Identification

3.3.1 Identification

It is well known that SVMs are only identified up to an arbitrary scaling and location. The parameters of the model are only meaningful when compared to all of the other parameters.

It is, therefore, necessary to take information from outside of the model in order to establish a basis for comparison. Because of its logical and pragmatic value, an identification method similar to that proposed by CJR (2004) is adopted. First, the variance of the latent variables Y_{ij}^* are restricted to equal one. Second, three voters whose preferences are known to be extreme and three proposal yea positions are fixed. Third, all of nay proposal positions are fixed at zero.

3.3.2 Priors

$X_i \sim N_2(\nu_i, V_i)$

$B_j^{yea} \sim N_2(\tau_j, T_j)$

$B_j^{nay} \sim N_2(0, \epsilon)$

where,

$\nu_i = 0$ and $V_i = I_2 * \lambda$ for all nonfixed Congressmen,

$\nu_i = x_i$ and $V_i = I_2 * \epsilon$ for all fixed Congressmen,

x_i is the point at which the fixed voter i will be fixed,

$\tau_j = 0$ and $T_j = I_2 * \lambda$ for all nonfixed proposals,

$\tau_j = b_j$ and $T_j = I_2 * \epsilon$ for all fixed proposals,

b_j is the point at which the fixed voter j will be fixed.

For any $\lambda > 1$ the effect of the priors on the estimators is negligible. For any $\lambda > 4$ the effect of the priors is immeasurably small. For all tests and evaluations in this article a $\lambda = 25$ is used. The value of λ is set as to make the priors sufficiently vague for diagnostic

purposes. The values of the fixed points are arbitrarily set as follows:

$$x_1 = (-1, -1) \quad b_1 = (0, 1)$$

$$x_2 = (1, 1) \qquad b_2 = (-1, 0)$$

$$x_3 = (-1, 1) \qquad b_3 = (1, .5)$$

Although fixed points may, for the most part, be set arbitrarily, there are some restrictions and some choices that are better than others. As a general rule, every fixed x_i should be closer to those fixed proposals on which he voted yea than those on which he voted nay, i.e. you should fix voters so there is no violation of proximity. When choosing fixed points within the constraints laid out above, a good rule of thumb is to choose voters and proposals that are in some way extreme. For example, a proposal outlawing abortion would be an extreme proposal along the social issues dimension. A proposal abolishing the Internal Revenue Service would be an extreme proposal along the fiscal issues dimension. Common choices for extreme voters in past studies have been Jesse Helms and Ted Kennedy (CJR 2004)

3.3.3 Estimation

Step 1: Sample Y^*

Draw Y_{ij}^{*t} from:

$$
Y_{ij} = \begin{cases} N_{(-\infty,0)}(\mu_{ij}^{t-1}, \sigma^2) & if \quad Y_{ij}^* > 0 \\ N_{(-\infty,\infty)}(\mu_{ij}^{t-1}, \sigma^2) & if \quad Y_{ij}^* = 0 \\ N_{(0,\infty)}(\mu_{ij}^{t-1}, \sigma^2) & if \quad Y_{ij}^* < 0 \end{cases},
$$

where,

$$
\mu_{ij}^{t-1} = \sqrt{((X_{i1})^{t-1} - (B_{j1}^{nay})^{t-1})^2 + ((X_{i2})^{t-1} - (B_{j2}^{nay})^{t-1})^2}
$$

$$
-\sqrt{((X_{i1})^{t-1} - (B_{j1}^{yea})^{t-1})^2 + ((X_{i2})^{t-1} - (B_{j2}^{yea})^{t-1})^2}.
$$

Step 2: Sample B

For $j = 1$ to m,

Use Metropolis-Hastings to sample from $f(B_j^{nay^t}, B_j^{yea^t}|X^{t-1}, Y_j^{*t})$,

where,

the proposals follow a random walk $b^t = B^{t-1} + N_2(0, I_2 * \sigma)$, and σ (the step size) is

adjusted to optimize mixing and achieve a desirable acceptance rate,

$\mathcal{L}_j = \prod_{i=1}^{n} \left(\frac{1}{\sqrt{2\pi}}\right) e^{-\frac{(Y_{ij}^* - \mu_{ij})^2}{2}}$,

X is the vector of all ideal points $\forall i \in (1, 2, \ldots, n)$,

Y_j^* is the $j'th$ column of Y^*.

Note that through the use of spike priors on the nay positions, $B_j^{nay^t}$ will be zero $\forall j \in (1, 2, \ldots, m)$.

Step 3: Sample X

For $i = 1$ to n,

Use Metropolis-Hastings to sample from $f(X_i^t | B_j^{nay^t}, B_j^{yea^t}, Y_i^{*t})$

where,

the proposals follow a random walk $x^t = X^{t-1} + N_2(0, I_2 * \sigma)$, and σ (the step size) is

adjusted to optimize mixing and achieve a desirable acceptance rate,

$\mathcal{L}_i = \prod_{j=1}^m \left(\frac{1}{\sqrt{2\pi}} \right) e^{-\frac{(Y_{ij}^* - \mu_{ij})^2}{2}}$,

B^{nay} is the vector of all nay proposal positions $\forall\ j \in (1, 2, \ldots, m)$,

B^{yea} is the vector of all yea proposal positions $\forall\ j \in (1, 2, \ldots, m)$,

Y_j^* is the $j'th$ column of Y^*.

3.3.4 Consistency and bias

The estimators resulting from this method are consistent, but, to a small degree, biased. When ideal points are estimated using known proposal location parameters, the ideal point estimates tend to be further from the origin than their corresponding true values. The bias is increasing with the distance of the true value from the origin. When proposal location parameters are estimated using known ideal points, the resulting estimates will be biased towards the origin. The magnitude of this bias is also positively correlated to the proximity of the true value to the origin. When ideal points and proposal locations are estimated simultaneously, the outward bias from the ideal points is the dominant force. Not only do ideal points cause an outward bias in their own estimates, but they also pull the proposal location estimates outward. This bias is further discussed in Section 3.4 where it is shown to be a decreasing function of sample size. Moreover, the bias is essentially a scaling of the model, and is, therefore, of of little consequence.

3.4   Testing and Results

There are two metrics by which the estimation method presented in the previous section is measured: comparison of the estimated parameters to their "true" values and evaluation of the predictive power of the estimated parameters. The first is conceptually desirable, but will give misleading results unless some very specific conditions are met. The second has a desirable pragmatic essence and is not contingent on the first. In the sections that follow, each metric will be further explained, and the virtues of this new estimation method will be examined.

