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Matching Funds in Public Campaign Finance

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Abstract

Matching provisions in state clean elections acts have been ruled unconstitutional by the U.S. Supreme Court on First Amendment grounds (*Arizona Free Enterprise Club's Freedom Club PAC v. Bennett*, 2011). By modeling political speech as a costly advertising activity in an electoral contest, we show that matching funds can indeed decrease speech by privately funded candidates. Moreover, the state can undo any restrictions on matching programs imposed by courts, and replicate the equilibria under a matching program, by adopting an appropriately chosen lump-sum funding scheme. We also evaluate the validity of two specific arguments made by the Supreme Court in its Arizona decision, finding that one is incorrect and one is correct within the context of our model. Lastly, we provide preliminary evidence that the Arizona ruling has in fact increased private spending and increased the number of candidates per election race.

Keywords: Public campaign finance; matching funds; trigger funds; clean elections.

JEL codes: D72, H41, H71, H76, K19

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1 Introduction

Half of the states in the U.S. provide some form public funding to political campaigns in state elections, and sixteen of these states allocate public funds directly to candidates. The goals of public campaign funding are to curb political corruption and encourage entry by candidates who would not otherwise have the means to run for public office. As a general rule, political candidates who accept public funding are required to limit their campaign spending and restrict their fundraising activities. Seven states have adopted "clean elections" acts, which prohibit publicly funded candidates from accepting any private donations.[1]

States that provide public campaign funding differ, however, in the mechanisms through which these funds are allocated to candidates. One particular such mechanism, clean elections with *matching funds* (or *trigger funds*), works as follows: Candidates who opt for public financing first receive an initial distribution of state funds to their campaigns. Additional matching grants are then awarded if campaign spending by privately funded candidates exceeds the initial public outlay. Matching ends once the publicly funded candidates have received a predetermined maximum of state funding. Until 2010, such matching programs were used in Arizona and Maine, which enacted clean elections legislation in 1998 and 1996, respectively.[2] In 2011, however, the U.S. Supreme Court ruled that matching funds violate the First Amendment and are thus unconstitutional.[3]

We examine the role of matching provisions in public campaign finance and assess the consequences of eliminating matching funds on political campaigns. In our theoretical model, political speech is a costly campaign activity in a two-candidate electoral contest. Candidates differ in their fundraising costs, reflecting differences in the candidates' wealth or access to wealthy donors. Before the contest, candidates decide whether to accept public campaign funds. A candidate who declines the public option can freely choose how much to advertise, but must pay for it privately. A candidate who accepts the public option does not have to pay for advertising privately, but also cannot spend more than the amount he receives from the state, including potential matching funds.

[1]Source: National Conference of State Legislatures (www.ncsl.org). The seven clean elections states are Arizona, Connecticut, Maine, New Jersey, New Mexico, North Carolina, and Vermont.

[2]Several other states (Florida, Hawaii, Maryland, Massachusetts, Nebraska, Michigan, New Jersey, and Rhode Island) award public matching grants to candidates as a function of a candidate's *own* private donations. These programs are used as a "continuous" alternative to threshold grants that require candidates to demonstrate their viability by collecting a certain amount of private donations before being eligible for a fixed public subsidy. Our paper does not analyze this type of matching.

[3]The case, *Arizona Free Enterprise Club's Freedom Club PAC v. Bennett*, concerned Arizona's matching funds provision. The court's decision also rendered unconstitutional a similar law in Maine. For detailed legal analyses of the case, see LoBiondo (2011), United States Supreme Court (2011), Rahmanpour (2012), and Steele (2012).

We establish three sets of results. First, the candidates' equilibrium campaign funding choices and success probabilities depend on the matching program only through its maximum funding level. The same is true for actual spending and advertising levels, except when both candidates are publicly funded. Thus, when forced to terminate their matching programs, states can replicate the equilibria of their previous funding system almost entirely by adopting a lump-sum funding system that awards to each public candidate a one-time grant equal to the previous maximum funding level, and nothing thereafter. Second, we examine what happens when states abolish their matching grants without adjusting the lump-sum component. We show that, if candidates do not adjust their financing choices, both privately and publicly funded advertising in the electoral contest decreases. Third, whenever at least one candidate switches his funding mode from public to private spending, advertising by both candidates increases. Thus, the provision of matching funds in addition to a fixed initial public grant can decrease or increase speech, depending on whether or not this affects the incentives to accept the public option in the first place.

These theoretical results illuminate some of the Supreme Court's reasoning in *Arizona Free Enterprise*. In particular, the court's ruling discusses two different adjustments in campaign contributions and political speech that can take place in response to the state's awarding of matching funds. The first is an intensive margin adjustment: Matching funds given to publicly funded candidates may lead to fewer contributions to privately funded candidates, thereby reducing their speech. The second is an extensive margin adjustment: The availability of matching funds may induce more candidates to accept the public option, thereby limiting their speech to the amount possible with restricted state funds. In our contest model, both intensive and extensive margin adjustments occur when the parameters of the matching program are altered. The consequence of the second (i.e., extensive margin) adjustment is indeed a decrease in public and private speech when matching funds are awarded. Interestingly, however, the consequence of the first (i.e., intensive margin) adjustment in our model is an *increase* in speech, both public and private. Thus, our theoretical model confirms one part of the court's intuition in *Arizona Free Enterprise*, but negates the other.

We then examine empirically the relationship between the elimination of matching funds and political contributions—and hence speech—using campaign finance data for state House and Senate races in Arizona and Maine during six election cycles between 2000 and 2010. We exploit the fact that an injunction halted Arizona's matching program in 2010 while it was being challenged in court. The same injunction did not apply to Maine, which administered its matching program as usual during the 2010 elections. We are, therefore, able to obtain difference-in-difference estimates of the effect of abolishing matching funds in state elections on campaign spending and other outcome variables. In both House and Senate races, the elimination of matching funds is associated with an increase in private contributions and a decrease in public contributions. On bal-

ance, in House races the elimination of matching funds is associated with an increase contributions of \$187 per 1,000 House district residents (22.7% of spending per race), but is not significantly correlated with per capita contributions in Senate races. These results suggest that the elimination of matching funds in Arizona had a positive effect on campaign spending in 2010.

This increase, however, may have been caused by an increase in the number of candidates per race or by an increase in the number of privately funded candidates, rather than by changes in any single candidate's spending behavior resulting from the elimination of matching funds. Indeed, we find that the elimination of matching funds was associated with 0.61 (0.73) additional private candidates per House (Senate) race, 0.02 additional public candidates per House race, and 0.17 fewer public candidates per Senate race. Thus, elimination of matching funds seems to have been associated with both net entry of candidates and a switch from public to private funding. To disentangle the issue of entry from other channels through which matching funds affect campaign spending, we repeat our estimations, controlling for the number of candidates per race. Significant positive correlations remain with private spending, as do the negative correlations with public spending. For overall spending, we find that the elimination of matching funds was correlated with an increase of \$98 per 1,000 residents in House races, and correlated (though not significantly) with a decrease of \$141 per 1,000 residents in Senate races. Thus, increases in total campaign spending after the elimination of matching funds may be attributable in part to increased entry of privately funded candidates.[4]

The remainder of the paper is organized as follows. In Section 2 we review the related literature. In Section 3 we present a contest model of two-candidate elections with a public option and matching funds. Section 4 contains our analytical results. In Section 5 we present our empirical results, using campaign spending data from 2000–2010 state legislative races in Arizona and Maine. Section 6 concludes, and an Appendix contains all proofs and tables.

