Uncertainty and resistance to reform in laboratory participation games

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Abstract

This paper presents a participation game experiment to study the impact of uncertainty and costly political participation on the incidence of reform. We introduce intra-group conflict into the framework of Fernandez and Rodrik (1991) by incorporating costly political participation, which creates a natural incentive for free-riding on fellow group members' efforts to influence policy outcomes. Our experimental findings show that uncertainty reduces the incidence of reform even with costly political participation, and that an increase in the cost of participation reduces the participation of all agents, regardless of whether they belong to the majority and minority. This second result cannot be reconciled with the standard mixed strategy Nash equilibrium, but is consistent with the quantal response equilibrium.

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1. Introduction

This paper presents a laboratory participation game experiment to study the impact of individual-specific uncertainty and costly political participation on the incidence of reform. In a pioneering study, Fernandez and Rodrik (1991, hereafter FR) show that uncertainty regarding the distribution of gains and losses from reform can prevent efficiency-enhancing reforms from taking place. They argue that when making decisions regarding whether to support a reform, citizens may not know whether they will benefit or suffer from the reform. If policy outcomes are determined by majority preferences and the majority estimate ex ante that their expected payoff from the reform is lower than their expected payoff from the status quo, then the reform will not take place. The reform can fail in this way even if everyone knows that it will improve the welfare of the majority of the citizens ex post and will thus generate majority support for its continuation if it is adopted.

This insight has been influential in the recent literature on the political economy of reform as well as in other areas of political economy.[1] To our knowledge, however, there has not been any empirical work that provides a direct test of the validity and significance of the mechanism articulated in this influential paper. Furthermore, to focus on how individual-specific uncertainty can lead to the non-adoption of reform, FR do not develop an explicit model of the political process. Instead they assume that political participation is costless and that policy reform is more likely to be adopted if it is favored by a larger number of individuals. In this

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[1] The importance of individual-specific uncertainty has been emphasized in general discussions of the political economy of reforms (see, for examples, surveys such as Rodrik (1996), Robinson (1998), and Drazen (2000, chapters 10 and 13) and the references cited there). It also features prominently in the literature on the merit of gradualism vs. big bang in reform (e.g., Sachs, 1995; Aslund et al. 1996; the relevant essays in Sturzenegger and Tommasi, 1998; and Laffont and Qian, 1999). Recently, Jain and Mukand (2003) extend the FR model to study whether or not the probability of reform adoption is increasing in the efficiency gain from the reform. Highly selective examples of recent studies in other areas of political economy that have addressed the issue of individual-specific uncertainty include empirical studies of public preferences over tax, deficit, and spending (Hansen, 1998), and the political economy of public enterprise reform (Campos and Esfahani, 2000).

paper, drawing on the participation game framework of Palfrey and Rosenthal (1983), we extend the FR model to allow for costly political participation, and study how uncertainty and costly participation affect the incidence of reform, as well as the incidence of political participation by the supporters and opponents of reform.

We were motivated to extend the FR model to allow for costly political participation for two main reasons. First, when political participation is costly—for example, the act of voting by citizens, or the effort of lobbying by interest groups in affecting policy outcomes—whether or not a reform will be adopted depends on the actual support expressed by those citizens who incur the costs to participate in the political process, rather than simply the ex ante preferences of the majority of the citizens. We show that costly political participation in the FR model typically leads to multiple equilibria, and it is possible that uncertainty can actually *increase*, instead of *decrease*, the incidence of reform, contrary to the FR model with costless participation.. This makes the laboratory method particularly attractive. Besides enabling us to provide a direct test of the original FR model, it also enables us to determine empirically which of the multiple equilibria is more consistent with subjects' behavior when participation is costly.

Second, as Drazen (2000) points out, the key defining characteristic of the fast-growing literature in the political economy of reform is its emphasis on heterogeneity and conflict of interest. In analyzing how heterogeneity and conflict of interest determine whether or not reform will take place, scholars usually view economic policy as determined by conflict between contending social groups or their political representatives (Haggard, 1997). Although many of the important contributions on the political economy of reform collected in Sturzenegger and Tommasi (1998) or discussed in Drazen (2000) study how strategic interactions between competing interest groups determine whether or not reform will take place (e.g., Alesina and

Drazen, 1991; Velasco, 1998), none of them studies the interactions between inter- and intra-group conflicts explicitly. The participation game pioneered by Palfrey and Rosenthal (1983, 1985) provides a useful framework to address how the presence of both inter- and intra-group conflicts affects policy outcomes. Therefore, the integration of the participation game into the political economy literature of reform will contribute to the study of this under-explored dimension of reform. Our effort to integrate the FR model with the participation game is a first step in this direction.

In particular, while an agent wants a particular outcome to be adopted, when political participation is costly she will prefer that others in her group incur the necessary costs to bring about this outcome. This free-rider problem (Olson, 1965) thus creates intra-group conflicts within both the groups of supporters and opponents of reform. As emphasized by Palfrey and Rosenthal (1983, 1985) and Bornstein (1992) and Bornstein et al. (1994), however, when deciding whether to incur the cost to influence a policy outcome, an agent should take into account how likely members from the opposing group as well as fellow members from her own group will participate in the political process. This implies that although an agent has the incentive to free-ride on her fellow members' efforts, she will be willing to incur the cost to participate in the political process if she believes that her participation will likely be decisive in determining the policy outcome given the probabilities of participation by other supporters and opponents of the policy.

The rest of this paper is organized as follows. Section 2 first introduces a laboratory participation game that captures the argument in FR that uncertainty can lead to resistance to reform. We then develop a theoretical model for this participation game and derive comparative static predictions. Section 3 presents the details of the experimental design. Section 4 reports the results and Section 5 concludes.

2. Theory

2.1 Individual-specific uncertainty and resistance to reform

To motivate our laboratory environment, consider the following example used by FR to explain their basic argument. Figure 1 shows an economy that consists of two-sectors—for example, an exporting sector and an import-competing sector—in which individuals are aligned uniformly on the $[0,1]$ continuum. Now consider a trade-reform that will benefit the exporting sector (the "winning sector"), but will hurt the import-competing sector (the "losing sector"). The magnitudes of the gains and losses are displayed in the top panel of the diagram. Individuals in the losing (winning) sector lie to the left (right) of *D*. The winning sector has 40 percent of the individuals in the economy.

Note that besides the individuals in the winning sector who all gain from the reform, those individuals in the losing sector between *E* and *D* will also benefit from the reform because they are able to switch to the winning sector. When there is no uncertainty regarding who will lose or gain from the reform, the supporters of the reform constitute the majority. If the preferences of the majority determine the policy outcome then the reform will be adopted. In this example the supporters equal 60 percent of the population, comprised of 40 percent already in the winning sector and 20 percent in the losing sector who know *for certain* that they will be able to join the winning sector if the reform is adopted.

Now suppose that it is common knowledge that this same proportion of individuals in the losing sector will be able to switch to the winning sector if the reform takes place, but ex ante it is equally likely that any single one of them can switch. In other words, due to individual-specific uncertainty, individuals in the losing sector do not know who among them will gain or lose if the reform is adopted. As illustrated in the lower panel of the diagram, in this case all individuals in the losing sector will prefer the status quo to the reform and the reform will be blocked by the majority. This can occur even though it is common knowledge that if the reform is adopted, it will enjoy majority support ex post (after the uncertainty is resolved). Therefore, the presence of individual-specific uncertainty can prevent a reform from taking place. FR present a two-sector model to show that this conclusion can hold in a general equilibrium setting.

As pointed out in the introduction, when political participation is costly both inter- and intra-group conflicts are important in determining the incidence of reform. An integration of the participation game with the FR model enables us to study how participation cost and individual-specific uncertainty interact to determine the incidence of reform. In deciding whether to incur the cost to participate in the political process to influence whether or not reform will take place, an agent should take into account how likely members from the opposing group as well as fellow members from her own group will participate in the political process. Although an agent has the incentive to free-ride on her fellow members' participation, she may be willing to incur the cost to participate in the political process if she believes that her participation might be decisive in determining the policy outcome given the probabilities of participation by others. Different groups may participate at different rates, however, so multiple equilibria exist and the impact of uncertainty on reform is ambiguous for positive participation costs.

For the specific parameterization of the participation game that we employ in the laboratory, five players simultaneously choose whether to incur the cost to vote for either allocation X (the status quo) or allocation Y (the reform). The allocation that receives the majority support is implemented. Table 1 presents the payoffs (excluding the cost of voting) of the game we study in the experiment.

There are at least three reasons for adopting a "small group" design in our experiment. First, while FR explain their argument using the language of majority voting, they note that their argument will also hold for other social-choice mechanisms so long as "a policy reform is more likely to be adopted the larger is the number of individuals in favor of it" (Fernandez and Rodrik, 1991, p.1147). Obviously, when there is no participation cost, the basic insight of FR regarding the effect of individual-specific uncertainty on the incidence of reform holds regardless of the group sizes involved in the political competition. Second, as pointed out earlier, whether or not a reform will be adopted depends on the actual support expressed by those citizens who incur the costs to participate in the political process, rather than simply the ex ante preferences of the majority of the citizens. It is plausible that the role of strategic incentives caused by costly participation and uncertainty is most significant with a small number of players. Finally, although larger groups might be more appropriate to study the specific case of majority voting, large groups pose special logistical problems for laboratory experimentation—particularly when the experimenter wishes to employ random rematching of multiple groups of subjects in order to control for repeated game effects but allow for subject learning.[2] Existing participation game experiments also use groups of small and medium sizes, so our use of small group is therefore consistent with much of the existing literature.[3]

Although in what follows we also use the terminology of "voting" for policy "outcomes"

[2] Isaac et al. (1994) utilize groups of up to 100 subjects in a public goods (voluntary contribution mechanism) experiment, and surprisingly they find that contributions increase with group size. Although their experiment demonstrates that it is feasible to conduct experiments using large groups, they employ repeated play by the same group whereas we want to minimize repeated game incentives by using random group rematching. This random rematching is most effective in reducing repeated game incentives if there are many more subjects than the size of the individual groups, which makes large groups extremely difficult to implement in a laboratory.

[3] For example, Schram and Sonnemans (1996a, 1996b) report experiments to study voter turnout, also based on the Palfrey and Rosenthal (1983) participation game framework. Their sessions have between 12 to 28 subjects, and they employ group sizes that range between 6 and 14.

(as in a referendum), we think that the appropriate interpretation of this model is for a small number of interest groups or individual agents deciding whether or not to incur participation costs to influence policy. For example, in the context of trade reforms, these may be firms and trade unions in both the import-competing and exporting sectors.

In all treatments in our experiment, two, one, and two subjects are randomly assigned the role of Blue, Green, and Red players, respectively, before they make their decisions. Both the Blue and Green subjects prefer reform to the status quo. The Blue subjects correspond to the individuals in the winning sector, while the Green subject corresponds to those who will be able to switch to the winning sector when reform takes place. The Red subjects correspond to those who will remain in the losing sector and receive a lower payoff under reform.

In the *Certain Roles* treatment, subjects learn their roles before they make their decisions. In this case, supporters of the reform constitute the majority. In the *Uncertain Roles* treatment, subjects are only informed whether or not they are Blue or non-Blue subjects before they make their decision. The instructions also inform them that "each group will have 2 Blue participants, 1 Green participant, and 2 Red participants. Therefore, there are 3 non-Blue participants. If you learn that you are non-Blue, since roles are assigned randomly you know that there is a 1/3 chance that you are a Green participant and a 2/3 chance that you are a Red participant." For the three non-Blue subjects the expected payoff from reform is 10/3. This is less than the certain payoff of 5 from the status quo, so opponents of reform constitute the majority in the Uncertain Roles treatment. Since the only difference between the two treatments is the absence or presence of uncertainty, the insight in FR implies that the incidence of reform should be higher in the Certain Roles treatment than in the Uncertain Roles treatment.[4]

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[4] The example from FR discussed in this subsection shows how individual-specific uncertainty can cause a reform that would otherwise be ex post popular to be rejected ex ante. Fernandez and Rodrik point out, however, that one

An interesting feature of our experiment is that it allows us to evaluate hypotheses regarding majority versus minority participation rates with unequal group sizes. As van Winden (2002) points out in his survey on the experimental studies of collective action, this issue has not received much attention in the participation game literature, and previous experimental studies of the participation games that we are aware of focus on the case of equal-sized groups.[5] In our experiment, we find that an increase in the cost of political participation reduces the participation of all agents, regardless of whether they belong to the majority or minority.