3.4.1   Test data

The benchmark test data used for the majority of testing is as follows. One hundred ideal points are generated from $N_2(0, \Sigma)$ where $\Sigma = I * 0.35$. The value of Σ is a construct of convenience, loosely constricting the ideal points to the double unit square. The results presented below are not sensitive to changes in Σ. The first three ideal points are then fixed such that $X^a = \begin{pmatrix} -1 \\ -1 \end{pmatrix}$, $X^b = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$, and $X^c = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$.

One hundred proposal yea points are constructed in the same manner as the ideal points. The first three proposal yea positions are fixed such that $B^a = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$, $B^b = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$, and $B^c = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$. One hundred proposal nay points are set to the origin.

From the proposals and ideal points, a 100 x 100 array, Y^*, is created such that

$$Y_{ij}^* = \sqrt{((X_{i1} - B_{j1}^{nay})^2 + (X_{i2} - B_{j2}^{nay})^2)} - \sqrt{((X_{i1} - B_{j1}^{yea})^2 + (X_{i2} - B_{j2}^{yea})^2)} + e_{ij}.$$

For benchmark tests, $e_{ij} = 0$, $\forall\ i, j \in (1, 2, \ldots, 100)$. Finally $Y = sign(Y^*)$ where Y is the roll call data with -1 indicating a nay vote, 1 indicating a yea vote, and 0 indicating an abstention. Robustness checks showing the minimal effect of changes in the data construction on the predictive qualities of the estimates are presented in Section 3.4.5.
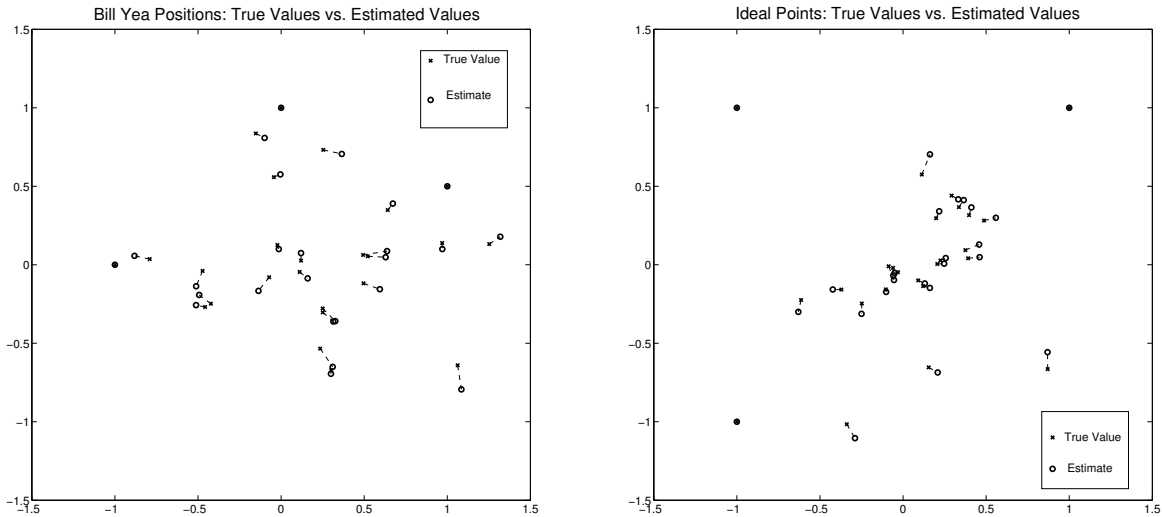
Figure 3.1: Estimated proposal locations and ideal points vs. their respective "true" values

3.4.2 Comparing estimates to "true" values

It should be mentioned that true values only exist when data has been generated. In reality, this model is meant to measure the proportional proximity of parameters; therefore, it is invariant to scale and location, which makes the concept of a "true" value vague, at best. Since the test roll call data has been generated from specific values, it is useful to evaluate the recoverability of those values to lend validity to the estimation method. In order to recover these true values, the fixed ideal points and proposal locations must be fixed to their respective true values. Once that is done, the true values for all non-fixed parameters are recovered surprisingly well. Accuracy in proposal location estimation increases with the number of ideal points, and accuracy in ideal point estimation increases with the number of proposal locations.

Figure 3.1 (a) and (b) show the estimation results of proposals and ideal points respectively. One hundred proposals and ideal points were used for the estimation; however, only the first 25 of each are included to avoid clutter. Although the proposals and ideal points are estimated in the same space, as per the goal of this estimation method, they are shown

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separately for clarity. Estimated values tend to be further from the origin than the true values. This bias decreases as the number of proposals and the number of voters increase.

For the estimation illustrated in Figure 3.1, 5,000 iterations of the main sampler with 10,000 iterations of each Metropolis-Hastings step were ran with starting points equal to the true values. The first 500 iterations of the main sampler and 1,000 iterations of the Metropolis-Hastings steps were discarded. Robustness checks of the starting positions are presented in Section 3.4.5.

3.4.3 Convergence and mixing

When estimating the parameters of this model, the quality of mixing is not the same across all parameters. Most converge after 50 iterations of the main sampler and have a relatively tight range. However, a few take as long as 250 iterations to converge and exhibit a wider range. The differences are driven by the quality of information on a given parameter.

Ideal point parameters that mix well tend to have at least 10 yea and 10 nay votes. Voters with, say, many yea votes, but only one or two nay votes have a more blunted marginal density, causing greater error. The same is true for proposals that have a near unanimous vote. So long as there is at least one contrasting vote, ideal points and proposal locations are identified under this model; however, accuracy decreases for low contrast votes or voters with extreme preferences.

Figure 3.2 shows the mixing of several parameters. Plots (a) and (b) are two proposal location parameters and (c) and (d) are two ideal point parameters. Plots (a) and (c) are representative of the typical mixing, while (b) and (d) show the extreme conditions that result in poorer mixing. All parameters that meet the condition of at least one contrast point eventually converge; however the time until convergence is a function of how contrasting the data points are.