2 Literature Review

The clean elections acts passed in Arizona and Maine in the late 1990s were the first clean elections acts, and still constitute the most comprehensive attempts at campaign finance reform in the United States to date (for an overview of earlier reforms, see Jones

[4]We caution that our difference-in-difference approach may not be sufficient to identify causation, as it only controls for factors that affected both Arizona and Maine. There may well have been other factors that affected one state but not the other. Most notably, we are unable to control for effects on campaign spending caused by the Supreme Court's *Citizens United v. FEC* decision, which went into effect at the same time as the Arizona ruling, and which affected Arizona but not Maine. In Section 5.2, we provide a detailed discussion of the extent to which our approach can isolate the impact of the *Arizona Free Enterprise* decision from that of the *Citizens United* decision.

(1981)). For this reason, a number of studies have examined the effects of public campaign financing on electoral outcomes in these two states. Malhotra (2008) compares win margins for incumbents in senate races in Arizona and Maine before and after these states introduced a public option in 2000. He finds that win margins for incumbents decreased from 1998 to 2000. Stratmann (2009) finds that public financing in Maine reduced vote margins in house elections compared to other states with limited or no public financing. These results suggest that having a public option makes elections more competitive. Miller (2011a) finds that total spending in Arizona House and Senate races increased significantly after 2000, and that total spending in Maine House and Senate races decreased slightly after 2000. Miller (2011b) finds that publicly funded candidates in Arizona and Maine spent more time interacting with the public in crucial election phases, compared to privately funded candidates (a possible reason being that publicly funded candidates need to spend less time fundraising). Miller (2012) finds that the introduction of a public option in Arizona and Maine yielded greater benefits to Democratic challengers than to Republican ones.

The papers discussed above, however, do not examine specifically the effects of the matching funds provisions in Arizona or Maine. Our paper appears to be the first to analyze (theoretically and empirically) the effects of matching funds on campaign contributions. Two other papers examine empirically the effects of matching funds provisions in Arizona and Maine on the *timing* of privately funded candidates' expenditures (Miller 2008; U.S. Government Accountability Office 2010). These studies find that privately funded candidates strategically delay their expenditures in order to postpone triggering matching funds for their publicly funded opponents.

Finally, several papers in the literature examine other matching mechanisms through which public funds can be allocated to parties or candidates in elections. Coate (2004) and Ashworth (2006) analyze the efficiency of campaign finance systems in which the state matches any private contributions to a party with public contributions to the same party (see Footnote 2 for a list of states that use this mechanism). In contrast, we examine a system that matches private contributions to a candidate with public contributions to opposing candidates. Ortuno-Ortín and Schultz (2005), Prat et al. (2010), and Klumpp (2011) examine European systems of public financing in which candidates receive public funds in proportion to their vote shares. In contrast, we analyze American systems of public financing, in which candidates receive a lump-sum transfer of money, plus matching grants that depend directly on contributions to their opponents, but not on electoral outcomes.

3 Political Contests with Matching Funds

Two candidates ($i = 1, 2$) compete to win an election, worth 1 to each. We model this competition as an advertising contest, where candidate i's amount of advertising is $x_i \geq 0$ ($i = 1, 2$). The candidates' probabilities of winning the election are described by the *Tullock contest success function*:

$$Pr\big[\,\text{candidate 1 wins}\,\big|\,x_1, x_2\,\big] \;=\; f(x_1, x_2) \;\equiv\; \begin{cases} \dfrac{x_1}{x_1 + x_2} & \text{if } \; x_1 + x_2 > 0, \\ 1/2 & \text{if } \; x_1 + x_2 = 0. \end{cases} \tag{1}$$

Candidate 2 wins with probability $1 - f(x_1, x_2) = f(x_2, x_1) = x_2/(x_1 + x_2)$. The function in (1) is one of several commonly studied functions in the contest literature (see Konrad 2009).

3.1 Campaign financing

Each unit of advertising costs one unit of money, and for the purpose of this paper we equate advertising, campaign spending, and political speech.[5] We consider two sources of campaign financing, private funding and public funding.

Private funding. If candidate i is privately funded, he freely chooses x_i. The cost of raising these private funds is $c_i\, x_i$. The coefficient $c_i > 0$ has several interpretations. It may represent i's opportunity cost of a dollar spent on campaigning. A candidate with a low c_i can be thought of as a "rich" politician, and a candidate with a high c_i can be thought of as a "poor" politician. Alternatively, c_i may represent i's fundraising costs. A candidate with a low c_i can thus be thought of as a politician with access to a large number of wealthy supporters, relative to one with a high c_i.

Public funding. If candidate i is publicly funded, he cannot set x_i autonomously. Instead, he first receives an initial outlay T from the state to spend on his campaign. He may then receive additional *matching funds* determined as follows: For every dollar spent by i's opponent above T (assuming the opponent is privately funded), candidate i receives one dollar from the state until i's funding reaches μT ($\mu \geq 1$). The overall funds received by a publicly financed candidate i are therefore given by

$$x_i \;=\; \gamma(x_{-i}) \;\equiv\; \begin{cases} T & \text{if } \; x_{-i} \leq T, \\ x_{-i} & \text{if } \; T < x_{-i} \leq \mu T, \\ \mu T & \text{if } \; x_{-i} \geq \mu T, \end{cases} \tag{2}$$

[5] Clearly, campaign funds can be used for activities other than speech. Furthermore, some forms of political speech may not require much spending, and not all costly advertising by politicians may be considered political speech. Nevertheless, to address the issues raised by the Supreme Court's 2011 Arizona decision, the assumption that spending equals speech seems reasonable.

where $-i$ denotes i's opponent.[6] There is no cost to the candidate of obtaining these public funds; however, a publicly funded candidate cannot at the same time spend private funds. If both candidates are publicly funded, then both receive T.

The timing is as follows. First, both candidates simultaneously decide whether to use private or public campaign funding (stage 1). For candidate $i = 1, 2$, this choice is denoted $s_i \in \{Pr, Pu\}$. The candidates then observe each other's choice and engage in the electoral contest (stage 2). A publicly funded candidate does not have any further decisions to make, as his spending level is determined automatically via (2). A privately funded candidate, on the other hand, has to decide how much to spend.

3.2 Equilibrium definition

To investigate the subgame perfect equilibria of this game, denote by $v_i(\cdot|s_i, s_{-i})$ candidate i's payoff function in the electoral contest at stage 2, given the funding choices s_i and s_{-i}:

$$v_i(\, x_i, x_{-i} \,|\, s_i, s_{-i}\,) \;=\; \begin{cases} f(x_i, x_{-i}) - \, c_i x_i & \text{if } \; (s_i, s_{-i}) = (Pr, Pr), \\ f(x_i, \gamma(x_i)) - \, c_i x_i & \text{if } \; (s_i, s_{-i}) = (Pr, Pu), \\ f(\gamma(x_{-i}), x_{-i}) & \text{if } \; (s_i, s_{-i}) = (Pu, Pr), \\ f(T, T) & \text{if } \; (s_i, s_{-i}) = (Pu, Pu). \end{cases} \tag{3}$$

Let $v_i^*(s_1, s_2)$ be candidate i's expected Nash equilibrium payoff in the subgame at (s_1, s_2).[7] At the initial stage 1 of our model, a pure strategy Nash equilibrium in funding choices is a pair $(s_1, s_2) \in \{Pu, Pr\} \times \{Pu, Pr\}$ such that

$$v_i^*(s_i, s_{-i}) \;\geq\; v_i^*(s_i', s_{-i}) \quad \forall i \in \{1, 2\} \;\; \forall s_i' \in \{Pu, Pr\}.$$

We distinguish three types of equilibria in particular:
All-public equilibrium: Both candidates choose public funding, i.e., $(s_1, s_2) = (Pu, Pu)$.
All-private equilibrium: Both candidates choose private funding, i.e., $(s_1\, s_2) = (Pr, Pr)$.