2.2 The model

Consider the following participation game that modifies the game in Palfrey and Rosenthal (1983) to incorporate individual-specific uncertainty. There are *M* Blue voters and *N* non-Blue voters. Ex ante, a voter knows whether she is Blue or non-Blue. Moreover, it is common knowledge that after the vote takes place, N_1 of the non-Blue voters will be chosen randomly as Green voters, and $(N - N_1)$ non-Blue voters will be chosen randomly as Red voters. The *S*, *G* and *L* shown in Table 1 represent the payoffs of the players.

Let $P = \frac{N_1}{N}$ denote the probability that a non-Blue voter will be chosen as a Green voter.

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can also construct examples in which uncertainty leads to adoption of reforms that turn out to be unpopular ex post. They further emphasize that there is an important asymmetry between the two cases. When a reform is passed that turns out to be unpopular, the implementation of the reform reveals information concerning who benefits or suffers. Therefore, if there is ever a chance to reconsider, the reform may be repealed. When reform is not adopted, no new information is revealed, since the status quo is maintained. This asymmetry is the reason why uncertainty can lead to a status quo bias. Our experiment does not attempt to test whether uncertainty leads to a status quo bias, which requires us to test whether uncertainty has the hypothesized effects with costly participation in both cases described above. Instead, our experiment directly tests the hypothesis that even in the presence of both inter- and intra-group conflicts, uncertainty can still reduce the probability of reform adoption even though the majority would prefer the reform in the absence of uncertainty. This is a necessary condition for FR's argument that uncertainty can lead to a status quo bias to hold in the presence of costly political participation. We should also mention that after the completion of this paper, we came across the paper by (Ciccone, 2004) who constructs a dynamic model of trade reform to further identify conditions under which individual-specific uncertainty will lead to status quo bias.

[5] For example, Schram and Sonnemans (1996b), Bornstein (1992) and Bornstein et al. (1994) employ equal numbers of players in each group, and Schram and Sonnemans (1996a) employ equal numbers in each group in 14 of their 16 sessions. Equal-sized groups is a special case that is qualitatively different from unequal-sized groups; for example, pure strategy Nash equilibria typically only exist with equal group sizes.

Let $T = PG + (1-P)L$ denote a non-Blue voter's expected payoff when the reform takes place but before she learns whether she will be a Green or a Red voter. Consistent with the original argument by FR, we shall assume that:

A 1. $S - T = S - \left[PG + (1-P)L\right] > 0$

This assumption means that when a non-Blue voter faces uncertainty regarding whether she will be Green or Red, she prefers the status quo to the reform.

A 2. $M < N$ and $(M + N_1) > (N - N_1)$

Assumption A2 says that under uncertainty opponents of the reform constitute the majority, but when there is no uncertainty opponents of the reform constitute the minority.[6]

We shall also assume that all voters incur a voting cost of *c*. For simplicity, we also adopt a status quo tie-breaking rule; that is, for the reform to be implemented it must receive a strict majority of votes among the votes cast. In case of a tie vote, the status quo is maintained.[7] We also assume that voters vote for the outcome that provides them with the highest expected profit. This seemingly innocuous assumption could be violated if, for example, participants have strongly other-regarding or egalitarian preferences. But in a recent experiment that also features voting by five-person groups, Frechette et al. (2003) find that players quickly abandon proposals for egalitarian distributions of benefits in favor of highly unequal distributions that are

[6] In the example given by FR discussed above, the total gain from reform is larger than the total loss and the reform constitutes a potential Pareto improvement over the status quo. This condition will be satisfied when $(M + N_1)(G - S) > (N - N_1)(S - L)$. In our experiment, however, reform brings a small1increase in the total payoffs (from 25 to 26 experimental dollars). Furthermore, when the reform occurred as a result of the participation of a large proportion of subjects with high voting cost, it no longer constitutes an efficiency-enhancing change (although it will still be efficiency-enhancing if the reform occurred as the result of one supporter voting for it while others abstain). Hence, our study should be interpreted as a study on how distributional conflict in the presence of uncertainty prevents reform from taking place, and is not about efficiency gains from reform.

[7] It can be shown that as in Palfrey and Rosenthal (1983), an alternative "coin flip" rule results in slightly more complicated expressions for the voting probabilities in this participation game with uncertainty, but it generates predictions that are qualitatively similar to the status quo tie-breaking rule. About 18 percent of the votes in this experiment were tied.

qualitatively consistent with theoretical predictions. Moreover, their statistical analysis shows that players vote to maximize their own earnings and not to promote equality of payoffs.

Let EV_V^i and EV_{NV}^i denote the expected payoffs to player *i* from voting and not voting, respectively, given the strategies of other players. Throughout the paper we assume risk neutrality. This is a reasonable assumption for our experiment with its average payments of less than \$30, and the model's implications are qualitatively unchanged for moderate levels of risk aversion.[8] Denote by *m* (*n*) the total number of actual voters among the Blue voters (non-Blue voters) and by m^i (n^i) the total number of actual voters among the Blues (non-Blues) other than *i*. The expected payoffs can be expressed as follows:

For Blues:

$$EV_V^i = G\,prob\left[m^i + 1 > n\right] + S\,prob\left[m^i + 1 \leq n\right] - c$$

$$EV_{NV}^i = G\,prob\left[m^i > n\right] + S\,prob\left[m^i \leq n\right]$$

For non-Blues:

$$EV_V^j = S\,prob\left[n^j + 1 \geq m\right] + T\,prob\left[n^j + 1 < m\right] - c$$

$$EV_{NV}^j = S\,prob\left[n^j \geq m\right] + T\,prob\left[n^j < m\right]$$

It is easy to verify that this game does not have a pure strategy Nash equilibrium for $c > 0$. It can also be shown that similar to the model without uncertainty considered in Palfrey and

[8] The main complication from adding risk aversion is that the indifference condition for the mixed strategy equilibrium cannot be simplified to an equation that involves a single key probability as shown in equations (2.1) and (2.2) below. But the same conclusions arise in a version of the model with risk aversion – for example, equilibrium vote probabilities vary monotonically with the voting cost *c*, and multiple equilibria of the type described below typically exist. As we show below, the observed behavior cannot be reconciled with risk neutral Nash equilibrium. We ultimately emphasize bounded rationality rather than risk aversion as an explanation of our observed deviations from the risk neutral Nash equilibrium, however. This is because risk aversion generally implies a reduction in the equilibrium voting probabilities for all types of voters, while the data usually indicate a voting rate that exceeds the risk neutral Nash equilibrium for at least one type of voter. The specific model of bounded rationality we use is consistent with this feature of the data.

Rosenthal (1983), this game has two classes of Nash equilibria: *mixed-pure strategy equilibria* and *totally mixed strategy quasi-symmetric equilibria*. Since the mixed-pure strategy equilibria involve coordination that is rather implausible, we shall focus on the totally mixed strategy quasi-symmetric equilibria (hereafter referred to simply as mixed strategy equilibria).[9] These equilibria are quasi-symmetric because all voters of a particular type vote with the same probability strictly between zero and one. Suppose that the Blues vote with a probability $q \in (0,1)$ and non-Blues vote with a probability $r \in (0,\ 1)$. For the Blues to be willing to randomize, it must be the case that:

$$EV_V^i = EV_{NV}^i \Leftrightarrow c = prob\left[m^i = n\right](G-S) \tag{2.1}$$

For the non-Blues to be willing to randomize, it must be the case that:

$$EV_V^j = EV_{NV}^j \Leftrightarrow c = prob\left[n^j = m-1\right](S-T) \tag{2.2}$$

When every Blue votes with probability q and every non-Blue votes with probability r,

$$prob\left[m^i = n\right] = \sum_{k=0}^{\min[M-1,N]} \binom{M-1}{k}\binom{N}{k} q^k (1-q)^{M-1-k} r^k (1-r)^{N-k}$$

$$prob\left[n^j = m-1\right] = \sum_{k=0}^{\min[M-1,N-1]} \binom{M}{k+1}\binom{N-1}{k} q^{k+1} (1-q)^{M-1-k} r^k (1-r)^{N-1-k}$$

Equations (2.1) and (2.2) can be rewritten, respectively, as:

$$\frac{c}{(G-S)} = \sum_{k=0}^{\min[M-1,N]} \binom{M-1}{k}\binom{N}{k} q^k (1-q)^{M-1-k} r^k (1-r)^{N-k} \tag{2.3}$$

[9] In the *mixed-pure strategy equilibria*, all voters of a particular type vote with a probability strictly between zero and one, while the voters of the other type are divided into two subgroups, one whose voters vote with certainty and one whose voters abstain with certainty. This type of equilibrium requires that voters of a particular type must be divided into subgroups of voters and non-voters in a precise way so that there is no uncertainty about how many votes one of the two alternatives will receive. Palfrey and Rosenthal (1983) consider these equilibria implausible, and Schram and Sonnemans (1996a) point out that they are especially implausible for the randomly regrouped ("strangers") design that their (and our) experiment employs.

$$\frac{c}{(S-T)}=\sum_{k=0}^{\min[M-1,N-1]}\binom{M}{k+1}\binom{N-1}{k}q^{k+1}(1-q)^{M-1-k}r^{k}(1-r)^{N-1-k} \tag{2.4}$$

The set of mixed strategy equilibria is characterized by equations (2.3) and (2.4).

The participation game without uncertainty shares all the above assumptions, except that each non-Blue voter now knows whether she is Green or Red ex ante.[10] In this case, the Blue and the Green voters have identical preferences ex ante, so we simply refer to them as the Blue/Green voters. Thus, by assumption A2, supporters of the reform constitute the majority. When every Blue/Green votes with probability *q* and every Red votes with probability *r*, for this Certain Roles environment it is straightforward to show that the set of mixed strategy equilibria is characterized by the following two equations:

$$\frac{c}{(G-S)}=\sum_{k=0}^{\min[M+N_1-1,N-N_1]}\binom{M+N_1-1}{k}\binom{N-N_1}{k}q^{k}(1-q)^{M+N_1-1-k}r^{k}(1-r)^{N-N_1-k} \tag{2.5}$$

$$\frac{c}{(S-L)}=\sum_{k=0}^{\min[M+N_1-1,N-N_1-1]}\binom{M+N_1}{k+1}\binom{N-N_1-1}{k}q^{k+1}(1-q)^{M+N_1-1-k}r^{k}(1-r)^{N-N_1-1-k} \tag{2.6}$$

2.3 Theoretical predictions

Our objective is to understand how changes in the cost of political participation and the presence or absence of uncertainty affect the incidence of reform. This requires us to first analyze how these changes affect the political participation incentives for different types of agents. Figure 2 illustrates how the equilibrium voting probabilities vary with (i) the voting cost *c* and (ii) the presence or absence of uncertainty for the payoff parameters used in the experiment. This participation game has two types of totally mixed strategy equilibria in both the certainty and the uncertainty cases, which we shall refer to as Type *A* and Type *B*.

A simple (non-strategic) cost-benefit reasoning suggests that since voting becomes less

[10] In the absence of uncertainty, our participation game is identical to the participation game analyzed in Palfrey and Rosenthal (1983).

attractive as the voting cost (*c*) increases, an increase in the voting cost should cause all voters to decrease their probability of voting. Figure 2, however, indicates that an increase in *c* has opposite effects on the equilibrium behavior of the majority and the minority. Recall that Blue/Green voters constitute the majority in the Certain Roles treatment while non-Blue voters constitute the majority in the Uncertain Roles treatment. For the Type *A* equilibria, the majority's probability of voting is decreasing in *c*, while the minority's probability of voting is increasing in *c*. For the Type *B* equilibria, the majority's probability of voting is increasing in *c*, while the minority's probability of voting is decreasing in *c*. Since these participation games involve more than two players, and a voter's preferences between voting and abstaining depend on both *q* and *r*, we cannot use a simple best response function diagram to understand the intuition behind these comparative static results. We therefore developed the "strategic indifference curves" shown in Figures 3 and 4 to provide intuition.