As mentioned in Section 3.3.4 and as seen in Section 3.4.2, the estimates produced by this model are biased, but consistent. The bias tends to be relatively small and is all but
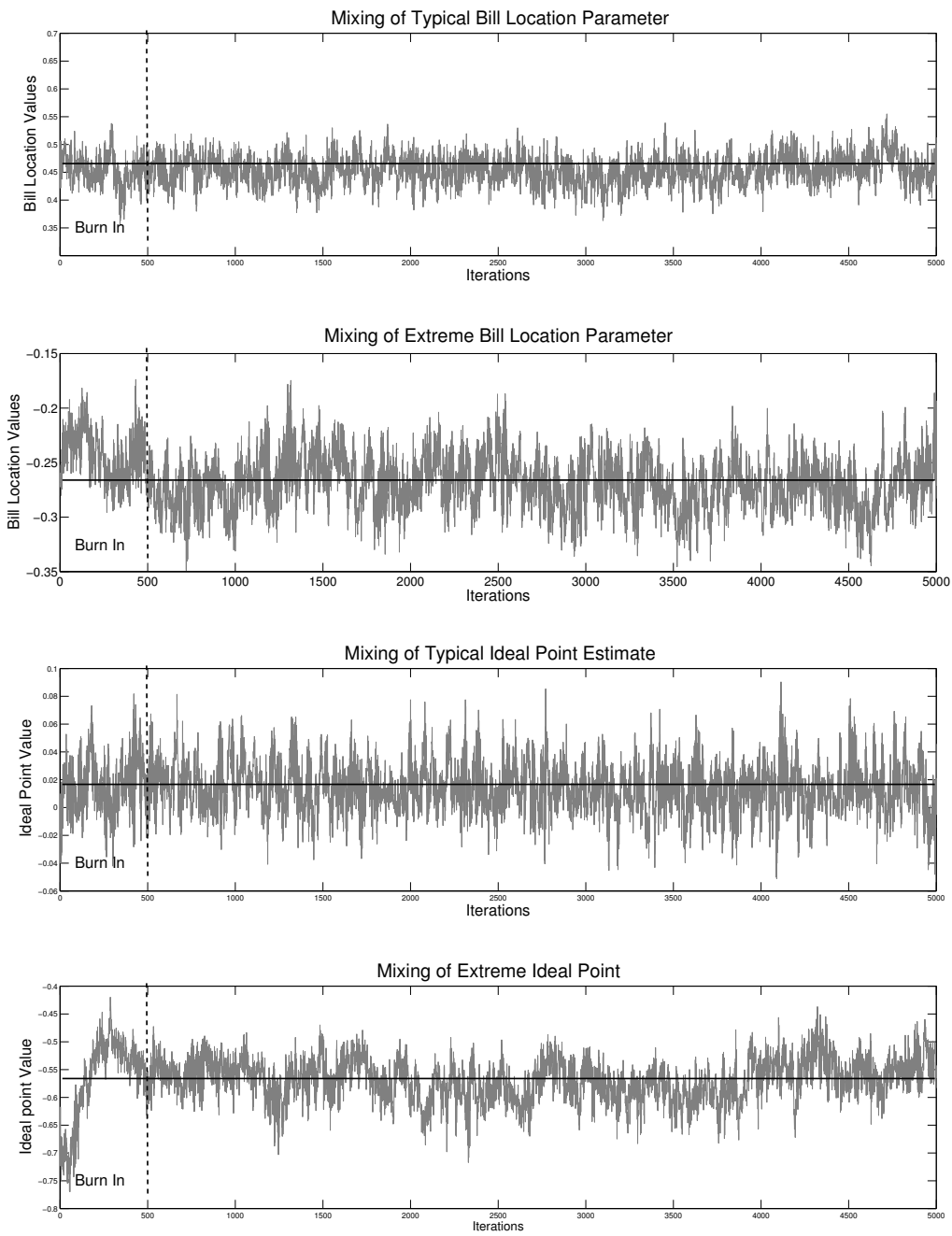
Figure 3.2: Mixing of parameters

eliminated when working with large amounts of data. Figure 3.3 shows how the average bias is reduced as the number of data points is increased.

Plot (a) of Figure 3.3 is constructed by averaging the absolute bias of 10 proposal location parameters that have been estimated from an increasing number of known ideal points, from 3 (the minimum needed for identification) to 10,000. A measure of absolute bias is needed because the bias is not unidirectional; rather it is toward the origin, and thereby a function of the quadrant. To show only the bias generated from the proposal location parameters, the known true values of the ideal points are used. The plot shows the absolute bias of the proposal location estimates (on the vertical axis) as a function of the number of ideal points used for estimation (on the horizontal axis).

Plot (b) of Figure 3.3 is constructed in the same manner as plot (a), by averaging the absolute bias of 10 ideal point parameters estimated from an increasing number of known proposal location parameters, from 3 to 10,000. The plot shows the absolute bias of the ideal point estimates (on the vertical axis) as a function of the number of known proposal location parameters used for estimation (on the horizontal axis).

As can be observed from Figure 3.3, the bias of ideal points is small and all but eliminated with 1,000 proposals. The bias of proposal location estimates is a bit larger and more persistent, but is nearly eliminated with 3,000 ideal points.

3.4.4 Predictive power

Although comparing estimated values to true values is intuitively appealing, it is only meaningful under very specific conditions. The real power of the estimates is determined by their ability to actually predict voting outcomes. Furthermore, this power is not conditioned on the estimated values at all resembling the true values. Any scaling, rotating, inverting, or combination of the three, to the parameter space will result in the same predicted voting outcomes as the original parameters.
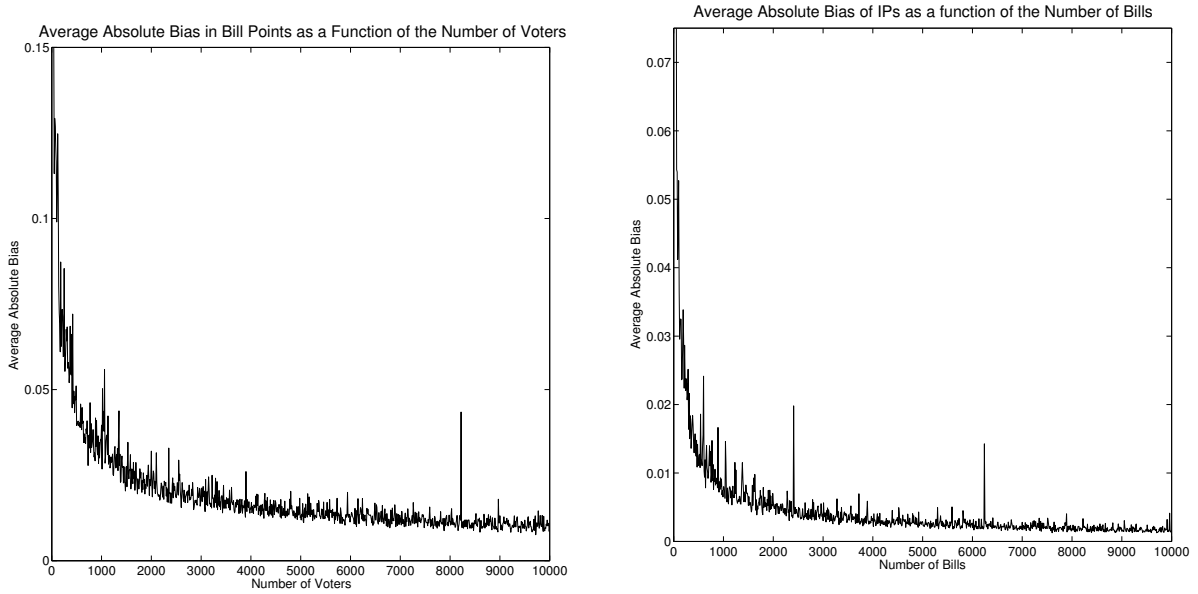
Figure 3.3: Bias as a function of the number of data points