[6] This is a simplified model of the actual matching programs that were used in Arizona and Maine. For example, Arizona's 2008 formula awarded to every candidate who took public funding to run for state representative in district d the amount

$$\gamma(x_d) \;=\; \$13,000 \;+\; \min\Big\{\; 0.93 \cdot \max\Big\{0,\; x_d - \$13,000\Big\},\; \$39,000 \;\Big\},$$

where x_d denotes the maximum private spending among the candidates in district d. The matching rate of 93 public cents per private dollar, as well as the maximum state funding of $39,000, could be adjusted by the state election commission at various points during an election cycle, depending on the proportion of Arizona's budgeted public campaign funds that had already been allocated.

[7] Solutions to stage 2 are in the Appendix. As shown there, the continuation equilibrium payoffs are uniquely determined for all but a measure zero set of parameter values.

Private-public equilibrium: One candidate chooses private funding while the other chooses public funding, i.e., $(s_1, s_2) = (Pr, Pu)$ or $(s_1, s_2) = (Pu, Pr)$.

In addition, the game may possess mixed strategy equilibria, in which candidates randomize over public and private financing.[8]

4 Theoretical Results

In this section, we characterize the equilibrium funding choices of the candidates, their advertising levels, and their winning probabilities. We also examine how these outcomes vary in response to changes in the policy parameters T and μ. The necessary solutions to the stage-2 subgames are presented in the Appendix.

4.1 Equilibrium characterization

To characterize the equilibrium variables, we define the following:

$$K \equiv \frac{3/2 - \sqrt{2}}{\mu T}, \quad L(c) \equiv c \cdot \left((\mu T c)^{-1/4} - 1 \right).$$

The candidates' funding choices in equilibrium are described in the following result.

Proposition 1. *The following characterizes all pure strategy equilibrium outcomes of the model.*

(a) An all-public equilibrium exists if and only if $c_i \geq K \; \forall i = 1, 2$. In this equilibrium, both candidates obtain T from the state, both win with probability $1/2$, and total spending equals $2T$.

(b) An all-private equilibrium exists if and only if $c_i \leq L(c_{-i}) \; \forall i = 1, 2$. In this equilibrium, candidate i ($i = 1, 2$) spends $c_{-i}/(c_1 + c_2)^2$ from private funds, and wins with probability $c_{-i}/(c_1 + c_2)$. Total spending equals $1/(c_1 + c_2)$.

(c) A private-public equilibrium in which candidate i is privately funded and candidate $-i$ is publicly funded exists if and only if $c_i \leq K$ and $c_{-i} \geq L(c_i)$. In this equilibrium, candidate i spends $\sqrt{\mu T / c_i} - \mu T$ from private funds and candidate $-i$ spends μT from public funds. Candidate i wins with probability $1 - \sqrt{\mu T c_i}$ and candidate $-i$ wins with probability $\sqrt{\mu T c_i}$. Total spending equals $\sqrt{\mu T / c_i}$.

[8] In general, a Nash equilibrium (in pure or mixed strategies) is a pair $(p_1, p_2) \in [0, 1] \times [0, 1]$, where p_i is the probability that candidate i chooses public financing, such that $p_i > 0$ ($p_i < 1$) implies

$$p_{-i} v_i(Pu, Pu) + (1 - p_{-i}) v_i^*(Pu, Pr) \;\; \geq \; (\leq) \;\; p_{-i} v_i(Pr, Pu) + (1 - p_{-i}) v_i^*(Pr, Pr) \qquad (i = 1, 2).$$

Recall that the public funding system examined in this paper is characterized by two parameters: T, the initial outlay of public funds, and μ, the matching parameter that determines the maximum outlay of public funds. Proposition 1 shows that the candidates' incentives to choose public or private financing depend on the maximal level of state funding μT, but not on μ or T individually. Moreover, in every equilibrium the candidates' winning probabilities depend on μT only. This implies that the state can replicate the outcomes of any matching program (T, μ) via a simple lump-sum funding program (T', μ'), where $T' = \mu T$ and $\mu' = 1$. The same equivalence is true for spending levels, with one exception: If both candidates are publicly funded, each spends T. Thus, a program with a low initial outlay and matching may cost the state less than an outcome-equivalent lump-sum program.

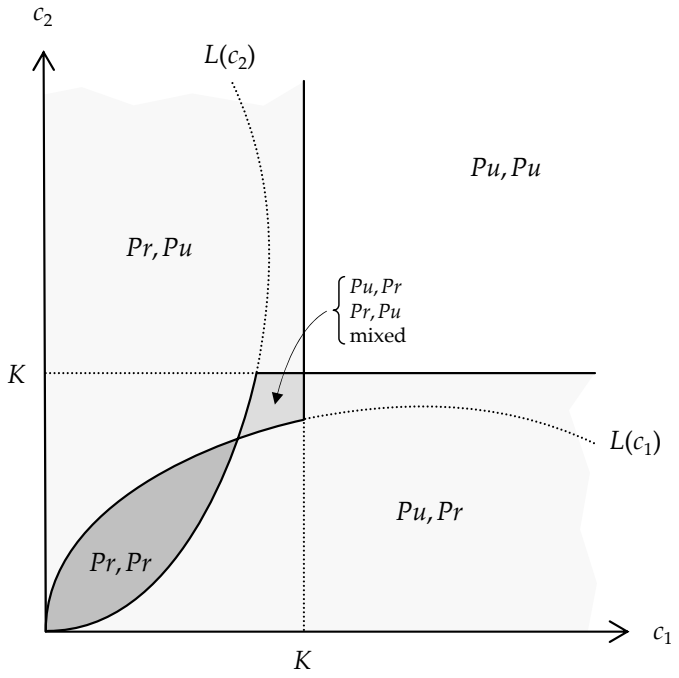

Figure 1: Equilibrium funding choices

The graph in Figure 1 depicts the regions and equilibria identified in Proposition 1. In the small diamond-shaped area at the center of the figure, two types of private-public equilibrium exist—one in which candidate 1 is privately funded and candidate 2 is publicly funded, and one in which candidate 1 is publicly funded and candidate 2 is privately funded. In this parameter region, the candidates' problem constitutes an anti-coordination game, i.e., a game of "Chicken." This implies that there is also a mixed strategy equilibrium, which depends on the public funding system only through μT:

Corollary 2. *If $L(c_{-i}) < c_i < K \ \forall i \in \{1,2\}$, a mixed strategy equilibrium exists. This equilibrium depends on the policy parameters μ and T only through μT. In particular, expected private spending, expected public spending, and the candidates' winning probabilities in the mixed strategy equilibrium depends on μT.*

4.2 Comparative statics

We now examine the effect of policy changes (i.e., changes in μ or T) on the equilibrium. There are two responses to a change in these policy parameters. First, suppose that a change in μ or T does not affect the candidates' funding choices. In this case, the change may still affect the quantity of speech, because x_1 and x_2 can depend on these variables in the second-stage continuation equilibrium. The following result characterizes this effect.

Proposition 3. *Suppose that the contest success function is given by* (1)*. Further suppose that either μ or T increases, without altering the candidates' equilibrium funding choices.*

(a) In an all-private equilibrium, the amount of speech by each candidate is unchanged.