Figure 3 depicts the strategic indifference curves for the Certain Roles treatment with a voting cost of 0.3. The horizontal axis and vertical axis are *r* (the probability that a Red voter will vote) and *q* (the probability that a Blue/Green voter will vote). The curve labeled *AA* is a strategic indifference curve for a Blue/Green voter. *This is a set of (r, q) combinations such that if a Blue/Green voter expects that all Red voters will vote with probability r and all Blue/Green voters other than herself will vote with probability q, then she will be indifferent between voting or not voting*. The analogous curve labeled $A'A'$ is a strategic indifference curve for a Red voter.[11] For now ignore the curve labeled E_AR, which is useful in our subsequent discussion of the quantal response equilibrium.

[11] The term "indifference" here refers to the fact at any point on a strategic indifference curve a voter is indifferent between voting and abstaining. At two different points along a strategic indifference curve, however, a voter receives a different payoff. This differs from standard indifference curves in other economic applications such as in consumer theory.

At the intersection point of the strategic indifference curves of the representative Blue/Green voter and the Red voter—for example, point E_A, where *AA* intersects $A^{'}A^{'}$—the value of *(r, q)* is such that both types of voters are indifferent between voting or not. Therefore, an intersection point of the strategic indifference curves of both types of voters is a Nash equilibrium. Note that as long as we restrict our attention to quasi-symmetric equilibria, these strategic indifference curves can be used to analyze any team game—not just the participation game—that involves only two teams comprised of any finite number of players.

In the diagram, each type of voter has two strategic indifference curves, which is why multiple equilibria exist. In particular, point E_A is the Type *A* equilibrium in which the majority (the Blue/Green voters) vote with a higher probability than the minority (the Red voters). Point E_B, where *BB* (the "lower" strategic indifference curve for a Blue/Green voter) intersects $B^{'}B^{'}$ (the lower strategic indifference curve for a Red voter), is the Type *B* equilibrium in which the majority vote with a lower probability than the minority.

Why does each type of voter have two strategic indifference curves? For all *(r, q)* combinations above *AA*, a Blue/Green voter prefers to abstain rather than to vote. A Blue/Green voter strictly prefers to abstain if (the probability of her vote being decisive) × (the benefit from getting her preferred outcome) < *c*. In the region above *AA*, *q* is much larger than *r*, which implies that her Blue/Green group will almost certainly win. Therefore, the probability that her vote is decisive is too small to justify the cost of voting and she may as well free-ride on the efforts of her fellow team members. In the region bounded by her two indifference curves *AA* and *BB*, the race is sufficiently "close" so that she will strictly prefer to incur the cost to vote because there is a large enough probability that her vote will be decisive. In the region below *BB*, *q* is much less than *r*. The Blue/Green group will almost certainly lose in this situation. The probability of being decisive is again too small to justify the cost of voting and she may as well "give up" on the race. Similar explanations hold for the Red voter's preferences, except that above $A^{'}A^{'}$ the Red voter prefers to abstain because her team is too "far behind" in the race, while below $B^{'}B^{'}$ she prefers to abstain because her team is almost certain to win.

To illustrate the impact of differing voting costs, Figure 4 displays the voters' strategic indifference curves for the Certain Roles treatment with a cost of voting *c* = 0.7 and *c* = 0.3. The curves labeled *CC* and *DD* ($C^{'}C^{'}$ and $D^{'}D^{'}$) are the indifference curves for the Blue/Green voter (the Red voter) when *c* = 0.7. The increase in *c* causes the upper indifference curves to shift to the Southeast, but it causes the lower indifference curves to shift to the Northwest. The competition between groups must be more intense to justify incurring the higher voting cost, so both types of voters abstain for more combinations of (*r*, *q*).[12] The intersection point of the upper indifference curves for the two types of voters—that is, the Type *A* equilibrium—therefore shifts from E_A to $E^{'}_A$, which involves a lower *q* and a higher *r*.

Using the equilibrium *r* and *q* we can determine the equilibrium reform rate in the following way. Consider first the Certain Roles treatment. Let *m* (*n*) denote the total number of actual voters among the Blue/Green voters (Red voters). Reform will take place only when $m > n$ under the status quo rule. Therefore reform will take place with probability:

$$f = prob[m > n] = \sum_{m=1}^{M} \left\{ \binom{M}{m} q^m (1-q)^{M-m} \sum_{n=0}^{m-1} \binom{N}{n} r^n (1-r)^{N-n} \right\} \tag{2.7}$$

[12] For example, consider the effect of an increase in *c* on the Type *A* equilibrium. A Blue/Green voter is indifferent between voting and abstaining when (the probability of her vote being decisive) × (the benefit from getting her preferred outcome) = *c*. When *c* = 0.3, any point that lies on *AA* satisfies this indifference condition. However, when *c* increases to 0.7, the only way to maintain this indifference condition is to increase the probability that a vote by the Blue/Green voter will be decisive. Since *q* is larger than *r* for any point on *AA*, this requires either a *decrease* in *q*, an *increase* in *r*, or both. Therefore, an increase in *c* causes the Blue/Green voter's upper indifference curve to shift to the Southeast. Similar arguments explain why an increase in *c* causes the Red voter's indifference curve to shift to the Southeast.

Note that (2.7) also characterizes the equilibrium incidence of reform for the Uncertain Roles treatment when (i) m (n) denote the total number of actual voters among the Blue voters (Non-Blue voters) and (ii) q and r denote the probabilities that the Blue voters and the non-Blue voters vote in equilibrium, respectively. Figure 5 provides a comparison of how the equilibrium reform incidence varies with voting cost and for the Certain and Uncertain Role treatments. Note that Fernandez and Rodrik's original prediction that the incidence of reform will be lower in the presence of uncertainty holds with positive voting costs only for the Type A equilibria. Moreover, note that the difference between the reform rates in the Certain and Uncertain Role treatments declines as the voting cost increases. Finally, note that FR's original prediction, based on zero participation costs, holds regardless of the size of the incentive to support or oppose reform; however, with positive voting costs the difference in payoffs affects q and r (through equations 2.3 – 2.6) and thus the reform probability. The empirical model that includes errors in decision-making presented below in section 4.3 allows the size of the incentives to affect the reform probability even with zero participation costs. This is consistent with our observation that reform is often adopted even when it is only supported by a minority, since for our parameters the reformers have more reason to support reform than opponents have to support the status quo.

3. Experimental design

3.1 Treatment variables, design and procedures

We conduct treatments with voting costs of zero, 0.1, 0.3 and 0.7 experimental dollars. In the Certain Roles treatment it is clear from Table 1 that if Blue and Green subjects vote they should vote for the reform; and if Red subjects vote they should vote against the reform. In the Uncertain Roles treatment all Blue subjects learn their role before voting, but Green and Red subjects only learn that they are "non-Blue." For a non-Blue subject the expected value of the reform is 10/3. This is less than the certain payoff of 5 from the status quo, so if non-Blue subjects vote they should vote against the reform. Consistent with the model presented above, these payoffs and the number of subjects of each type are common knowledge.

We report 4 sessions using a total of 85 subjects. In each session 20 or 25 subjects vote in up to 40 decision periods. Decisions are framed as a choice between "outcome *X*" and "outcome *Y*." In each period subjects choose to vote for either *X* or *Y*, or abstain. All sessions employ the status quo tie-breaking rule; that is, for the reform to be implemented it must receive a strict majority of votes. All sessions are implemented using a web browser interface. The experiment instructions are available from the authors upon request.[13]

Each period the computer server randomly repartitions the 20 or 25 subjects in each session into four or five groups of five voters each. The server also randomly reassigns subjects to Blue, Red or Green roles. Group and role assignments are always private information. This random and anonymous reassignment procedure (sometimes called a "strangers" design) substantially reduces the repeated game incentives that would arise if groups remained intact for a sequence of periods (see, e.g., Andreoni and Croson (2004) for a discussion).[14]

Subjects remained either certain or uncertain of their roles throughout a session, so we evaluate the impact of this treatment variable using a between-subjects comparison. The voting

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[13] The instructions and decision screens use the voting terminology, unlike the more "neutral" terminology employed by Schram and Sonnemans (1996a, 1996b). Subjects in Schram and Sonnemans' study participate in influencing the outcome by buying an imaginary "disc." We believe that the voting terminology does not lead to a strong bias toward voting or abstaining. We therefore use this terminology to help subjects more readily understand the decision they face. In any case, this terminology is held constant across all sessions, so it cannot affect the conclusions regarding the comparative static hypotheses that are the focus of this research.

[14] A drawback of this random matching is that, strictly speaking, each session provides only one statistically independent observation after the first period. Experimenters have recently begun employing multiple, independent matching groups in individual sessions, increasing the number of independent observations to permit reliance on simple and conservative statistical tests. We have also employed this experimental design innovation in our ongoing research. For the present study, however, we use panel data techniques that are appropriate for non-independent observations, such as random effects regression models.

cost was varied within sessions, in ten-period blocks for each voting cost. That is, subjects participated in ten consecutive periods of one voting cost, followed by ten consecutive periods of another voting cost, and so on.[15] As shown in Table 2, each session began with a baseline block of zero voting costs, but the positive voting cost treatments were implemented in different orders in different sessions to avoid confounding the positive voting cost treatments with subject learning. We found no evidence that the treatment sequencing had a significant impact on behavior, so when presenting the results we pool the sessions.

All subjects were students recruited from undergraduate economics classes at Purdue University. No subject participated in more than one session reported here. Subjects' earnings during the experiment were denominated in experimental dollars, which were converted to U.S. dollars at a rate of 10 experimental dollars = 1 U.S. dollar. These earnings were paid in cash at the end of the experiment. Subjects' earnings ranged between U.S. $16.00 and $29.25, with a mean of $22.52. Sessions lasted between 80 and 105 minutes, including the instruction time.

Instructions were read aloud while subjects followed along on their own copy. At the beginning of each new period block the experimenter wrote the new voting cost on the whiteboard, and the session was paused for a few minutes while subjects reset their web browser for the new block. No communication took place during the experiment.

3.2 Hypotheses

Figures 2 and 5 summarize the main comparative static predictions of this participation game's mixed strategy Nash equilibria. The theoretical model highlights the fact that if the majority always vote with a higher probability than the minority—for example, if all the voters

[15] Due to a software bug, occasionally we were unable to conduct all ten periods in a block. This could lead to problems with the interpretation of the results if we used a repeated ("partners") design, because end-period effects might occur with repeated interaction of the same group of subjects. But since subjects were randomly reassigned to groups in a "strangers" design, we believe that this unexpected early termination is mostly inconsequential.

play according to the Type *A* equilibria both in the presence or absence of uncertainty—then uncertainty will reduce the incidence of reform. If, however, voters play the Type *B* equilibria (in which the minority vote with a higher probability than the majority) either in the presence or absence of uncertainty, then uncertainty may not decrease the incidence of reform. As we shall document later, the data are completely at odds with the Type *B* equilibria. Therefore, we focus on testing hypotheses derived from the comparative static predictions of the Type *A* equilibria.

Hypothesis 1: (a) Reform occurs with a lower probability in the Uncertain Roles treatment than in the Certain Roles treatment when voting is costless; and (b) Reform occurs with a lower probability in the Uncertain Roles treatment than in the Certain Roles treatment when voting is costly.

Part (a) of this hypothesis follows from the original argument in FR. Part (b) indicates that in this game with inter- and intra-group conflicts, there also exist equilibria in which individual-specific uncertainty can lead to resistance to reform, in a probabilistic sense.

Hypothesis 2: (a) Reform likelihood is increasing in the voting cost in the Uncertain Roles treatment; and (b) reform likelihood is decreasing in the voting cost in the Certain Roles treatment.

The final hypothesis considers the voting rates of each type of voter.