With deterministically generated test data, this model produces estimates that predict voting outcomes with 98.7% accuracy when estimated using 100 proposals and 100 voters. That is to say, when the estimated values of ideal points and proposal locations are used to compute $\hat{Y}$ (the predicted roll call data), it matches up with the actual (generated) roll call data 98.7% of the time. This level of accuracy is an appropriate benchmark against which the outcomes resulting from the introduction of error may be measured.

There are several reasons why error or uncertainty may exist in the data. First, a voter might not be fully aware of his own potential utility; after all, most legislation is very complex and voters' time is heavily taxed. Second, and more likely, there may be unseen influences on a voter for a given piece of legislation resulting in a vote in the opposite direction from what is expected.

Figure 3.4 shows how predictive power decreases as data error increases. The error built into the data generating process is distributed $N \sim (0, \sigma)$ where σ is increasing. The error term is added to Y^* as per the model described in Section 3.2. The horizontal axis of Figure 3.4 shows the increasing σ values. The vertical axis shows the percent of correct roll call
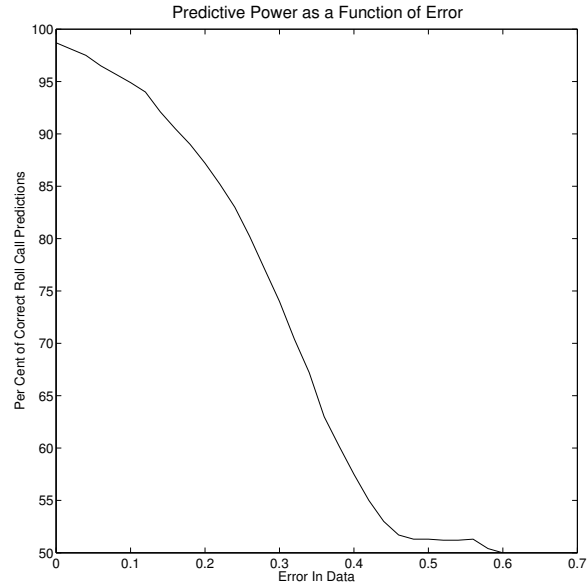
Figure 3.4: Predictive power as a function of data error

predictions. All estimations are done using 100 voters voting on 100 proposals in space scaled to contain all parameters in the double unit square. A $\sigma = .1$ represents an error equal to 5% of the state space. Note that 50% prediction accuracy is equivalent to a coin flip, i.e. the predictive power is zero. An error equal to about 25% of the state space (.6 in this example) results in a prediction accuracy of about 50%. If data errors are any larger than this, the model is not useful.

Another contributor to the predictive power of the estimates is the number of data points, i.e. the number of voters and proposals. As one would expect, more data points increase the predictive power; however, the added benefit of more data tapers off after about 100 proposals and 100 voters. This trend can be seen in Table-3.1, which shows the predictive accuracy of estimators predicted with varying numbers of proposals and voters.

Table 3.1: Predictive power as a function of the number of proposals and voters

		Number of proposals				
		10	25	50	100	300
Number of voters	10	66.8	83.7	93.1	95.8	96.0
	25	80.4	88.4	95.3	96.7	97.5
	50	86.7	90.8	96.7	97.5	98.0
	100	95.6	95.8	97.9	98.1	98.7
	300	95.7	96.3	98.0	98.6	99.4

3.4.5 Robustness

Although the test data used to analyze the model presented in this article has been contrived as to simplify tests, the results are not contingent on such simplicity. To show this, robustness tests were ran in five key areas: parameter starting positions, priors, location of fixed parameters, test data construction, and the functional form of utility.

To test the estimates' sensitivity to changes in the parameter starting values, the distance between the starting values and the true values was gradually increased. The effect was slower mixing, but little to no change in the estimates. As a worst case scenario, the starting values were all set to zero. This necessitated an increase to 10,000 iterations of the main sampler and a burn-in of 2,000, but produced similar estimates to the baseline.

Sensitivity to the priors is only noticeable when $\lambda < 1$ for $\Sigma = I * \lambda$ when $\nu = \tau = 0$. Table-3.2 shows a more complete picture of the sensitivity to priors. The table shows the average distance from the baseline estimates to the estimates produced using the given values of λ and ν/τ. For any reasonable prior mean, i.e. $-1 \leq \nu/\tau \geq 1$, a $\lambda \geq 3$ produces estimates indistinguishable from the baseline estimates.

The sensitivity of estimates to changes in the fixed values away from their true values cannot be measured in the same way as other sensitivities. If one of the fixed parameters is fixed to some point other than its true value, all of the other estimates are expected to change. Therefore, sensitivity must be measured by changes in the predictive power of the estimates. Simply put, there is no change in predictive power as a result of a movement of the fixed values away from their respective true values. This is important since, "true"

Table 3.2: Prior sensitivity as a function of λ and ν/τ

		λ							λ			
		.1	.2	.5	1	3			.1	.2	.5	1	3
	0	.21	.15	.08	.01	0		0	.19	.14	.07	.01	0
	.5	.17	.10	.05	.01	0		.5	.18	.12	.06	.02	0
ν	1	.22	.17	.10	.03	0	τ	1	.21	.15	.12	.03	0
	2	.30	.19	.15	.05	.01		2	.29	.23	.12	.06	.01
	10	3.1	1.2	.95	.40	.10		10	3.1	1.6	.90	.46	.15

values only exist in the context of contrived data. One change that does weaken the accuracy of the model is using fixed parameters that are close to one another or close to the middle of the pack.