(b) In an all-public equilibrium, the amount of speech by each candidate is either constant (if μ increases and T is constant) or strictly increasing (if T increases).

(c) In a private-public equilibrium, the amount of privately funded speech, publicly funded speech, and total speech strictly increases.

The second response is that a change in μ or T can affect the candidates' choice of funding. For example, a privately funded candidate may decide to obtain public funding when the public system becomes more generous. The direction of these shifts in funding can be obtained by differentiating the bounds K and L with respect to μT.

$$\begin{aligned} \frac{\partial K}{\partial \mu T} &= -\frac{3/2 - \sqrt{2}}{(\mu T)^2} < 0, \\ \frac{\partial L(c)}{\partial \mu T} &= -\frac{c^{3/4}}{4(\mu T)^{5/4}} \cdot \left((c\mu T)^{-1/4} - 1 \right) < 0 \quad (\text{for } c \leq K). \end{aligned}$$

Because candidate i prefers public over private funding when his cost c_i exceeds either K or $L(c_i)$ (depending on whether i's opponent is publicly or privately funded), a decrease in the thresholds K and L implies that politicians are more inclined to accept public funding as μT increases.

Figure 2 shows how the equilibrium regions identified in Proposition 1 adjust as μ or T increase. When either μ or T increases by a small margin, an all-public equilibrium must persist. On the other hand, a public-private equilibrium may become an all-public

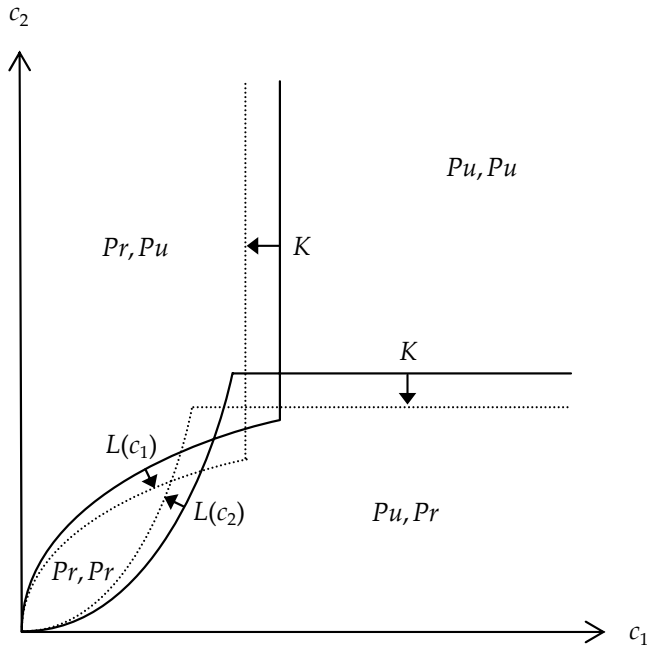

Figure 2: Funding changes in response to increases in μ or T

equilibrium, and an all-private equilibrium may become a public-private equilibrium.[9] In both cases, an increase in μ or T causes an unambiguous drop in speech for each candidate:

Proposition 4. *Suppose that the contest success function is given by* (1)*. Further suppose that μ or T (or both) increase.*

(a) If a private-public equilibrium becomes an all-public equilibrium, then both candidates decrease their speech (and thus the total amount of speech decreases).

(b) The same is true when an all-private equilibrium becomes a private-public equilibrium.

Proposition 3 and Proposition 4 show two opposing effects that could result from the elimination of matching funds. If candidates do not adjust their funding choices, then Proposition 3 implies that elimination of matching funds will at best leave the

[9]There is one more possibility: An equilibrium in which candidate 1 is publicly funded and candidate 2 is privately funded may turn into one in which these choices are reversed (i.e., candidate 1 is privately funded and candidate 2 is publicly funded). For this to happen, the equilibrium—before or after the policy change—must lie in the small region where two public-private equilibria exist. We ignore this possibility. That is, we assume that when a private-public equilibrium exists before and after the policy change, then the publicly funded candidate remains publicly funded, and the privately funded candidate remains privately funded.

equilibrium level of speech the same, but may decrease that level. On the other hand, if candidates adjust their funding choices, then Proposition 4 implies that elimination of matching funds will increase speech.

To see the combined effects of changes in the matching parameter μ, we consider the following numerical example. Suppose $c_1 = 0.02$ and $c_2 = 0.015$. Let $T = 1$, and let $\mu \in [1, \infty)$. Figure 3 shows the equilibrium type (i.e., funding choices) as well as the equilibrium level of speech as μ varies. All of our theoretical results are illustrated in the graph: For $\mu \leq 2.25$ there is an all-private equilibrium. The quantity of speech in this equilibrium does not depend on μ. When $\mu = 2.25$, candidate 1 switches to public funding. The amount of speech for each candidate jumps downward at this point. However, as μ increases beyond 2.25, both publicly funded and privately funded speech increase, but remain below their levels when $\mu \leq 2.25$. At $\mu = 5.71$, candidate 2 switches to public funding, and the amount of speech in equilibrium once again jumps downward. Because T is assumed constant and only μ varies, speech stays constant for $\mu > 5.71$.

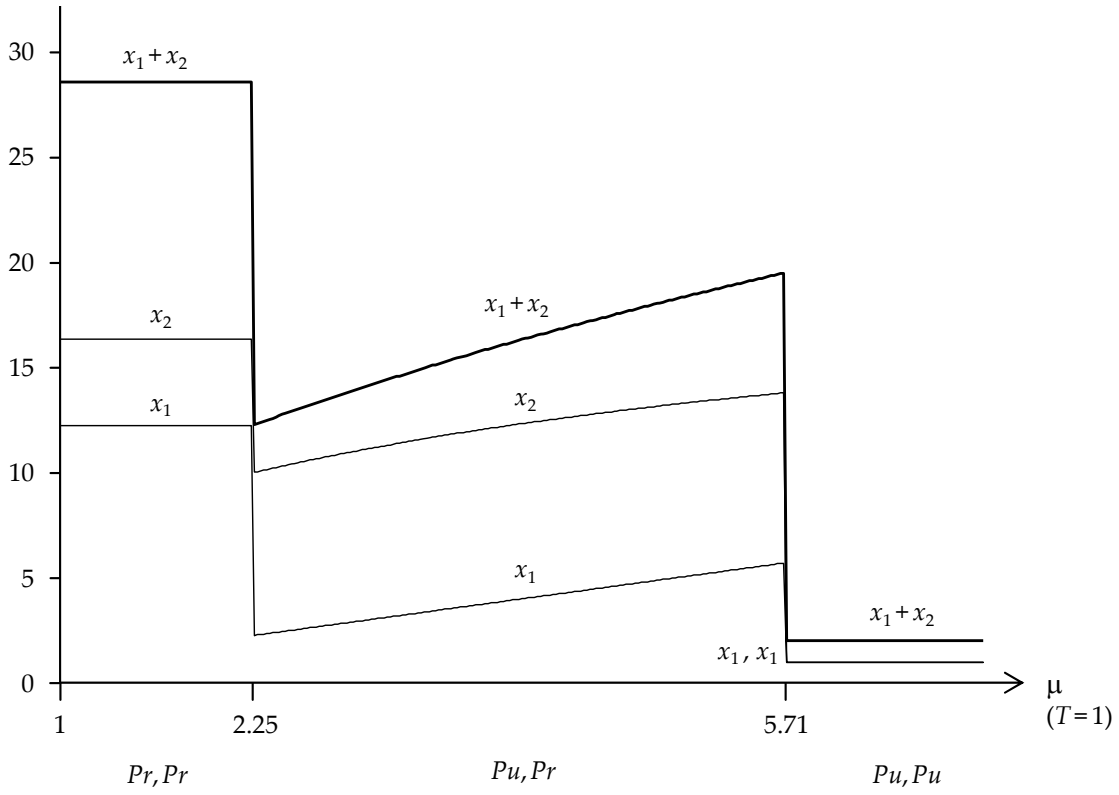

Figure 3: Equilibrium speech as μ varies ($c_1 = 0.02$, $c_2 = 0.015$, $T = 1$)