Hypothesis 3: In both the Certain Roles and Uncertain Roles treatments, (a) voters in the majority are less likely to vote as the voting cost increases; and (b) voters in the minority are more likely to vote as the voting cost increases.

4. Results

4.1. Does uncertainty lead to resistance to reform?

We find that uncertainty does reduce the rate of reform in this environment with both inter- and intra-group conflicts. Figure 6 presents the reform rates when pooling across all periods. When subjects are certain of their roles, they implement the reform in 73 to 82 percent of the periods. Consistent with Fernandez and Rodrik's original insight, adding uncertainty reduces the reform rate: in the Uncertain Roles treatment, subjects implement the reform in only 47 to 66 percent of the periods.[16]

Although this reduction in the reform rate is smaller than predicted by the theoretical model, the first column of Table 3 formally tests Hypothesis 1 and indicates that uncertainty has a statistically significant impact on the likelihood of reform in all four voting cost treatments. In this probit regression model the dependent variable equals 1 if the reform takes place, and 0 otherwise. The data are pooled across treatments, but the voting cost dummy variables and the interaction terms for the certainty treatment allow the impacts of certainty to differ in the various voting cost treatments.[17] All four certainty treatment interaction estimates are positive and highly significant, which indicates that in all four voting cost treatments the reform rates are higher when voters are certain of their payoff from reform. The positive estimate on ln(period) indicates

[16] We do not present the time series of reform rates in Figure 6 because there exists little evidence of significant reform rate trends across periods. Reform rates rise only moderately (but by a statistically significant amount) in two or three of the eight treatment conditions. To establish this we regressed the reform rate on time using alternative specifications (e.g., period, 1/period, ln(period)), and found three cases in which the reform rate rose modestly over time: (1) with vote cost=0 and Certain Roles, the reform rate rose after periods 1 and 2 because several Blue/Green subjects incorrectly vote to maintain the status quo in period 1 and 2 of this initial treatment; (2) with vote cost=0.7 and Uncertain Roles, the reform rate rose because more non-Blue subjects vote for the reform in later periods; and (3) with voting cost=0.1 and Uncertain Roles, there is (weaker) evidence that the reform rate rose because non-Blue subjects are less likely to vote in later periods—which leads to a higher reform rate since when non-Blue subjects vote they vote to maintain the status quo. We account for these minor time trends in the regression analysis in Table 3.

[17] The individual voting models presented below in Table 4 employ individual random subject effects to account for significant subject heterogeneity. Individual subject effects are obviously inappropriate for the present model of the group (reform) outcome, since these outcomes are determined by 5-subject groups that are randomly reshuffled each period. We explored but rejected the appropriateness of random session effects in these reform rate models (e.g., the relevant $\chi^2_{1\text{ d.f.}}$ test statistics were less than 0.1). It appears that our use of a random matching protocol averages out the subject heterogeneity across groups.

that reform rates tend to increase over periods.[18] A series of Wald tests (not shown on the table) indicate that the impact of certainty is similar in all four voting cost treatments, since pairwise tests always fail to reject the null hypothesis of equality of the certainty interaction dummies ($\chi^2_{1\ \text{d.f.}}$ test statistics range between 0.04 and 3.37).

Figure 7 displays the participation rates for each type of voter, and these rates suggest why uncertainty does not reduce the reform rate by a large amount in this environment.[19] Blue subjects in the Uncertain Roles treatment (and Blue/Green subjects in the Certain Roles treatment) strongly prefer reform, and they participate at relatively high rates—usually exceeding 80 percent and only decreasing by a small amount as the voting cost increases. Red subjects in the Certain Roles treatment (and all non-Blue subjects in the Uncertain Roles treatment) prefer the status quo, but they participate at a lower rate and try to free ride on the votes of others in their group. Exacerbating this problem, particularly in the voting cost=0 case which began each session, subjects sometimes voted for the outcome that gives them a lower expected profit. We call these mistakes "misvotes." Consequently, non-Blue subjects are frequently unable to maintain the status quo even though they benefit from the rule that the status quo wins any tie votes. Even when the status quo-preferring subjects are in the majority (i.e., in the Uncertain Roles treatment) their lower participation and higher misvote rate (see Table 5) allows them to maintain the status quo in only about half of the periods. Note that on average all types of voters

[18] Period is coded from 1 to 10 in each voting cost treatment, and is restarted at 1 at the beginning of each treatment. Alternative specifications (1/period, or simply period) provided qualitatively similar conclusions.

[19] Figure 7 does not display the time series of these voting rates, but we found very little evidence that these rates varied systematically over time. As with the reform rates, we regressed the voting rates on some time trends using alternative specifications (e.g., period, 1/period, ln(period)) to determine if any statistical evidence exists for significant changes in voting rates over time. Of the 16 separate time series of voting rates (4 voting costs × 2 Certain/Uncertain Roles × 2 voter types in each treatment), we found a significant time trend in only one case: with vote cost=0.1 and Uncertain Roles, non-Blue subjects vote at a declining rate over time. We estimated alternative specifications of the voting models shown in Table 4 with time trends, but none of these trends even remotely approached standard significance levels. Therefore, to improve the efficiency of the Table 4 estimates we did not include an insignificant time trend.

reduce their participation rate as the participation cost increases. We show next that this observed behavior is inconsistent with the mixed strategy Nash equilibrium of this participation game.

4.2 Does an increase in participation cost reduce the incidence of reform and participation?

Note that even without reference to the theoretical model developed in Section 2, our experiment allows us to investigate empirically whether uncertainty reduces the incidence of reform. Relating the experimental findings to the theoretical model explicitly, however, provides a framework to evaluate how changes in participation cost affect the incidence of reform and participation.

Figure 6 indicates that across all voting cost treatments, the reform rate is higher in the Certain Roles treatment. A comparison with Figure 5 indicates that this result is qualitatively consistent with the Type *A* equilibria, but is inconsistent with the Type *B* equilibria. Figure 5 also shows that in the Type *A* equilibria the reform rate also rises as the voting cost rises when voters face uncertainty, and it falls as the voting cost rises when voters do not face uncertainty. Contrary to this Hypothesis 2, the visual impression from Figure 6 is that the reform rate does not vary systematically with the voting cost.

The regression results in the second and third columns of Table 3 are consistent with this impression. Column 2 presents a probit model of the reform rate for the Uncertain Roles treatment, with dummy variables for the three positive voting cost treatments. The zero voting cost treatment is the omitted dummy variable, whose reform rate is captured by the intercept term. None of the voting cost dummy variable coefficients are significantly different from zero, indicating that the reform rates in these positive voting cost treatments are not significantly different from the reform rate with zero voting cost. Moreover, a Wald test fails to reject the null hypothesis that the voting cost=0.1 and voting cost=0.3 dummy variable coefficients are equal.

The Wald tests do, however, reject the null hypothesis that the dummy variable coefficients for the voting cost=0.7 treatment are equal to those for the voting cost=0.1 and 0.3 treatments, in the direction predicted in Hypothesis 2(a).

Column 3 of Table 3 reports the analogous regression for the Certain Roles treatment. As in the Uncertain Roles treatment, none of the voting cost dummy variable coefficients are significantly different from zero. The Wald tests indicate that the voting cost dummy variable coefficients are also not significantly different from each other, so the data from this treatment provide no evidence to support Hypothesis 2(b).

Our analysis assumes that when subjects vote, they vote for the outcome that gives them a higher expected payoff. For example, Blue and Green subjects in the Certain Roles treatment should vote for the reform if they vote, and Red subjects should vote for the status quo if they vote. As an initial check that subjects understood these basic incentives, we examined the "misvote" rate in the Certain Roles treatment, where a misvote is defined as a status quo vote by a Blue or Green subject, or a reform vote by a Red subject. The misvote rate was 16.7 percent in the first two periods of these 40-period sessions, and it declined to 8.7 percent in the remaining periods of the initial zero voting cost treatment. In the positive voting cost treatments (periods 10 through 40), the misvote rate varied between 3.1 and 4.4 percent. Similar results hold for the Blue subjects in the Uncertain Roles treatment. Therefore, errors quickly decline to low levels, especially when compared to the error rates estimated in other settings such as voluntary contribution games (Andreoni, 1995; Houser and Kurzban, 2002).

Given these low error rates, for now we focus on whether or not subjects vote. (We revisit misvotes later in the quantal response equilibrium analysis.) The overall voting rates shown in Figure 7 indicate that all voter types vote at a lower rate as the voting cost increases.[20] This is consistent with the first part of Hypothesis 3, which predicts an inverse relationship between the voting cost and the voting rate for voters in the majority (i.e., Blue/Green voters in the Certain Roles treatment, and non-Blue voters in the Uncertain Roles treatment). But it is inconsistent with the second part of Hypothesis 3, which predicts that the voting rate for voters in the minority is increasing in the voting cost. Nevertheless, the voting rates overall are more consistent with the Type *A* equilibria for voters in the majority than for voters in the minority.[21]

Table 4 presents statistical evidence to document the negative relationship between voting cost and the voting rate displayed in Figure 7. These probit models have a dependent variable equal to 1 if the subject votes, and 0 otherwise. Individual subjects often vote at substantially different rates; for example, 10 of the 85 subjects vote in every period, while 9 subjects vote in less than 60 percent of the periods. One subject never voted, while the other 84 subjects voted in at least half of the periods. To account for this subject heterogeneity (and the repeated measures of this panel dataset), the estimates shown in Table 4 are based on a random subject effect error specification.

The voting cost treatment dummy variables are negative in all of the models shown in Table 4, and they are highly significant for all but the Blue subjects in the Uncertain Roles treatment (column 3). The negative coefficient estimates indicate that subjects are less likely to

[20] Moreover, 35 of the 85 individual subjects exhibit voting rates that (weakly) monotonically decline as the voting cost increases.

[21] For positive voting costs, voting rates for voters in the majority differ from the Type *A* equilibria by 0.03 to 0.14, while they differ from the Type *B* equilibria by 0.6 to 0.85. A binomial test (conducted for individual periods so that each subject contributes no more than one observation) for voters in the majority fails to reject the Type *A* equilibrium voting rate in 41 of 59 periods, but it never fails to reject the Type *B* equilibrium. Voting rates for voters in the minority are closer to the Type *B* equilibria, however. They are usually within 0.2 of the Type *B* equilibria, and are usually more than 0.3 away from the Type *A* equilibria. But neither type of equilibria accurately describes the behavior of the minority voters, which we address in the quantal response equilibrium analysis in the next subsection. For the minority voters, a binomial test fails to reject the Type *B* equilibria in 25 of the 49 periods in which it exists, and it fails to reject the Type *A* equilibria in 15 of the 59 periods.

vote when voting costs are positive, compared to the omitted dummy variable case of zero voting costs. These negative coefficient estimates are only consistent with the Type *A* equilibrium for the voters in the majority (columns 1 and 4); in this equilibrium the prediction is for positive coefficient estimates for the voters in the minority (columns 2 and 3). Moreover, the Wald tests indicate that the voting likelihood can almost always be ordered inversely by the voting cost. Therefore, all types of voters participate at a lower rate as the voting cost increases. This is consistent with only the first part of Hypothesis 3.[22]

4.3 Can the quantal response equilibrium organize the data better?

The Type *A* mixed strategy equilibria analyzed above accurately describe the participation rates for the subjects in the majority. But these equilibria predict that increases in the voting cost increase the voting rate of the minority voters, and this prediction is clearly inconsistent with the data. These equilibria also predict voting rates that are lower than observed for the subjects in the minority. More generally, it is well recognized that mixed strategy equilibria yield comparative static predictions that are often inconsistent with observed behavior (see, for example Cheng and Zhu, 1995, Goeree and Holt, 2000, and the references cited there). One unintuitive feature of mixed strategy equilibrium is that in deciding how to randomize between her set of available pure strategies, a player selects her choice probability so as to make others indifferent between a particular set of pure strategies. It is therefore natural to ask whether modifications to the equilibrium concept can explain the behavior of *both* the voters in the

[22] The reader may notice that the intra-group free-riding incentive faced by subjects in this participation game is similar in some respects to threshold public goods voluntary contribution games. Croson and Marks (2000) conduct a meta-analysis of such games and find that contributions are higher when the step-return (SR=aggregate group payoff from the public good/cost of meeting the contribution threshold) is higher. The (numerator) payoff in the SR definition is constant for our experiment, since reform and status quo payoffs are constant across treatments. Higher voting costs could lead to higher costs of meeting the threshold (the denominator), so our lower contribution (voting) rate for higher voting costs would seem to be consistent with Croson and Marks' conclusion regarding the step-return. However, this participation game has the additional complication of an inter-group conflict, which makes the threshold endogenous since it depends on the contributions (votes) of the other group. Thus, the step-return is also endogenous in this environment.

majority and the minority. Here we consider one such modification of Nash equilibrium—the quantal response equilibrium (QRE)—developed for normal form games with finite strategy sets by McKelvey and Palfrey (1995). This approach does not abandon the concept of equilibrium, but it relaxes the assumption of perfect rationality.