The test data used in this article was constructed as to give the most intuitive results possible, i.e. it was constructed such that $x, y \in (-1, 1)$, ideal points and proposal locations follow a normal distribution, centered on the origin. This is also the scale used to fit the model. The only way to recover the "true" values needed for diagnostics is to have the model span the same space and to have the fixed parameters fixed to their "true" values. Clearly, any deviation from this in the construction of test data would result in estimates that do not resemble the true values. However, changing the construction of the test data has no observable effect on the predictive power of the estimates. Tests were conducted using data centered away from the origin, data constructed in the unit square, and data distributed uniformly. All of these data sets were fit to the same space as the baseline, i.e. $x, y \in (-1, 1)$, with no change in the predictive power of the estimates. These changes, however, do result in a slower mixing time.

The assumption that all proposal nay location parameters are fixed to the origin may seem troublesome at first thought, but it does not impact the predictive power of the estimates. To test this, test data is constructed allowing proposal nay positions to be free parameters in the same space as the proposal yea parameters. The model is then estimated while still restricting the nay locations to the origin. Although the space was transformed in a complex way, the predictive power of the estimates did not falter.

In addition to Euclidean utility, with which the model has been presented, several other functional forms of utility were tested. Specifically, quadratic utility, absolute utility, and city-block utility were evaluated. The functional forms are listed below:

Quadratic Utility: $U_{ij} = A_i - \left[\left(X_{i1} - B_{j1}^{nay} \right)^2 + \left(X_{i2} - B_{j2}^{nay} \right)^2 \right]$

Absolute Utility: $U_{ij} = A_i - \sqrt{ \left| X_{i1} - B_{j1}^{nay} \right| + \left| X_{i2} - B_{j2}^{nay} \right| }$

City-Block Utility: $U_{ij} = A_i - \left\{ \left| X_{i1} - B_{j1}^{nay} \right| + \left| X_{i2} - B_{j2}^{nay} \right| \right\}$

The estimates using the first two functional forms result in slightly less predictive power when compared to the baseline. The third is not appropriate for the data construction used in the baseline model. A voter with a city-block utility function will not vote the same as a voter with a Euclidean utility function with the same ideal point. The indifference curves from a city block metric are quadrilateral instead of spherical, which will result in a different roll call outcome. When using the city block metric on the baseline test data, the predictive power of the estimates is significantly reduced. However, when the roll call data is constructed using the city block metric, the resulting estimates yield a predictive power equal to that of the baseline. This is an important finding because it suggests that the metric of predictive power can be used as model selection criteria. That is to say, the utility function that most closely resembles the true utility function will yield the highest predictive power. Therefore, the researcher can engage in a model selection process to find the most likely utility function based on scientific criteria.

3.5 Conclusion

This article has developed a method for simultaneously estimating ideal points and proposal locations. The approach presented here goes beyond previous work by allowing for the simulation and observation of the full unconditional distribution of ideal points and proposal locations. Although the algorithm presented in this article was developed specifically to deal with the demands of SVM solution concepts, it is useful in any situation that requires draws from the joint distribution of ideal points and proposal locations.

Section 3.3 developed a cohesive identification scheme which maximizes the freedom of the researcher while minimizing the amount of prior knowledge necessary. This identification scheme is scalable to any arbitrary dimension and not dependent on the functional form of utility.

This new approach is robust to large error, misspecified data generation processes, and arbitrary transformations of the parameter space. Furthermore, through the robustness tests of Section 3.4, it has been shown that the predictive power of the estimates produced by this method is not negatively impacted by the employed identification strategy.

Although the model in this article is presented using simple Euclidean utility, any functional form of utility can easily be substituted, lifting the restrictive assumptions imposed by other methods and allowing researchers to perform model selection on a more scientific set of criteria. Furthermore, predictive power has been established as a possible metric by which we can choose the most likely utility function.

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A Common agency, menu auction

A.1 Sketch of model

What follows is a sketch of Grossman and Helpman's (1992) common agency game, modeled as a menu auction. It is presented adopting the notation and functional from used by Baron (2001). The purpose of this section is to describe the equilibrium conditions of a menu auction in order to assess the likelihood of a prisoners' dilemma. For a full derivation and formal treatment of the model see e.g. Bernheim and Whinston (1986), Grossman and Helpman (1992), or Baron (2001).

The game consists of three players, one executive (e) who ultimately decides on policy, and two opposing interest groups (g and h respectively). Each interest group has policy preferences represented by a quadratic utility function $u_j(x) = -\beta_j(x - z_j)^2$, $\beta_j > 0$, $j = g, h$. Let the ideal points $z_g > 0$ and $z_h < 0$. Interest groups seek to influence policy by offering contributions to the executive. Further, interest groups offer a menu of contributions ($c_j(x)$, $j = g, h$) to the executive, contingent on the specific policy outcome (x) chosen.

The executive has an ideal policy outcome, z, and quasilinear utility function, which considers her direct utility from a specific policy outcome, $u_e = -\alpha(x - z)^2$, $z_h < z < z_g$, and the contributions she will receive as a result of choosing that specific policy outcome. The executive's objective function is then, $U_e = u_e(x) + c_g(x) + c_h(x)$.

The interest groups simultaneously choose their contribution schedules as to maximize their utility, given the executive's optimal decision. The executive then chooses the policy outcome to maximize U_e, given the contribution schedules of the interest groups. Restricting equilibria to the set of 'truthful' equilibria[1] implies that $c_j(x) = \tau_j + u_j(x)$, $j = g, h$, where τ_j is some constant determined in equilibrium. The equilibrium outcome is then a function

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[1]Contribution schedules are 'truthful' because they reveal the true preferences. Some truthful contribution schedule is always a best response to any strategy of the opposing interest, therefore, an equilibrium always exists (Baron 2001).

of ideal points $(z_g,\ z_h,\ z)$ and the salience of preferences held by each player $(\beta_g,\ \beta_h,\ \alpha)$. Equilibrium conditions are summarized below.