4.3 Relationship to the Arizona ruling

Our model provides insights that are useful when assessing the validity of certain arguments made by the U.S. Supreme Court in *Arizona Free Enterprise*. There, the court argues that

> Any increase in speech resulting from the Arizona law is of one kind and one kind only—that of publicly financed candidates. The burden imposed on privately financed candidates and independent expenditure groups reduces their speech. . . . Thus, even if the matching funds provision did result in more speech by publicly financed candidates and more speech in general, it would do so at the expense of impermissibly burdening (and thus reducing) the speech of privately financed candidates and independent expenditure groups. (564 U.S. ___ (2011), at 15.)

In our model, this argument is incorrect: Whenever a private-public equilibrium exist, private and public speech are strategic complements and move in the same direction. If the funding mechanism succeeds at raising public speech, it increases private speech as well. In particular, if at $\mu = 1$ the equilibrium is of the private-public type, then providing some matching funds increases speech by both candidates. However, in its ruling the court also argues that

> If the matching funds provision achieves its professed goal and causes candidates to switch to public financing . . . there will be less speech: no spending above the initial state-set amount by formerly privately financed candidates, and no associated matching funds for anyone. Not only that, the level of speech will depend on the States judgment of the desirable amount, an amount tethered to available (and often scarce) state resources. (564 U.S. ___ (2011), at 15.)

This argument holds up in our model: Once both candidates have switched to public funding, speech by both candidates is less than in either a private-public equilibrium or an all-private equilibrium. (For example, in Figure 3 this happens for $\mu \geq 5.71$.)

Thus, whether or not trigger funds have a chilling effect on private speech, and on overall speech, depends on the type of equilibrium being played and whether or not the elimination of trigger funds will lead to a change in equilibrium funding choices by candidates. This, in turn, depends on the generosity of the funding system (specifically, on μT), as well as on the fundraising costs of the candidates.

5 Empirical Analysis

In our theoretical model, the provision of public matching funds in campaign financing can increase or decrease campaign spending by political candidates, depending on

whether candidates switch their funding choices in response to changes in the funding system. In this section, we empirically examine the effect of matching funds on campaign spending. To do so, we utilize a dataset containing public and private campaign contributions to candidates who ran for state legislative office in Arizona and Maine between 2000 and 2010, the two states that, before *Arizona Free Enterprise*, had matching funds as part of their public campaign financing option. The data, which are aggregated on the candidate level, were obtained from the National Institute on Money in State Politics (followthemoney.org).

5.1 State legislative elections in Arizona and Maine, 2000–2010

Both the Arizona and Maine state legislatures are bicameral and elected to two-year terms. Arizona has 30 legislative districts that serve as both House and Senate districts. Each of these districts sends two members to the House and one member to the Senate. Maine, on the other hand, has 151 single member House districts and 35 single member Senate districts. Maine's House and Senate districts are not coterminous, that is, Senate district borders often "slice through" House districts. It is therefore possible for two voters to reside in the same House district but in different Senate districts, and vice versa. This feature of Maine's legislative map makes it problematic to pool House and Senate elections. We, therefore, conduct our analysis separately for each legislative chamber. Our data cover six elections (2000, 2002, 2004, 2006, 2008, and 2010), yielding observations on 180 House and 180 Senate races in Arizona, and on 906 House and 201 Senate races in Maine.

Table 1 contains race-level summary statistics on campaign contributions per race, per-capita contributions per race, and the number of candidates per race. The reported numbers are averaged over the six elections covered in our dataset; campaign contributions are reported in constant 2010 dollars.[10] Contributions in both House and Senate races are considerably higher in Arizona than in Maine, while per-capita contributions are higher in Maine. With the exception of Arizona Senate races, public contributions outweigh private contributions. Furthermore, in Arizona contributions to Republican candidates are higher than contributions to Democratic candidates (in both House and Senate races), while they are approximately equal in Maine. Finally, observe that Arizona House races see roughly twice the number of candidates than Maine House races, which can be explained by the fact that Arizona House districts are two-member districts.

[10] All per capita campaign contributions used in this paper were constructed from the data as follows. First, we adjusted contributions per district into 2010 dollars. Then we divided state population by the number of electoral districts to get an estimate of district population. Finally, we divided the inflation-adjusted contributions per district by the estimate of district population, to get per capita contributions.

Table 2 breaks down each election by race-level funding choices, showing the number of all-private, all-public, and private-public races per election. With only three exceptions,[11] there was at least one race of each type in every election. The most common election race is the private-public type, accounting for 760 of 1,476 observations, followed by the all-public type with 461 observations and the all-private type with 255 observations. Two shifts in funding choices seem particularly pronounced. First, in the Arizona Senate elections the number of all-public races steadily increased from one in 2000 to nine in 2008 and then fell to zero in 2010. Second, in the Maine House elections, the number of all-public races increased from 16 in 2000 to 75 in 2008, and then fell to 61 in 2010. At the same time, the number of all-private races fell from 85 in 2000 to four in 2010, and then increased to nine in 2010. In general, the number of all-public races decreased from 2008 to 2010 in both states, for both House and Senate elections, while the number of all-private and private-public races either increased or remained constant.

Table 3 shows mean per-capita contributions per race for each election in our dataset, further broken down by private and public contributions, as well as by the recipient's party. A trend of decreasing private contributions and increasing public contributions is apparent in both states. (These two trends seem to be offsetting each other, leaving no discernible trend in overall per-capita contributions.) However, when comparing only the 2008 and 2010 Arizona elections, we see a pronounced increase in private contributions and an equally pronounced decrease in public contributions; this holds for both the House and the Senate. The same pattern does not exist for the 2008 and 2010 Maine elections. This observation suggests an "Arizona 2010" effect, which we will quantify in the regression analysis in Section 5.2. Finally, Republican candidates have a funding advantage over Democratic candidates in Arizona, but no discernible advantage exists for either party in Maine.

Table 4 is organized along the same lines as Table 3, but shows the mean number of candidates per race. Similar to the time trends in per-capita contributions, an overall trend toward fewer private candidates and more public candidates exists until 2008. In 2010, Arizona witnessed a sharp increase in the number of candidates, in both House and Senate races. The additional candidates are all privately funded; in addition, some switching from public to private funding occurred. A similar, but weaker pattern exists for the 2010 Maine House elections, but not for the 2010 Maine Senate elections. Thus, changes in the pattern of campaign contributions in Arizona in 2010 were driven in part by additional entry of privately funded candidates. This issue is further examined in Section 5.2 below.

[11] These are the 2000 Arizona House elections, the 2006 Maine Senate elections, and the 2010 Arizona Senate elections.

5.2 The effect of eliminating matching funds

We now examine the impact of the elimination of matching funds in Arizona's 2010 state legislative elections on campaign spending in these races. To do so, we exploit the fact that Arizona's matching program was temporarily halted in 2010 while it was being challenged in court. The same injunction did not apply to Maine, which continued to administer its similar matching program throughout the 2010 elections. We are, therefore, able to obtain difference-in-difference estimates of the effect of abolishing matching funds in state elections on campaign contributions and other outcomes.[12]

Our main outcome variable is per-capita contributions per race. This variable is broken down by legislative chamber (House/Senate), source (private/public), and recipient party (Republican/Democrat). In all estimations, the independent variable of interest is a dummy variable, AZ×2010, that equals one for 2010 Arizona races and zero for all other observations. All estimations further include district, state, and year fixed effects.