In a QRE, an agent's expected payoff from each action is determined by the choice probabilities of the other agents. A quantal response is a smoothed-out best response, in the sense that a player does not choose a best response with probability one; instead, he chooses actions that yield higher expected payoffs with higher probability. A set of choice probabilities by all players constitute a QRE when each player's choice probabilities are a stochastic best response to the choice probabilities of all other players. This kind of choice framework may be modeled by specifying the payoff associated with a choice as the sum of two terms. One term is the expected utility of a choice, given the choice probabilities of other players. The second term is a random variable that reflects idiosyncratic aspects of payoffs that are not formally modeled.

In the *logit*-QRE (see, for example, McKelvey and Palfrey, 1995, Capra et al., 1999), which we consider here, each agent's choice probabilities follow a multinomial logit distribution with an error parameter μ. This error parameter can be interpreted as the likelihood of making mistakes or incorrectly evaluating expected payoffs. In this voting experiment, subjects have three choices—(1) vote for the outcome with the highest expected payoff; (2) vote for the alternative outcome (referred to above as a misvote); or (3) abstain. Index these three choices i=*V, MV* and *NV*, respectively, and denote the expected payoff of choice i as EV_i. These expected payoffs are determined by the choice probabilities of other agents. The choice probabilities in a *logit*-QRE are given by

$$Prob_i = \frac{e^{EV_i/\mu}}{\sum\limits_{k \in V,\, MV,\, NV} e^{EV_k/\mu}}, \; i = V, MV \text{ and } NV. \tag{4.1}$$

In this formulation, as the error parameter μ decreases each agent puts less weight on choices that yield sub-optimal expected payoffs. As μ approaches zero, the choice probabilities are very sensitive to expected payoff differences, so QRE outcomes approach the standard mixed strategy equilibria presented in Section 2. As μ increases, behavior essentially becomes random since choice probabilities depend less and less on expected payoffs, and in the limit each agent places equal (1/3) probabilities one each of the three pure strategies.

Figure 8 illustrates how the vote probabilities change in the QRE as μ increases for one of the experimental treatments. The equilibrium misvote rates (shown with the dotted lines) start at 0 for low μ before rising above 0.1 once μ reaches about 1. The curve E_AR in Figure 3 illustrates the impact of increasing μ in the (r, q) space, linking the Nash equilibrium ($\mu = 0$) to totally random behavior ($\mu = \infty$) denoted by R. Note that although the QRE has the free parameter μ, this curve illustrates that it implies a *specific* path that connects E_A to R as μ varies. It is not the case that by varying μ one can make the QRE consistent with any observed behavior.

Importantly, in this game a QRE with a small amount of decision error is consistent with both of the empirical findings that could not be explained by the mixed strategy Nash equilibrium—that all voters abstain at relatively low rates and that voting rates decrease for both voters in the majority and the minority as voting costs increase. Note from Figure 8 how minority (Red) voters in the Certain Roles treatment abstain at a lower rate as μ rises above 0. In this treatment we observed these voters abstain about 40 percent of the time (recall Figure 7), far below the Nash equilibrium (μ=0) abstain rate of 80 percent. A small amount of decision error ($\mu \geq 0.2$), however, reduces the QRE abstain rate for this type of voter to below 40 percent.

Moreover, numerical calculations for all experimental treatments indicate that as long as the error rate μ exceeds approximately 0.2, QRE voting rates decline with increases in the voting cost for all voter types. By contrast, in the Nash equilibria one type of voter always increases her voting rate as the voting cost increases.

Table 5 reports maximum likelihood estimates of the error rate μ for the logit-QRE. The results indicate a moderate level of decision noise ranging between μ=0.41 and 0.58 that is rather consistent across treatments. A Wald test is unable to reject the null hypothesis that these μ estimates are not significantly different across the four Uncertain Roles voting costs ($\chi^2_{3\text{ d.f.}}$ = 4.86), but this test does reject the null of equal μ across the four Certain Roles voting costs ($\chi^2_{3\text{ d.f.}}$ = 9.54; five-percent critical value = 7.82). The value of the likelihood function estimated for the QRE is substantially greater than the simple behavioral benchmark of random play (i.e., one-third probability on all three pure strategies).

Compared to the Nash equilibrium, the QRE more accurately describes the voting rates, abstain rates and misvote rates. For example, in the Nash equilibrium one type of voter always votes at a lower rate when the voting cost increases, but with the exception of *c*=0 with Certain Roles, the QRE correctly predicts that the abstention rate increases with the voting cost for both minority and majority votes. The point predictions of the QRE are particularly accurate for voters in the majority. Also consistent with the data but inconsistent with the Nash equilibrium, the QRE usually predicts that participation rates typically exceed 50 percent for both minority and majority voters. There is still room for improvement, of course. In particular, for the higher vote costs, the QRE for Red voters in the Certain Roles treatment predicts higher participation rates than observed; and the QRE for Blue voters in the Uncertain Roles treatment fails to predict the high observed participation rate.

5. Conclusions

This paper integrates the participation game into the FR framework to study whether or not individual-specific uncertainty will still lead to resistance to reform in the presence of costly political participation, as well as how changes in the cost of political participation affect the incidence of reform and the incidence of participation by both reform supporters and opponents. In our experiment, we find that (i) uncertainty does reduce the incidence of reform even with costly political participation, despite the fact that theoretically, uncertainty can increase or decrease the incidence of reform when political participation is costly; (ii) an increase in the cost of political participation reduces the participation of all agents, regardless of whether they belong to the majority or minority; and (iii) overall, changes in the cost of political participation do not have significant impact on the incidence of reform in this experiment. We also show that our finding that a change in the cost of political participation has similar impacts on both the majority and minority is inconsistent with a mixed strategy Nash equilibrium, but is consistent with the quantal response equilibrium.

Besides providing experimental evidence that uncertainty can lead to non-adoption of reform even with costly political participation, our experimental findings also generate interesting questions for future theoretical and field studies on reform. As we have elaborated elsewhere (Cason and Mui, 2003), by providing direct controlled tests of theoretical models and by generating new empirical behavioral regularities in these reform settings, laboratory studies of the political economy of reform can complement theoretical and field empirical work in this area. For example, our experiment shows that all types of subjects participate at a lower rate as the political participation cost increases, contrary to the Nash equilibrium prediction for this participation game. If future laboratory studies indicate that the negative relationship between participation costs and participation rates for both the majority and the minority is robust—in particular, if it holds with large groups—this suggests that researchers should investigate whether this regularity is also observed in the field, as well how this behavior may be important in determining whether reform will take place. Furthermore, our analysis shows that a quantal response equilibrium approach that allows for bounded rationality in decision-making provides a reasonably good explanation of the data. The literature on the political economy of reform has recognized the potential importance of bounded rationality, although there has been only limited effort to investigate its importance in formal models (see, for example, Robinson, 1998, Drazen, 2000 and van Winden, 2002 for discussion on this issue). Our findings suggest that models that allow for both strategic interactions and bounded rationality may be useful in studying the political economy of reform.

Finally, this study introduces intra-group conflict by simply assuming that each agent incurs the same cost of political participation regardless of whether she belongs to the group opposing or supporting the reform. Future research can study richer environments that allow for other kinds of heterogeneity. For example, as emphasized in the recent literature on special interest politics (see, for example, Grossman and Helpman, 2001), special interest group members may decide not only whether to participate in the group's effort to defeat the other group in influencing the policy outcome, but also *how much* to participate in this process. Members within the same group may also have different impacts on the groups' ability to influence political outcomes. Heterogeneity can also arise when the majority and the minority face different costs of political participation. This can be the case, for example, for reforms that cause a conflict between urban and rural interests.

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Table 1: Subject roles and payoffs for each policy outcome

	Blue Subjects	Green Subjects	Red Subjects
Number of that Type	2	1	2
Earnings from Outcome *X* (Status Quo)	5 Experimental Dollars (***S***)	5 Experimental Dollars (***S***)	5 Experimental Dollars (***S***)
Earnings from Outcome *Y* (Reform)	8 Experimental Dollars (***G***)	8 Experimental Dollars (***G***)	1 Experimental Dollars (***L***)

Table 2: Summary of four experimental sessions

	Number of Subjects	Period Block 1	Period Block 2	Period Block 3	Period Block 4
Session 1—Certain Roles	20	Voting Cost=0	Voting cost=0.7	Voting Cost=0.1	Voting Cost=0.3
Session 2—Uncertain Roles	20	Voting Cost=0	Voting Cost=0.7	Voting Cost=0.1	Voting Cost=0.3
Session 3—Certain Roles	25	Voting Cost=0	Voting Cost=0.3	Voting Cost=0.1	Voting Cost=0.7
Session 4—Uncertain Roles	20	Voting Cost=0	Voting Cost=0.3	Voting Cost=0.1	Voting Cost=0.7

Table 3: Probit regressions of reform outcomes

Dependent Variable = 1 if Reform is adopted, =0 otherwise

Variable or Statistic	All Treatments Pooled (1)	Uncertain Roles Treatment (2)	Certain Roles Treatment (3)
Intercept		-0.089 (0.213)	0.421* (0.212)
Voting Cost=0 Dummy Variable (VCDUM0)	-0.074 (0.182)		
Voting Cost=0.1 Dummy Variable (VCDUM1)	-0.254 (0.184)	-0.179 (0.205)	0.175 (0.217)
Voting Cost=0.3 Dummy Variable (VCDUM3)	-0.285 (0.185)	-0.210 (0.208)	0.287 (0.218)
Voting Cost=0.7 Dummy Variable (VCDUM7)	0.192 (0.184)	0.267 (0.203)	0.210 (0.215)
Certainty Dummy Variable * Voting Cost=0 Dummy Variable	0.480* (0.208)		
Certainty Dummy Variable * Voting Cost=0.1 Dummy Variable	0.834** (0.213)		
Certainty Dummy Variable * Voting Cost=0.3 Dummy Variable	0.977** (0.217)		
Certainty Dummy Variable * Voting Cost=0.7 Dummy Variable	0.423* (0.210)		
Ln(Period)	0.153* (0.076)	0.164 (0.154)	0.142 (0.109)
Wald Test of VCDUM1 = VCDUM3 (χ^2 with 1 d.f.)		0.02	0.26
Wald Test of VCDUM3 = VCDUM7 (χ^2 with 1 d.f.)		5.12*	0.13
Wald Test of VCDUM1= VCDUM7 (χ^2 with 1 d.f.)		4.60*	0.03
Number of Observations	643	300	343
Log likelihood function	-377.3	-201.7	-175.6
Restricted log likelihood	-404.7	-206.4	-177.6
Significance of Regression	< 0.001	0.049	0.422

Notes: Standard errors are shown in parentheses. * (**) indicates that the coefficient estimate is significantly different from zero or the test statistic rejects the indicated null hypothesis at the 5 percent (1 percent) significance level.