Let,

$$j = g,\ h$$

$$x = \text{policy outcome}$$

$$z = \text{ideal point of executive}$$

$$z_j = \text{ideal point of interest } j$$

$$\beta_j,\ \alpha > 0 \text{ are the saliences of preferences}$$

$$u_j(x) = -\beta_j(x - z_j)^2$$

$$u_e(x) = -\alpha(x - z)^2$$

$$c_j(x) = \text{payment schedule for policy x offered by interest } j$$

$$c_j(x) = \tau_j + u_j(x)$$

$$\tau_j = \text{constant chosen as to maximize the objective function of interest } j$$

$$U_j(x) = u_j(x) - c_j(x) = \text{objective function of interest}, j = g, h$$

$$U_e(x) = u_e(x) + c_g(x) + c_h(x) = \text{objective function of the executive}$$

$$x_j = \text{the policy outcome if only } j \text{ contributes.}$$

Then, in equilibrium we have:

$$x^* = \frac{\beta_g z_g + \beta_h z_h + \alpha z}{\beta_g + \beta_h + \alpha}$$

$$x_g = \frac{\beta_g z_g + \alpha z}{\beta_g + \alpha}$$

$$x_h = \frac{\beta_h z_h + \alpha z}{\beta_h + \alpha}$$

$$c_g^*(x) = \tau_g^* - \beta_g(x^* - z_g)^2$$

$$c_h^*(x) = \tau_h^* - \beta_h(x^* - z_h)^2$$

$$\tau_g^* = -\frac{\beta_h(z - z_h)^2}{\beta_h + \alpha} + k$$

$$\tau_h^* = -\frac{\beta_g(z - z_g)^2}{\beta_g + \alpha} + k$$

where,

$$k = \frac{\beta_g[\beta_h(z_h - z_g) + \alpha(z - z_g)]^2 + \beta_h[\beta_g(z_g - z_h) + \alpha(z - z_h)]^2 + \alpha[\beta_g(z_g - z) + \beta_h(z_h - z)]^2}{(\beta_g + \beta_h + \alpha)^2}$$

A.2 Conditions that lead to prisoner's dilemma

Several conditions must hold in order for a prisoners' dilemma to occur. First, when both interest groups contribute, they must both be worse off than would be the case if neither contributed. Second, each interest must be made better off by contributing when the other interest does not contribute. Third, when one group contributes, the other group must be better off by contributing than they would be if only their opposition contributes. Below, these conditions are put into the notations of the model sketched above.

Let $j = g, \ h \ and \ -j = h, \ g$.

In order for each interest group to be worse off when both contribute than they would be if neither contributed:

$$U_j(x^*) < U_j(z)$$

$$\Rightarrow u_j(x^*) - c_j(x^*) < u_j(z)$$

$$\Rightarrow -\beta_j(x^* - z_j)^2 - c_j(x^*) < -\beta_j(z - z_j)^2$$

$$\Rightarrow -\tau_j^* < -\beta_j(z - z_j)^2$$

$$\Rightarrow 0 < \tau_j^* - \beta_j(z - z_j)^2 \tag{1}$$

Given $-j$ has donated, it is better for j to donate than to not donate

$$U_j(x^*) > U_j(x_{-j})$$

$$\Rightarrow u_j(x^*) - c_j(x^*) > u_j(x_{-j})$$

$$\Rightarrow -\beta_j(x^* - z_j)^2 - c_j(x^*) > -\beta_j(x_{-j} - z_j)^2$$

$$\Rightarrow -\tau_j^* > -\beta_j(x_{-j} - z_j)^2$$

$$\Rightarrow 0 > \tau_j^* - \beta_j(x_{-j} - z_j)^2 \tag{2}$$

Given $-j$ has not donated, it is better for j to donate than to not donate

$$U_j(x_j) > U_j(z)$$

$$\Rightarrow u_j(x_j) - c_j(x_j) > u_j(z)$$

$$\Rightarrow -\beta_j(x_j - z_j)^2 - c_j(x_j) > -\beta_j(z - z_j)^2$$

$$\Rightarrow -\tau_j > -\beta_j(z - z_j)^2$$

$$\Rightarrow 0 > \tau_j - \beta_j(z - z_j)^2 \tag{3}$$

Preference extremity

The extremities of preferences which lead to a prisoners' dilemma are derived below, assuming equal and normalized salience such that $\beta_j = \alpha = 1$, and shifting the policy space such that $z = 0$.

Condition 1:

$$0 < \frac{-z_{-j}^2}{2} + \frac{(z_{-j} - 2z_j)^2 + (z_j - 2z_{-j})^2 + (z_j + z_{-j})^2}{9} - z_j^2$$

$$\Rightarrow 0 < 2(z_{-j} - 2z_j)^2 + 2(z_j - 2z_{-j})^2 + 2(z_j + z_{-j})^2 - 18z_j^2 - 9z_{-j}^2$$

$$\Rightarrow 0 < z_{-j}^2 - 4z_j z_{-j} - 2z_j^2$$

$$\Rightarrow 0 < \left(\frac{\sqrt{(6)} - 2}{2} z_{-j} - z_j \right) \left(\frac{\sqrt{(6)} + 2}{2} z_{-j} + z_j \right) \tag{4}$$

Assume $j = g$ and $-j = h$. The first expression of Equation 4 is then negative for any values in the domains of z_h and z_g. Therefore, in order for the condition to hold, the second expression

of Equation 4 must be less than zero, which implies:

$$2.22|z_h| > |z_g| \tag{5}$$

Assume $j = h$ and $-j = g$. The first expression of Equation 4 is positive for any values in the domains of z_h & z_g. Therefore, in order for the condition to hold, the second expression must be greater than zero, which implies:

$$2.22|z_g| > |z_h| \tag{6}$$

Condition 2:

$$0 > \tau_j^* - \beta_j(x_{-j} - z_j)^2$$
$$\Rightarrow 0 > -\frac{z_j^2}{3} + \frac{z_j z_{-j}}{3} - \frac{z_{-j}^2}{12}$$
$$\Rightarrow 0 < z_j^2 - z_j z_{-j} + \frac{1}{4} z_{-j}^2$$

$$\Rightarrow 0 < \left(z_j - \frac{1}{2} z_{-j}\right)^2 \tag{7}$$

This is true for all values in the domain of z_g and z_h. Condition 2 is non-binding.

Condition 3: The case in which $-j$ does not donate is equivalent to setting $\beta_{-j} = 0$ in the equilibrium case.

$$0 > \tau_j - z_j^2$$
$$\Rightarrow 0 > \frac{z_j^2 + z_j^2}{4} - z_j^2$$

$$\Rightarrow 0 < \frac{z_j^2}{2} \tag{8}$$

This condition is met by every value in the domain of z_j. Condition 3 is non-binding.