Before discussing our results, a word of caution is in order. In addition to the elimination of public matching funds, a second significant event affected Arizona's political landscape in 2010—namely, the Supreme Court's *Citizens United v. FEC* ruling.[13] Prior to 2010, Arizona prohibited most corporate and union expenditures in elections, including direct contributions to politicians as well as independent expenditures. In the wake of *Citizens United*, Arizona lifted its ban on independent expenditures, beginning with the 2010 elections. Maine, on the other hand, never had a ban on corporate or union expenditures and was hence unaffected by the ruling. Thus, part of the estimated Arizona 2010 effect may be due to the effect of the *Citizens United* decision on Arizona elections (instead of *Arizona Free Enterprise*), so that the coefficient of the AZ×2010 variable may capture the combined effect of both court decisions.

However, our analysis is concerned with the effect of eliminating matching funds on *direct* contributions to political campaigns. Arizona never allowed direct contributions by corporations or unions, and the state still does not allow such contributions. Thus, while corporations and unions may have undertaken significant independent expenditures in Arizona in 2010, these expenditures could not have come out of any direct contributions that corporations or unions would otherwise have made. Increased corporate and union spending post-*Citizens United* may have altered the incentives of ordinary citizens to contribute to political campaigns. If corporate and union spending crowds out citizens' contributions, our estimated effects on private contributions will be biased downward. If corporate and union spending increases citizens' contribu-

[12] For details on the Arizona injunction, see Goldwater Institute (2011). For information on Maine's 2010 public option, see Russell (2011). After the *Arizona Free Enterprise* decision in 2011, no matching program will be administered in any state, starting with the 2012 election cycle.

[13] *Citizens United v. Federal Election Commission*, 558 U.S. 50 (2010).

tions, our estimated effects will be biased upward. We have no evidence for or against either of these possibilities. Nevertheless, these caveats should be kept in mind when interpreting the results.

Table 5 reports our regression results using per capita, per race contributions as the dependent variable. In both the House and the Senate, the association AZ×2010 with private contributions is positive and significant, implying an additional 32 cents in private contributions in both cases. The correlation with public Senate contributions is negative and significant, offsetting the positive correlation with private contributions almost exactly. The association with public House contributions is negative but not significant. Overall, the net correlation with House contributions is positive (+18.7 cents) and significant at the 10% confidence level. These results may be driven in part by an influx of candidates in the 2010 Arizona state elections, as reported earlier.

In Table 6, we thus repeat our estimations controlling for the number of candidates per race. This specification also better reflects our theoretical model, where a fixed number of political candidates was assumed. The signs of all previously discussed estimates remain the same; however, the positive correlation with private contributions is now smaller, and the negative correlation with public contributions is larger, than before. On balance, AZ×2010 is associated with an increase in House contributions of 9.8 cents per capita, per race (significant on the 10% confidence level), and a decrease in Senate contributions of 14.1 cents (not significant).[14]

Table 7 reports the correlation of AZ×2010 with the actual number of candidates per race. The signs of the coefficients are in line with our discussion in Section 5.1 above; however, the estimates are generally not significant with the exception of total Senate candidates and privately funded Senate candidates.

Finally, recall that, in our theoretical model, the elimination of matching funds increased speech in two-candidate elections when it led one or both candidates to switch from public to private financing. To examine the extent to which candidates switched their funding sources in Arizona 2010, we also regressed the number of privately and publicly funded candidates against our independent variables, controlling for the total number of candidates in each race. The results are reported in Table 8. In both chambers, switching from public to private funding can be observed, with a stronger effect for Senate candidates. On average, 0.42 candidates in each 2010 Arizana Senate race switched from public to private funding (significant at 1%), while 0.29 candidates did so in each House race (not significant). Given that the AZ×2010 correlation with con-

[14]Furthermore, no significant associations were found on combined private and public contributions when broken down by political party, with one exception: Perhaps surprisingly, Democratic House candidates benefited from an additional 9.8 cents in contributions per capita in Arizona 2010, amounting roughly to an additional $10K in funding per (Democratic) candidate.

tributions was significant and positive only for House races, this result is somewhat surprising and not entirely consistent with our theoretical prediction.[15]

Our results suggest that the elimination of matching funds in Arizona increased political speech, by increasing privately funded speech more than the decrease in publicly funded speech. However, some of the increased spending was driven by the entry of additional privately funded candidates in Arizona in 2010. The estimated effects of 9.8–18.7 cents in additional per capita contributions in House races amount to $\$21,900$–$\$39,800$ in additional contributions per race, or $\$626,400$–$\$1,195,300$ statewide. These are relatively large amounts since they account for 11.8% and 22.7% of combined contributions to Arizona's 2010 House elections..

6 Conclusion

We developed a model of political speech as spending on advertising in political contests, and employed the model to evaluate the effects of matching funds programs in public campaign finance on the quantity of political speech. The model showed that a matching funds provision decreases the amount of private and overall speech if it induces a change in equilibrium funding choices by the candidates. We then used the model to evaluate two arguments made by the Supreme Court in *Arizona Free Enterprise* to abolish matching funds programs. We showed that, in the context of our model, the Supreme Court's argument that matching funds may induce more candidates to accept the public option, thereby limiting their speech to the amount possible with restricted state funds, is correct. However, the court's argument that matching funds may lead to fewer contributions to privately funded candidates, thereby reducing their speech, is incorrect. Lastly, we provided some preliminary evidence that the court's decision actually increased spending per candidate and the number of candidates per race.

Our analysis could be extended to account for independent as well as direct spending in elections. The case against matching funds programs may be even stronger if one takes into account their effects on independent spending. Consider supporters who spend independently in favor of a privately funded candidate who faces a publicly funded candidate in a matching funds system. By law, these supporters cannot coordinate their spending with their candidate, but their spending can trigger matching funds that their candidate's opponent can use directly. Independent supporters cannot avoid triggering these matching funds without stopping their spending. They may have the option to switch from independent spending to direct contributions, but not if they have already reached the legal limit on direct contributions. Thus, matching funds could strongly suppress their speech.

[15]This result may be explained by the pronounced shift from public to private funding that occured in the 2010 Maine House elections (shown in Table 2 and discussed in Section 5.1). This shift diminishes the difference-in-difference estimate of the switching effect for House candidates.

Appendix

Preliminaries: The political contest at stage 2

In the following, we solve for spending, winning probabilities, and payoffs at stage 2 of the model. These will be used in the proofs below. Throughout, candidate i's winning probability will be denoted P_i. Depending on the funding choices made at stage 1, the following three cases can arise at stage 2.

Both candidates are publicly funded. In this case, both candidates receive from the state an amount T to spend in the contest at no personal cost to themselves. We thus have

$$x_1 = x_2 = T, \quad P_1 = P_2 = \frac{1}{2} \quad \Rightarrow \quad v_1^*(Pu, Pu) = v_2^*(Pu, Pu) = \frac{1}{2}.$$

Both candidates are privately funded. In this case, stage 2 of our model is a standard Tullock contest with common prize 1 and marginal costs c_1 and c_2. In this contest, spending levels, winning probabilities, and payoffs in the equilibrium are given by

$$x_1 = \frac{c_2}{(c_1+c_2)^2},\ x_2 = \frac{c_1}{(c_1+c_2)^2}, \quad P_1 = \frac{c_2}{c_1+c_2},\ P_2 = \frac{c_1}{c_1+c_2},$$

$$\Rightarrow \quad v_1^*(Pr, Pr) = \frac{(c_2)^2}{(c_1+c_2)^2},\ v_1^*(Pr, Pr) = \frac{(c_1)^2}{(c_1+c_2)^2}$$

(see Konrad 2009).