Table 4: Probit regressions of voting decision

Dependent Variable = 1 if the subject votes in the current period, =0 if the subject abstains

Variable or Statistic	Blue/Green Subjects in Certain Roles Treatment (1)	Red Subjects in Certain Roles Treatment (2)	Blue Subjects in Uncertain Roles Treatment (3)	Non-Blue Subjects in Uncertain Roles Treatment (4)
Intercept	2.774** (0.191)	1.801** (0.240)	2.687** (0.191)	1.587** (0.143)
Voting Cost=0.1 Dummy Variable (VCDUM1)	-0.905** (0.200)	-1.129** (0.205)	-0.552 (0.378)	-0.728** (0.120)
Voting Cost=0.3 Dummy Variable (VCDUM3)	-1.240** (0.207)	-1.509** (0.218)	-0.368 (0.343)	-1.320** (0.134)
Voting Cost=0.7 Dummy Variable (VCDUM7)	-1.589** (0.192)	-1.984** (0.211)	-1.155** (0.403)	-1.694** (0.134)
Wald Test of VCDUM1 = VCDUM3 (χ^2 with 1 d.f.)	4.35*	7.29**	0.42	12.95*
Wald Test of VCDUM3 = VCDUM7 (χ^2 with 1 d.f.)	9.94**	17.73**	9.30**	8.61**
Wald Test of VCDUM1 = VCDUM7 (χ^2 with 1 d.f.)	24.38**	42.84**	9.36**	61.69**
Number of Observations	1029	686	600	900
Log likelihood function	-284.7	-333.1	-119.7	-428.9
Restricted log likelihood	-396.1	-440.9	-144.3	-560.3
Significance of Regression	< 0.001	< 0.001	< 0.001	< 0.001

Notes: Models are estimated using a random effects error structure, with the subject as the random effect. Standard errors are shown in parentheses. * (**) indicates that the coefficient estimate is significantly different from zero or the test statistic rejects the indicated null hypothesis at the 5 percent (1 percent) significance level.

Table 5: Maximum likelihood estimates of quantal response equilibrium voting participation model

		Red or non-Blue			Blue or Blue/Green					Log-Likelihoods	
		r	misvote	abstain	*q*	misvote	abstain	μ	Obs.	QRE	Random Play
Certain Roles	Actual	0.78	0.14	0.08	0.87	0.09	0.05				
Voting Cost=0	QRE Predicted	0.74	0.03	0.23	0.75	0.02	0.24	0.53 (0.018)	390	-288.85	-428.46
	Nash Predicted	1	0	0	1	0	0				
	Actual	0.66	0.04	0.30	0.88	0.03	0.09				
Voting Cost=0.1	QRE Predicted	0.69	0.11	0.20	0.85	0.03	0.12	0.58 (0.043)	425	-253.36	-466.91
	Nash Predicted	0.11	0	0.89	0.94	0	0.06				
	Actual	0.51	0.08	0.41	0.82	0.02	0.16				
Voting Cost=0.3	QRE Predicted	0.68	0.09	0.23	0.86	0.01	0.13	0.50 (0.061)	450	-323.58	-494.38
	Nash Predicted	0.20	0	0.80	0.89	0	0.11				
	Actual	0.42	0.04	0.54	0.77	0.03	0.21				
Voting Cost=0.7	QRE Predicted	0.70	0.03	0.27	0.82	0.004	0.18	0.41 (0.138)	450	-355.59	-494.38
	Nash Predicted	0.36	0	0.64	0.83	0	0.17				
Pooled Certain								0.52 (0.018)	1715	-1226.15	-1884.12
Uncertain Roles	Actual	0.65	0.25	0.09	0.96	0.02	0.02				
Voting Cost=0	QRE Predicted	0.68	0.11	0.21	0.59	0.12	0.29	0.57 (0.030)	400	-312.67	-439.45
	Nash Predicted	1	0	0	1	0	0				
	Actual	0.58	0.17	0.25	0.94	0.01	0.05				
Voting Cost=0.1	QRE Predicted	0.67	0.10	0.23	0.57	0.10	0.32	0.54 (0.033)	360	-283.19	-395.50
	Nash Predicted	0.82	0	0.18	0.40	0	0.60				
	Actual	0.50	0.10	0.40	0.93	0.03	0.04				
Voting Cost=0.3	QRE Predicted	0.67	0.07	0.26	0.55	0.06	0.39	0.46 (0.034)	340	-263.69	-373.53
	Nash Predicted	0.74	0	0.26	0.62	0	0.38				
	Actual	0.35	0.13	0.52	0.82	0.04	0.14				
Voting Cost=0.7	QRE Predicted	0.57	0.05	0.38	0.39	0.06	0.55	0.57 (0.070)	400	-353.02	-439.45
	Nash Predicted	0.64	0	0.36	0.94	0	0.06				
Pooled Uncertain								0.54 (0.020)	1500	-1215.00	-1647.92
All Pooled								0.52 (0.012)	3215	-2441.59	-3532.04

Note: Standard errors (for the QRE parameter μ) shown in parentheses.

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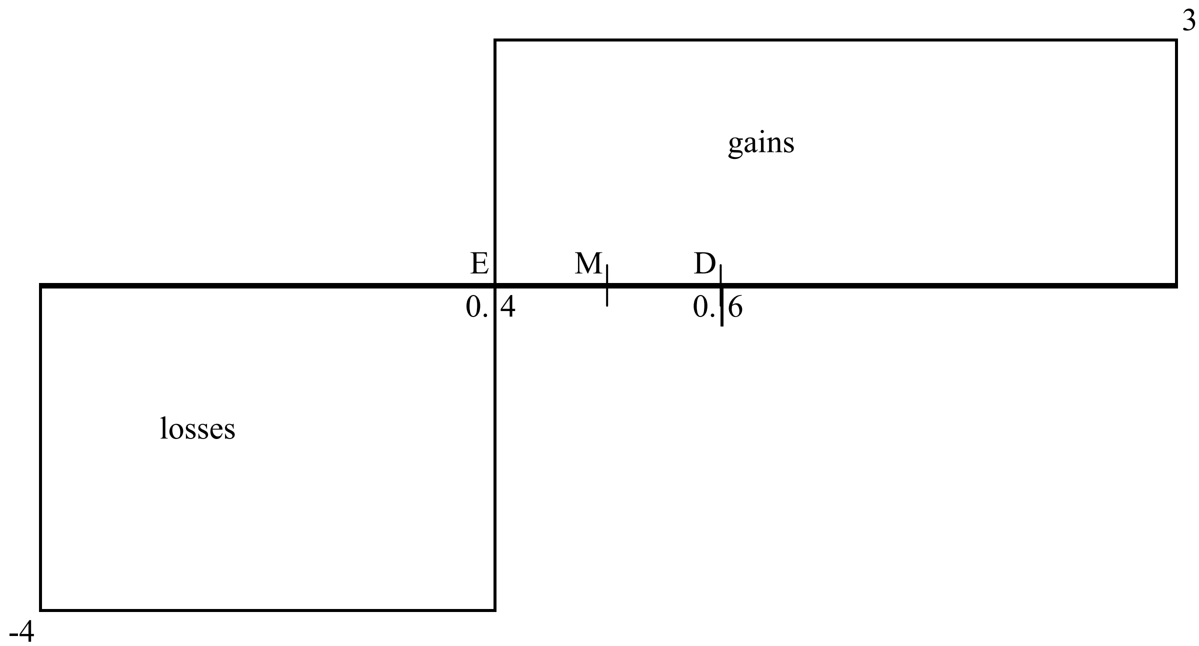
A. Majority is better off with reform ex post:



B. But expected benefit to reform is negative for the majority ex ante:

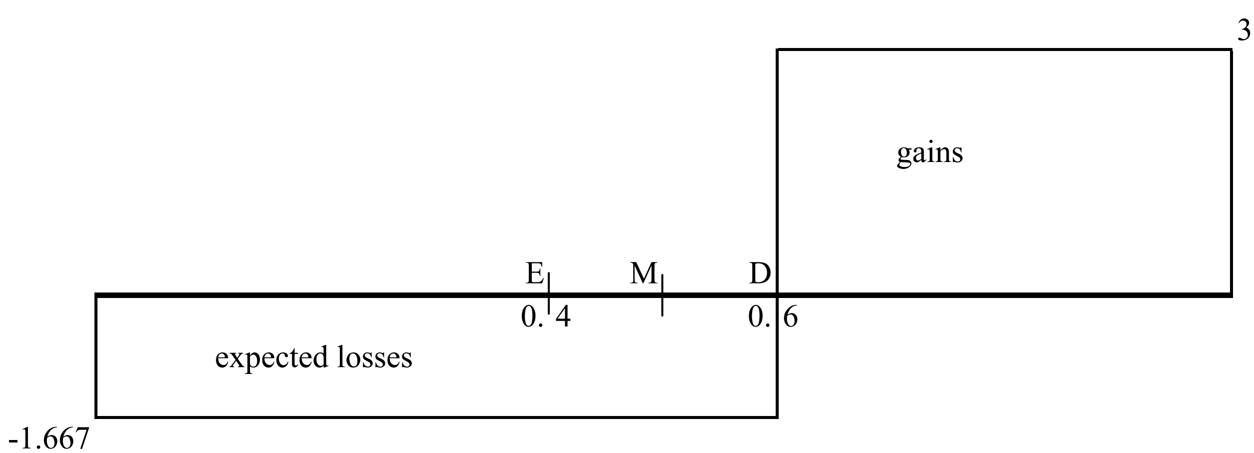


Fig. 1. Example gains and losses from reform (Fernandez and Rodrik (1991) example)