Necessary and sufficient conditions for a prisoners' dilemma:

$$.45|z_{-j}| < |z_j| < 2.22|z_{-j}|, \text{ given } \beta_j = \beta_{-j} = \alpha = 1 \text{ and } z = 0. \tag{9}$$

Given similar salience, the preferences of one interest group would need to be more than twice as extreme as the preferences of the opposing interest group in order to avoid a prisoners' dilemma.

Salience

The relative salience of interest group preferences which lead to a prisoners' dilemma are derived below. Scale and shift the policy space such that $z_g = 1$, $z_h = -1$, and $z = 0$. Further assume the executive is indifferent about the policy outcome itself, such that $\alpha = 0$.

Condition 1:

$$0 < \tau_j^* - \beta_j (z - z_j)^2$$

$$\Rightarrow 0 < -1 - \beta_j + k$$

$$\Rightarrow 1 + \beta_j < \frac{4\beta_{-j}\beta_j^2 + 4\beta_{-j}^2\beta_j}{(\beta_{-j} + \beta_j)^2}$$

$$\Rightarrow \beta_{-j} > \frac{\beta_j + \beta_j^2}{3\beta_j - 1} \tag{10}$$

Condition 2:

$$0 > \tau_j^* - \beta_j(x_{-j} - z_j)^2$$

$$\Rightarrow 0 > -1 - 4\beta_j + k$$

$$\Rightarrow 1 + 4\beta_j > \frac{4\beta_j\beta_{-j}}{\beta_j + \beta_{-j}}$$

$$\Rightarrow 0 < \beta_{-j} + \beta_j + 4\beta_j^2 \tag{11}$$

This is true for all values in the domain of β_g and β_h. Condition 2 is non-binding.

Condition 3:

The case in which $-j$ does not donate is equivalent to setting $\beta_{-j} = 0$ in the equilibrium case.

$$0 > \tau_j - \beta_j(z - z_j)^2$$

$$\Rightarrow 0 > -1 - \beta_j + \hat{k}, \text{ where } \hat{k} = k|_{\beta_{-j}=0}$$

$$\hat{k} = 0$$

$$\Rightarrow 0 > -1 - \beta_j \tag{12}$$

This is true for all values in the domain of β_g and β_h. Condition 3 is non-binding.

Necessary and sufficient conditions for a prisoners' dilemma:

$$\beta_{-j} > \frac{\beta_j + \beta_j^2}{3\beta_j - 1}, \text{ given } z_g = 1, \ z_h = -1, \ z = 0, \text{ and } \alpha = 0. \tag{13}$$

Let S be the average slope of $\beta_{-j} = f(\beta_j)$, $\beta_j \in (0, 10)$. Then $S|_{j=g} \approx .38$ and $S|_{j=g} \approx 2.6$. Over the given range, the salience of one group must be more than twice that of the other group
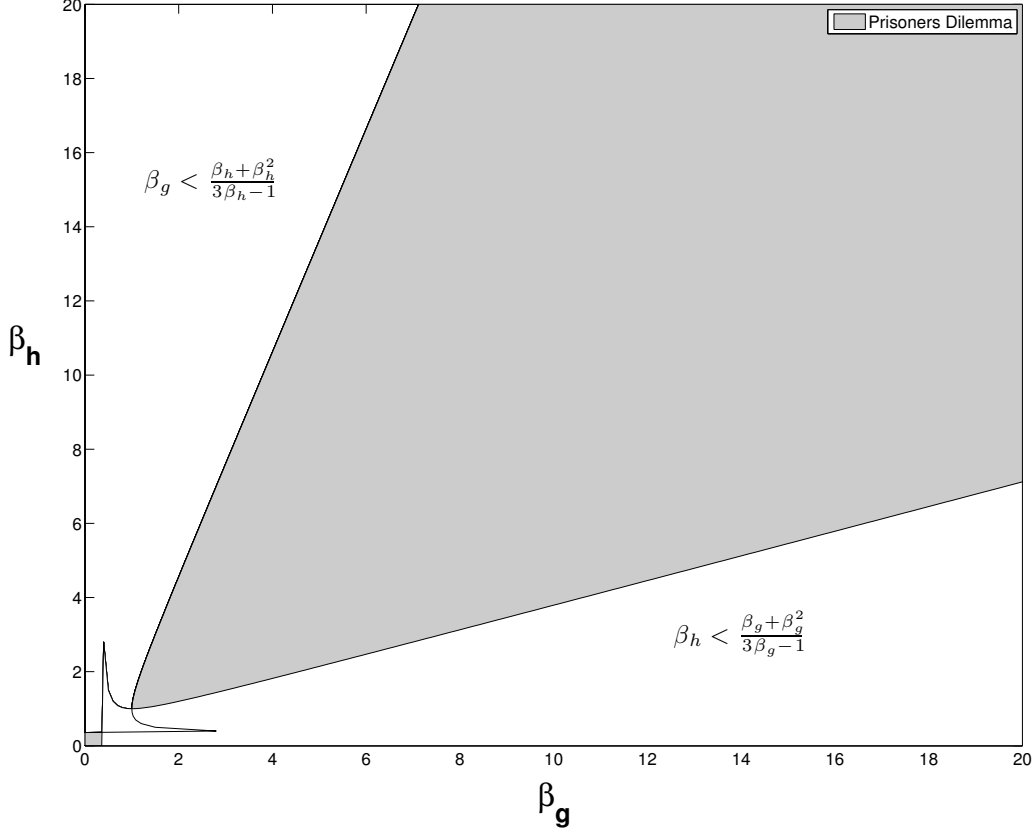
Figure 1: Relative salience necessary for a prisoners' dilemma

The figure shows the relative salience values (β_j) of opposing interest groups that would cause a prisoners' dilemma when groups compete (represented by the shaded ares), given $z_g = 1$, $z_h = -1$ $z = 0$ and $\alpha = 0$.

in order to avoid the prisoners' dilemma. Note that as $\beta_j \to \infty$, $S|_{j=g} \to \infty$ and $S|_{j=g} \to 0$. Figure 1 depicts the relative salience values of the opposing interest groups that are necessary to avoid a prisoners' dilemma.