One candidate is privately funded and the other is publicly funded. Without loss of generality, let 1 be the privately funded candidate (the analysis is similar when 2 is privately funded). Privately funded candidate 1 receives a payoff of

$$\frac{x_1}{x_1+\gamma(x_1)} - c_1 x_1 = \begin{cases} \dfrac{x_1}{x_1+T} - c_1 x_1 & \text{if } x_1 < T, \\ 1/2 - c_1 x_1 & \text{if } T < x_1 \leq \mu T, \\ \dfrac{x_1}{x_1+\mu T} - c_1 x_1 & \text{if } x_1 > \mu T. \end{cases}$$

Maximizing this function with respect to x_1, we get

$$x_1 = \begin{cases} 0 & \text{if } c_1 > \frac{1}{T}, \\ \sqrt{T/c_1} - T & \text{if } \frac{1}{T} \geq c_1 > \frac{1}{4T}, \\ T & \text{if } \frac{1}{4T} \geq c_1 > \frac{1}{4\mu T}, \\ \sqrt{\mu T/c_1} - \mu T & \text{if } c_1 \leq \frac{1}{4\mu T}. \end{cases}$$

The money received by publicly funded candidate 2 are obtained by plugging x_1 into (2):

$$x_2 \;=\; \gamma(x_1) \;=\; \begin{cases} T & \text{if } c_1 > \frac{1}{4\mu T}, \\ \mu T & \text{if } c_1 \leq \frac{1}{4\mu T}, \end{cases}$$

and the winning probabilities become

$$P_1\,,\,P_2 \;=\; f(x_1,x_2) \;=\; \begin{cases} 0\,,\,1 & \text{if } c_1 > \frac{1}{T}, \\ 1-\sqrt{Tc_1}\,,\,\sqrt{Tc_1} & \text{if } \frac{1}{T} \geq c_1 > \frac{1}{4T}, \\ 1/2\,,\,1/2 & \text{if } \frac{1}{4T} \geq c_1 > \frac{1}{4\mu T}, \\ 1-\sqrt{\mu Tc_1}\,,\,\sqrt{\mu Tc_1} & \text{if } c_1 \leq \frac{1}{4\mu T}. \end{cases}$$

Note that candidate 2 has no campaign costs. 2's payoff is therefore the same as his probability of winning, P_2. 1's payoff is his winning probability, P_1, minus his private cost, x_1c_1. After a few manipulations, the continuation payoffs can then be written as

$$v_1^*(Pr,Pu)\,,\,v_2^*(Pr,Pu) \;=\; \begin{cases} 0\,,\,1 & \text{if } c_1 > \frac{1}{T}, \\ \left(1-\sqrt{Tc_1}\right)^2\,,\,\sqrt{Tc_1} & \text{if } \frac{1}{T} \geq c_1 > \frac{1}{4T}, \\ 1/2-Tc_1\,,\,1/2 & \text{if } \frac{1}{4T} \geq c_1 > \frac{1}{4\mu T}, \\ \left(1-\sqrt{\mu Tc_1}\right)^2\,,\,\sqrt{\mu Tc_1} & \text{if } c_1 \leq \frac{1}{4\mu T}. \end{cases}$$

Proof of Proposition 1

To prove part (a), suppose that candidate $-i$ chooses public funding. Then candidate i gets

$$v_i^*(Pu,Pu) = \frac{1}{2} \tag{4}$$

if i chooses public funding, and

$$v_i^*(s_i=Pr,s_{-i}=Pu) \;=\; \begin{cases} 0 & \text{if } c_i > \frac{1}{T}, \\ \left(1-\sqrt{c_iT}\right)^2 & \text{if } \frac{1}{T} \geq c_i > \frac{1}{4T}, \\ 1/2-c_iT & \text{if } \frac{1}{4T} \geq c_i > \frac{1}{4\mu T}, \\ \left(1-\sqrt{c_i\mu T}\right)^2 & \text{if } c_i \leq \frac{1}{4\mu T} \end{cases} \tag{5}$$

if i chooses private funding. The first three terms in (5) are strictly less than (4), and the fourth term is weakly greater than (4) if and only if

$$c_i \;\leq\; K \;=\; \frac{3/2-\sqrt{2}}{\mu T} \;<\; \frac{1}{4\mu T}.$$

Part (a) of the result now follows immediately.

To prove part (b), suppose that candidate $-i$ chooses private funding. Then candidate i gets

$$v_i^*(s_i{=}Pu, s_{-i}{=}Pr) \;=\; \begin{cases} 1 & \text{if } \; c_{-i} > \frac{1}{T}, \\ \sqrt{c_{-i}T} & \text{if } \; \frac{1}{T} \geq c_{-i} > \frac{1}{4T}, \\ 1/2 & \text{if } \; \frac{1}{4T} \geq c_{-i} > \frac{1}{4\mu T}, \\ \sqrt{c_{-i}\mu T} & \text{if } \; c_{-i} \leq \frac{1}{4\mu T} \end{cases} \tag{6}$$

if i chooses public funding, and

$$v_i^*(Pr, Pr) \;=\; \frac{(c_{-i})^2}{(c_i + c_{-i})^2} \tag{7}$$

if i chooses private funding. Consider the fourth term in (6), which applies if $c_{-i} \leq 1/(4\mu T)$. This term is less than or equal to (7) if and only if

$$c_i \;\leq\; L(c_{-i}) \;=\; c_{-i} \cdot \left((c_{-i}\mu T)^{-1/4} - 1 \right).$$

In order to prove part (b) of the result we show two claims: (i) $c_i \leq 1/(4\mu T)\ \forall i$ is necessary for an all-private equilibrium; (ii) $c_i \leq L(c_{-i})\ \forall i$ implies $c_i \leq 1/(4\mu T)\ \forall i$.

The following properties of L can be established:

$$L(c) \underset{<}{\overset{>}{\equiv}} c \;\; \text{if} \;\; c \underset{>}{\overset{<}{\equiv}} \bar{c} \qquad \text{and} \qquad L(c) \leq \bar{c} \;\; \text{if} \;\; c \leq \bar{c}, \tag{8}$$

where $\bar{c} \equiv 1/(16\mu T)$. To show claim (i), note that, if $c_i > \bar{c}\ \forall i$, then (6) implies that $v_i^*(s_i = Pu, s_{-i} = Pr) > 1/4\ \forall i$. On the other hand, (7) implies that $v_i^*(Pr, Pr) = (c_{-i})^2/[(c_i + c_{-i})^2] \leq 1/4$ for some i (regardless of the candidates' costs). It follows that, if both candidates have costs above $\bar{c}$ and choose private funding, at least one candidate wants to deviate to public funding. Therefore, in an all-private equilibrium at least one of c_1 and c_2 must be weakly below $\bar{c}$, and thus below $1/(4\mu T)$. Without loss of generality, assume $c_1 \leq \bar{c}$. By (8), this implies that $L(c_1) \leq \bar{c}$. Candidate 2 prefers private to public funding if and only if $c_2 \leq L(c_1)$. Since $L(c_1) \leq \bar{c} < 1/(4\mu T)$, we have $c_2 \leq 1/(4\mu T)$ and claim (i) follows. To prove claim (ii), assume $c_1 \leq L(c_2)$

and $c_2 \leq L(c_1)$. Suppose, contrary to the claim, that $c_1 > \bar{c}$. By (8), this implies that $L(c_1) < c_1$. Also, since $c_1 \leq L(c_2)$, we have $L(c_2) > \bar{c}$. By (8) this implies $c_2 > \bar{c}$, and thus $L(c_2) < c_2$. Combining these inequalities, we get $c_2 \leq L(c_1) < c_1 \leq L(c_2) < c_2$, a contradiction. (The case against $c_2 > \bar{c}$ is similar.)