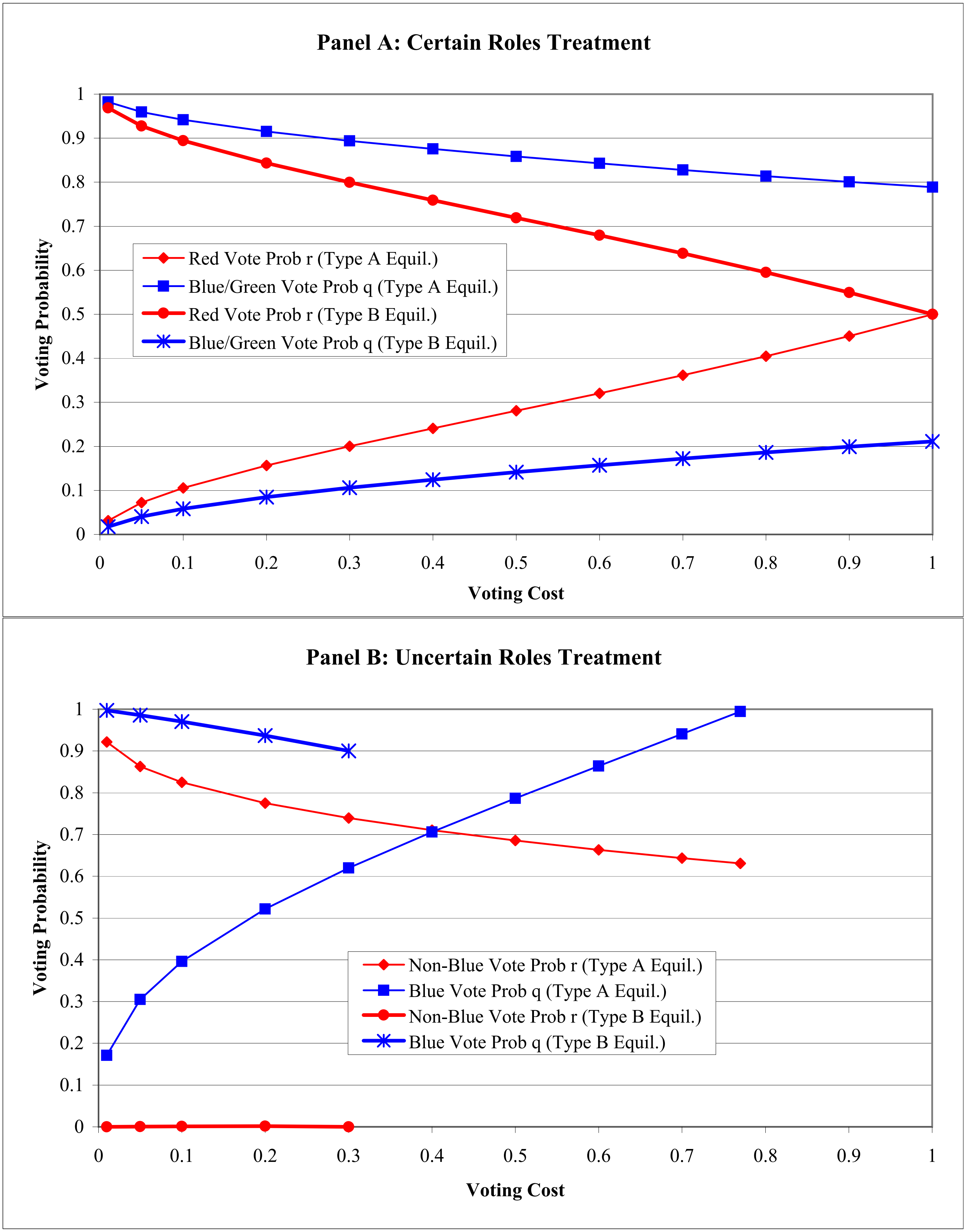


Fig. 2. Totally Mixed Strategy Quasi-Symmetric Equilibrium Vote Probabilities

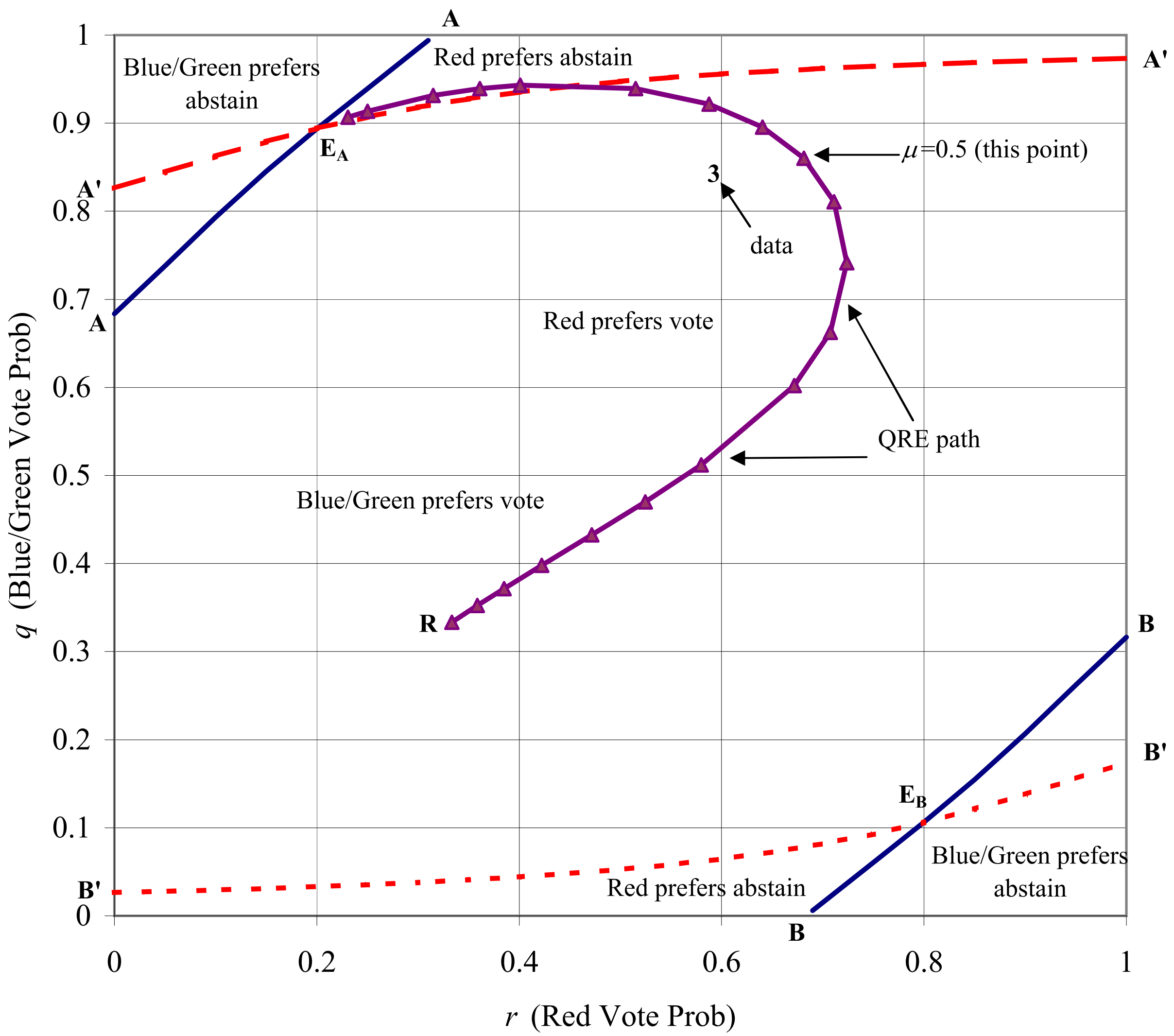


Fig. 3. Strategic Indifference Curves for Certain Roles, Vote Cost=0.3

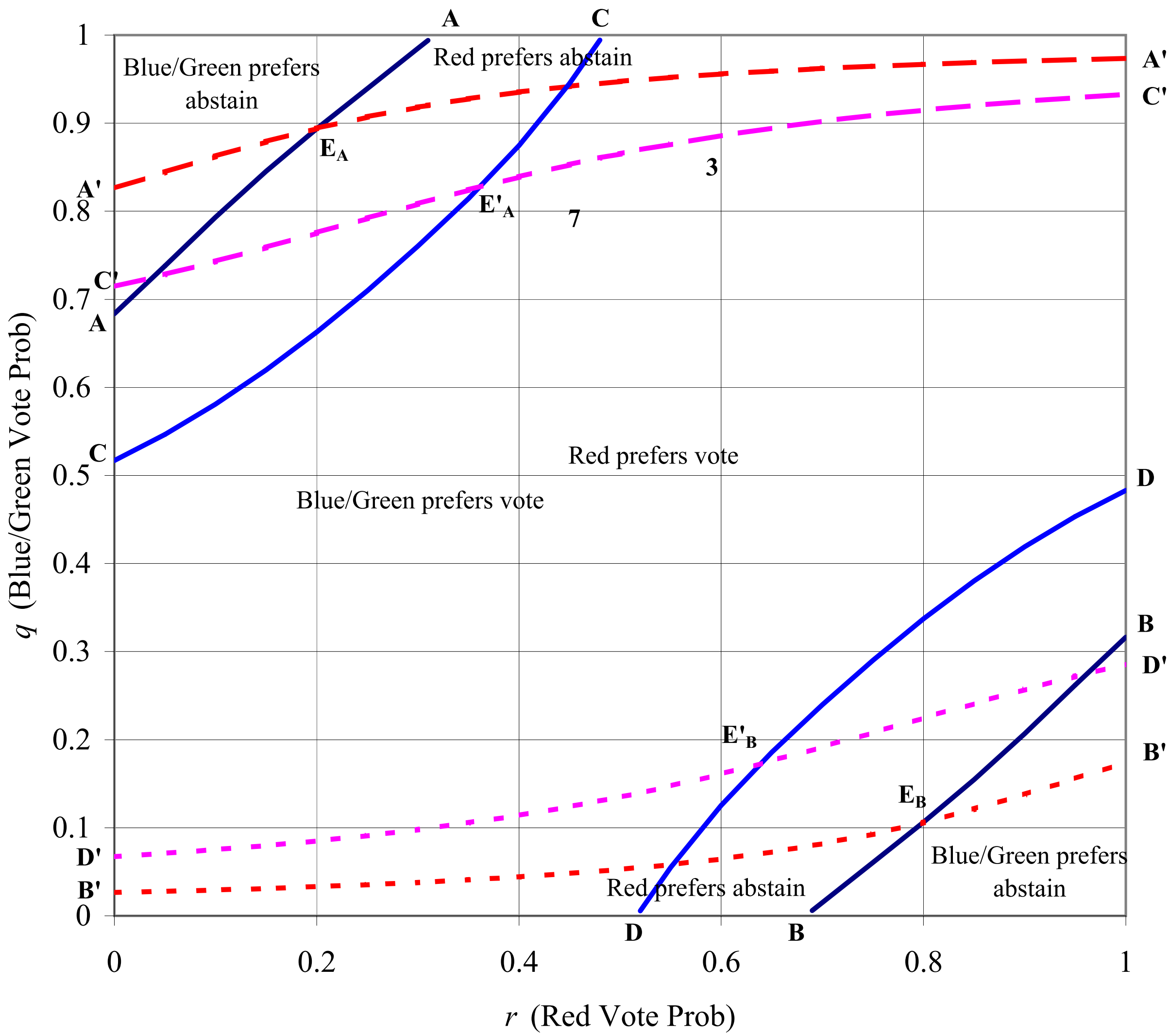


Fig. 4. Strategic Indifference Curves for Certain Roles, Vote Cost=0.3 and 0.7