B   Calculation of anti- and pro-development profits

Anti-development gross profits:

It is necessary to know several measurements in order to calculate the change in gross profits as a function of building permits issued. Let e be the price elasticity of demand for Los Angeles County, which is estimated at 28.5 (Treyz, Treyz, and Mata 2006). Then let P^0 be the average price per square foot of developed real estate, averaged across districts and

time. Using historical data from web sources (trulia.com & zillow.com), the average price is calculated to be $P^0 \approx 300$. Furthermore, it is necessary to know the average gross returns to value for real estate investment, estimated at 8% per annum (Ciochetti, Fisher, and Gao 2003) and the completion rate of permitted new structures, estimated at 95% (U.S. Census 2015). Then we have:

$$\frac{\Delta Q}{Q^0} \frac{P^0}{\Delta P} = e$$
$$\Rightarrow \Delta P = \frac{\Delta Q}{Q^0} \frac{P^0}{e}$$
$$\Rightarrow \Delta P = \frac{\Delta Q}{Q^0} 10.5.$$

Let ΔR be the change in the value of existing property:

$$\Delta R = Q^0 (\Delta P)$$
$$\Delta R = Q^0 \left(\frac{\Delta Q}{Q^0} 10.5 \right)$$
$$\Rightarrow \Delta R = 10.5 \Delta Q.$$

Let $\Delta \pi^{Anti}$ be the change in gross profit over a four-month period and $\hat{Q}$ be the quantity of permits issued, where:

$$Q = .95 \hat{Q}$$
$$\Delta \pi^{Anti} = \frac{.8}{3} \Delta R$$

then,

$$\Delta \pi^{Anti} \approx 0.27 \Delta \hat{Q}. \qquad \blacksquare$$

Pro-development gross profits:

In order to calculate the change in gross profit as a function of building permits issued, it is

necessary to know several additional measurements. Specifically, we must know the average return on a real estate development project as well as the average time to completion, which are estimated at $r = .25$ and $t = 24$ months, respectively (O'Connor 1986). Then we have:

$$P^0 - \frac{P^0}{1+r} = \$60 \text{ in expected gross profit over the life of the project.}$$

Let $\Delta\pi^{pro}$ be the change in gross profit over a four-month period.

$$\pi^{Pro} = \$60 \div \frac{t}{4} = \$10Q$$
$$\Rightarrow \pi^{Pro} = \$9.5\hat{Q}.$$

■

C   Vote-Trade Algorithm

The fully recursive algorithm employed in this article is a direct simulation of the process described in Section 2.2. It is similar in spirit to the methodology of Casella et al. (2010) but in a barter system. Trade equilibria are, in general dependent, on the initial trade proposal. This article uses normalized relative changes in a voter's expected utility to proxy for bargaining power, thereby choosing the most likely vote-trade solution. The next subsections present the algorithm along with the mechanism by which outcomes are chosen from the set of possible outcomes.

C.1   Algorithm

Step 1:

(i) Calculate each voter i's subjective probability of each bill j passing given bill j's yea and nay positions and voter i's beliefs about the preferences of the other voters.

(ii) Use those probabilities to calculate the expected utility of each voter given no vote-trading has occurred, $\bar{\mathcal{U}}$.

(iii) Identify the set T of all possible vote-trades.

Step 2

Initialize assuming all voters participate in trade t.

(i) For trade option t, calculate the expected utility for all voters given the voters who participate in the trade, $\hat{\mathcal{U}}$.

(ii) Let $\mathcal{U} = \hat{\mathcal{U}} - \bar{\mathcal{U}}$. All voters i corresponding to $\mathcal{U}_i \leq 0$ drop out of the trade.

(iii) Repeat (i) and (ii) until no voters wish to drop out of the trade or all voters have dropped out. If no voters are left in the trade, discard vote-trade option t as an unfeasible initial trade proposal, terminate iteration t and advance to iteration $t+1$. Otherwise, advance to Step 3.

Step 3

Initialize using the outcome of Step 2 as the only given coalition(s).

(i) Let $\bar{\mathcal{U}}$ be the expected utility of all voters given the coalition(s) that have already formed.

(ii) Taking all coalitions formed in previous Steps of iteration t as given, run Step 2 for all $\hat{t}$, $\hat{t} = (1, \ldots, T)$, with the voters not yet in a coalition using $\bar{\mathcal{U}}$ calculated in Step 3(i). Record which voters participate in each possible trade and their increase in expected utility, $\mathcal{U}$.

(iii) Use the choice mechanism described in A.2 to choose $\hat{t}$.

(iv) If a trade occurred in Step 3(iii), and there are two or more voters who are not yet in a coalition, repeat Step 3, adding the result of Step 3(iii) to the list of given coalitions. Otherwise, continue to Step 4.

Step 4

(i) Record the set of coalitions and trades as $\{C_k\}$

(ii) If $\{C_k\} = \{C_{k-1}\}$ record $\{C_k\}$ as the trade equilibrium given initial proposal t. Otherwise, discard all coalitions in $\{C_k\}$ except for the last coalition to form. Taking only that coalition

as given, repeat Step 3.

Step 5

(i) Repeat Steps 2 through 4 for all initial trade proposals $t \in T$.

(ii) Use the choice mechanism described below to choose the most likely of the initial proposals.

C.2 Choice mechanism

Each coalition in a set of coalitions, $\{C_k\}$, is the best response to all other coalitions and trades within the set. Therefore, given the formation of a coalition over a specific trade in some set of coalitions, $\{C_k\}$, all other coalitions in that set will form. It is then necessary to identify the coalition that is most likely to form over all possible sets, $\{C\}$. Multiple initial trade proposals may result in the same outcome, so first, reduce $\{C\}$ to $\{\hat{C}\}$ which contains only unique $\{C_k\}$. Then calculate δ_k^i, the net utility gain of each voter from each possible trade equilibrium $\{\hat{C}_k\}$ (resulting from each of the possible initial trade proposals). Assuming a voter will only opt for trades that result in an increase in expected utility, we can set decreases in utility to 0. Then, for voter i, normalize all increases in utility to sum to 1: $\hat{\delta}_k^i = \frac{\delta_k^i}{\sum_{k \in \gamma} \delta_k^i}$, where δ_k^i is the utility gained by voter i from $\{\hat{C}_k\}$ over the the utility of voter i from no trade, and γ is the set of k for which $\delta_k^i > 0$ (i.e. the trades i would willingly participate in).

Then for each coalition in every set of coalitions calculate the product of the normalized utilities of the trade participants: $\hat{\delta}_\psi = \prod_{i \in \lambda_\psi} \delta_\psi^i$, where Ψ ($\psi \in \Psi$) is the set of all trades within all sets of coalitions in $\{\hat{C}\}$, and λ_ψ is the set of all i who participate in trade ψ. If all products are zero, then no further trades occur. Otherwise, choose ψ^*, the trade that corresponds to the maximal element of $\hat{\delta}_\psi$. The trade outcome is the set of coalitions, $\{\hat{C}_k\}$ that contains ψ^*.