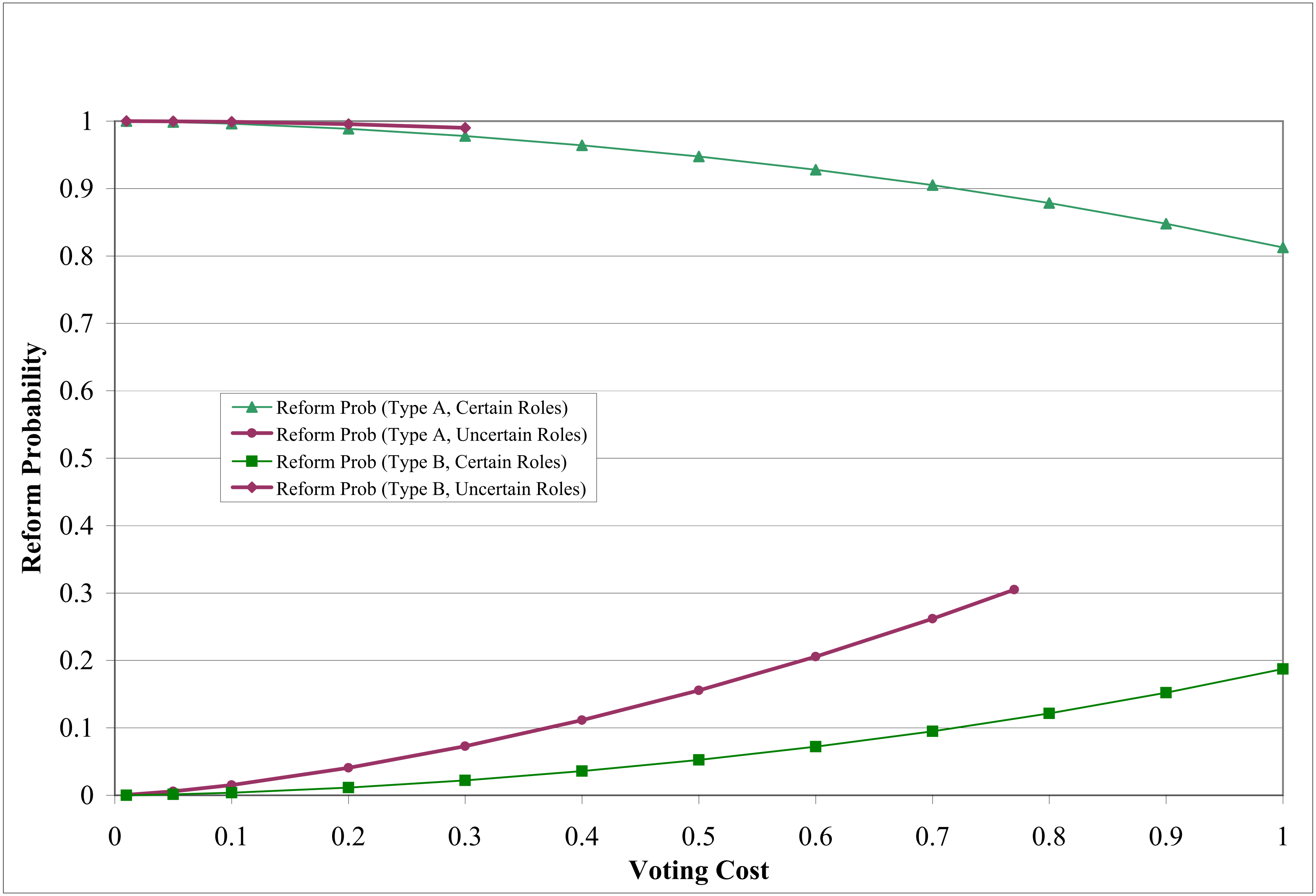


Fig. 5. Totally Mixed Strategy Quasi-Symmetric Equilibrium Reform Probabilities

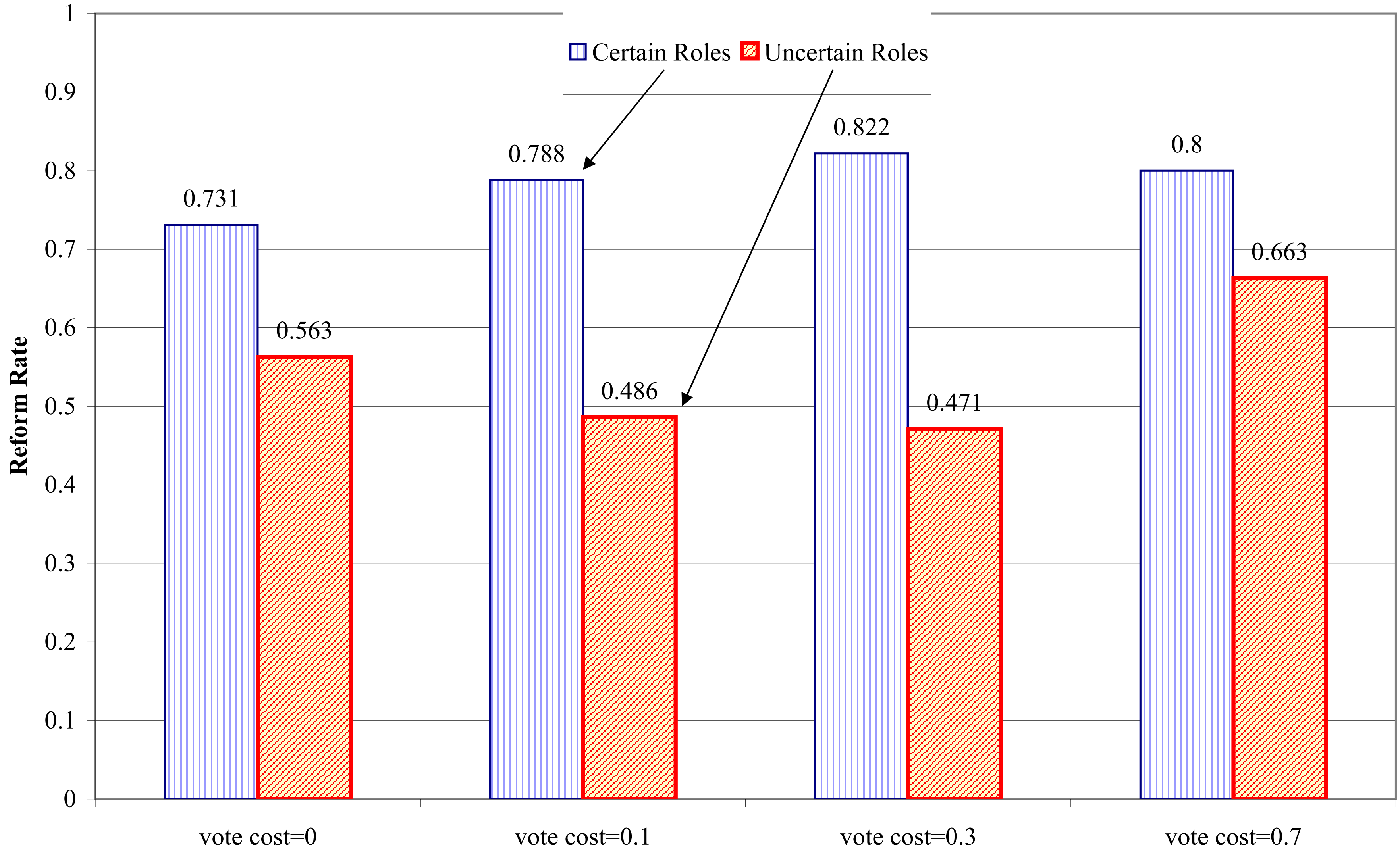


Fig. 6. Observed Reform Rates

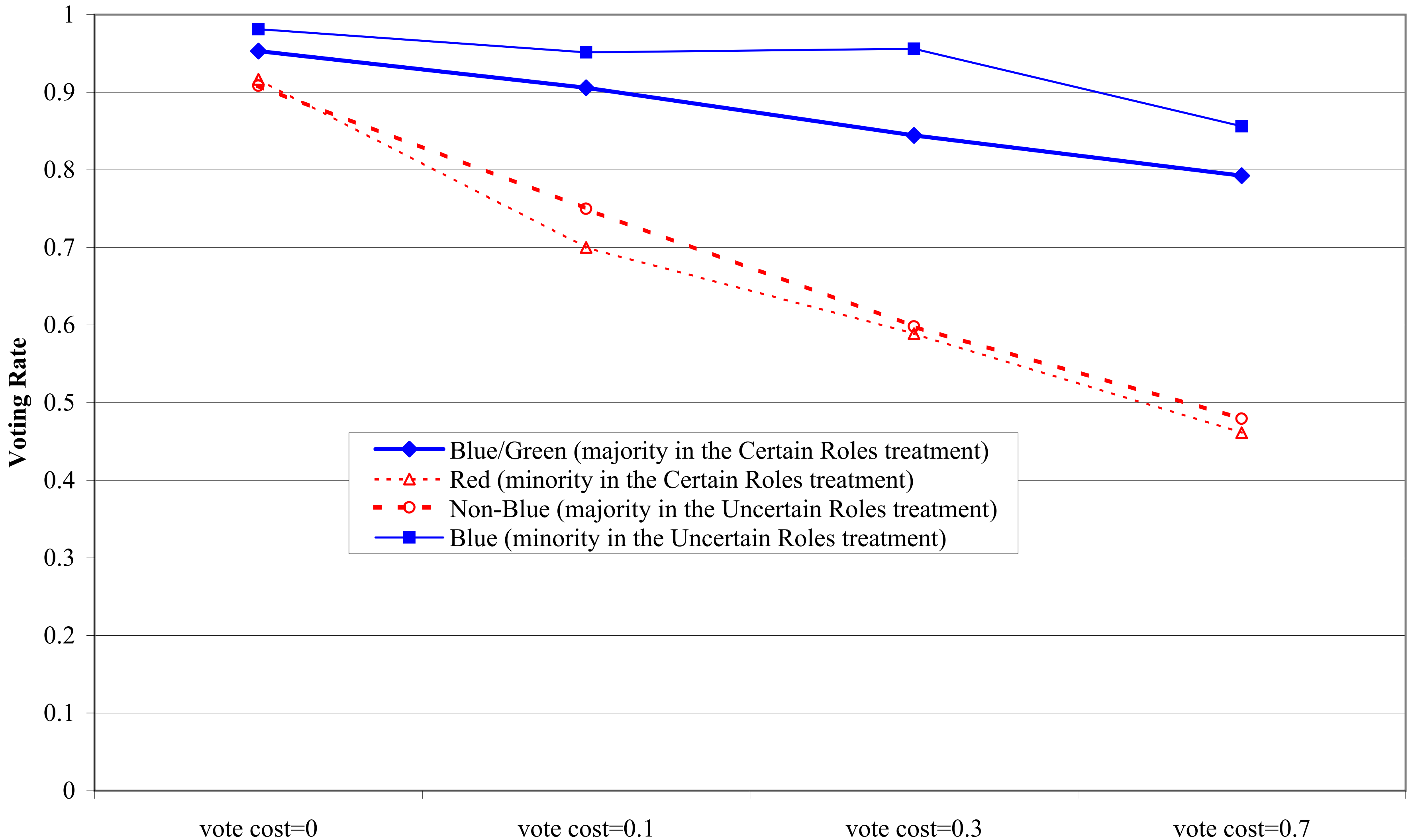


Fig. 7. Observed Voting Participation Rates

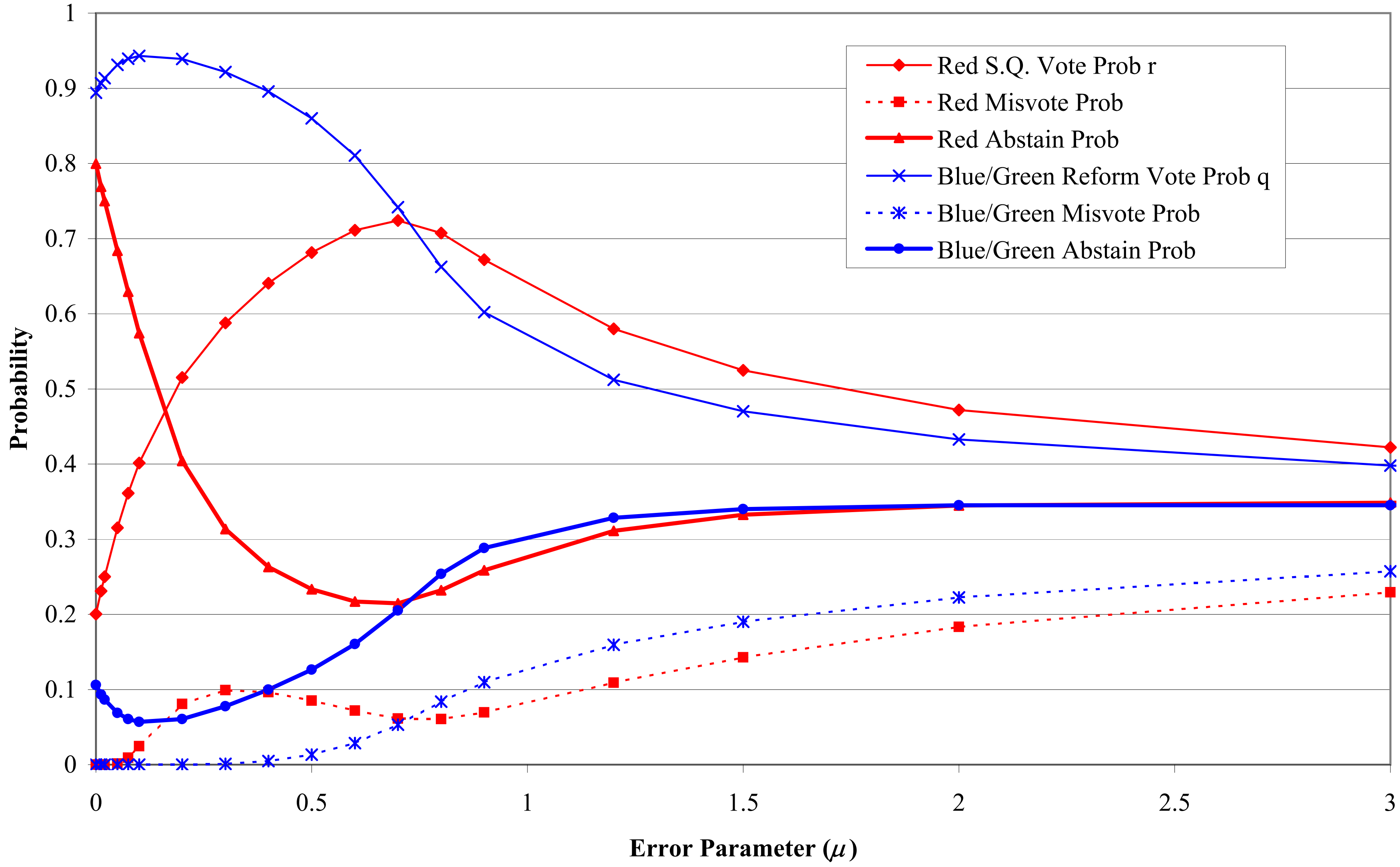


Fig. 8. Quantal Response Equilibria for Certain Roles and Vote Cost=0.3