Finally, we prove part (c). From the proof of part (a), we know that $s_i = Pr$ is a best response to $s_{-i} = Pu$ if and only if $c_i \leq K$. From the proof of part (b) we know that $s_{-i} = Pu$ is a best response to $s_i = Pr$ if and only if $c_{-i} \geq L(c_i)$, provided $c_i < 1/(4\mu T)$. Since $K < 1/(4\mu T)$, this is satisfied when $c_i \leq K$. The result then follows. □

Proof of Corollary 2

Proposition 1c implies that for $L(c_{-i}) < c_i < K \; \forall i \in \{1,2\}$, two (pure strategy) private-public equilibria exist. In one such equilibrium, candidate 1 is publicly funded and candidate 2 is privately funded; in the other equilibrium candidate 2 is publicly funded and candidate 1 is privately funded. A mixed equilibrium must then exist in which both candidates randomize their funding choices. Using the payoffs $v_i^*(s_1, s_2)$ derived in the preliminary section of the Appendix (and noting that $c_i < K$ implies $c_i < 1/(4\mu T)$), the probability that candidate i chooses public funding in the mixed strategy equilibrium is given by

$$p_i \;=\; \frac{\sqrt{\mu T c_i} \;-\; \dfrac{c_i^2}{(c_1+c_2)^2}}{\sqrt{\mu T c_i} \;-\; \dfrac{c_i^2}{(c_1+c_2)^2} \;+\; \left(1-\sqrt{\mu T c_{-i}}\right)^2 - \dfrac{1}{2}} \;\in\; (0,1).$$

This depends on μT but not on the parameters μ and T individually. Furthermore, x_1 and x_2 do not depend on μ and T individually when $c_i < 1/(4\mu T)$. It follows that expected private spending, expected public spending, and the candidates' winning probabilities depend on the policy parameters μ and T only through the product μT. □

Proof of Proposition 3

The amount of speech in an all-private equilibrium is $1/(c_1 + c_2)$, which is independent of μ and T. Similarly, the amount of speech in an all-public equilibrium is $2T$, which is increasing in T and independent of μ. This establishes parts (a) and (b). To show part (c), consider a public-private equilibrium. Without loss of generality, let i be the privately funded candidate and let $-i$ be the publicly funded candidate. By Proposition 1c, the amount of private speech is $\sqrt{\mu T/c_i} - \mu T$, the amount of publicly funded speech is μT, and the total amount of speech is $\sqrt{\mu T/c_i}$. Publicly funded speech and total speech are strictly increasing in both μ and T. Privately funded speech is increasing in μ and T if

and only if it is increasing in μT:

$$\frac{\partial}{\partial \mu T}\left[\sqrt{\mu T/c_i} - \mu T\right] \;=\; \sqrt{1/(4c_i\mu T)} - 1 \;>\; 0,$$

or $c_i < 1/(4\mu T)$. By Proposition 1c, $c_i \leq K < 1/(4\mu T)$, and the result follows. □

Proof of Proposition 4

To show part (a), consider a private-public equilibrium. Assume that candidate i is privately funded and candidate $-i$ is publicly funded. By Proposition 1c, this implies $c_i \leq K$ and $c_{-i} \leq L(c_i)$; furthermore, $x_i = \sqrt{(\mu T)/c_i} - \mu T$ and $x_{-i} = \mu T$. Now suppose that $c_i = K$. Then a small increase in μ or T will turn the public-private equilibrium into an all-public equilibrium (by Proposition 1a). In the new all-public equilibrium, spending will be $\widetilde{x}_i = \widetilde{x}_{-i} = T$. Thus, candidate $-i$ weakly decreases his spending when the switch occurs (the decrease is strict if $\mu > 1$). Furthermore, since $c_i = K = (3/2 - \sqrt{2})/(\mu T)$ we can express candidate i's spending in the original private-public equilibrium as

$$x_i \;=\; \sqrt{(\mu T)/c_i} \,-\, \mu T \;=\; \mu T\left(\sqrt{1/\left(3/2 - \sqrt{2}\right)} \,-\, 1\right).$$

This is larger than T if and only if $3/2 - \sqrt{2} < \mu^2/[(1+\mu)^2]$. Since $\mu \geq 1$, we have $\mu^2/[(1+\mu)^2] \geq 1/4 > 3/2 - \sqrt{2}$ and therefore $x_i > \widetilde{x}_i$. Thus, when the funding switch occurs, candidate i strictly decreases his spending as well.

To show part (b), consider an all-private equilibrium. By Proposition 1b, this implies $c_i \leq L(c_{-i})$ and $c_{-i} \leq L(c_i)$; furthermore, $x_i = c_{-i}/[(c_i + c_{-i})]^2$ and $x_{-i} = c_i/[(c_i + c_{-i})]^2$. Now suppose that $c_{-i} = L(c_i)$. Then an arbitrarily small increase in μ or T will turn the all-private equilibrium into a private-public equilibrium where candidate i remains privately funded, and candidate $-i$ has switched to public funding (by Proposition 1c). In the new private-public equilibrium, total spending equals $\widetilde{x}_i + \widetilde{x}_{-i} = \sqrt{\mu T/c_i}$. Using $c_{-i} = L(c_i)$, we can express candidate $-i$'s spending in the original all-private equilibrium as

$$x_{-i} \;=\; c_i \cdot \left(c_i\left[(c_i\mu T)^{-1/4} - 1\right] + c_i\right)^{-2} \;=\; \sqrt{(\mu T)/c_i} \;=\; \widetilde{x}_i + \widetilde{x}_{-i}.$$

That is, candidate $-i$ alone spends as much in the all-private equilibrium as the two candidates spend together in the public-private equilibrium. It follows that, at the moment the funding switch occurs, candidate $-i$ decreases his speech strictly. Lastly, let us consider candidate i's spending in the all-private equilibrium, which is $x_i = c_{-i}/[(c_i + c_{-i})]^2$. Recall from the proof of Proposition 1b that in an all-private equilibrium $c_i, c_{-i} \leq \overline{c}$, and thus $L(c_i) \geq c_i$. Since $c_{-i} = L(c_i)$, this implies $c_{-i} \geq c_i$, and thus

$x_i \geq x_{-i} > \widetilde{x}_i + \widetilde{x}_{-i}$. It follows that, at the moment the funding switch occurs, candidate i also decreases his speech strictly. □

Table 1: Summary statistics: Arizona and Maine election contributions and candidates per race, 2000–2010

	Arizona				**Maine**			
	House		Senate		House		Senate	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Contributions ($)	164,485	94,620	91,269	73,860	12,066	6,444	55,974	33,129
Private	71,380	70,031	56,393	63,942	3,794	5,306	13,986	32,007
Public	93,105	67,627	34,876	36,269	8,272	5,565	41,988	25,596
Republican	100,200	86,506	56,601	65,568	5,721	4,336	27,344	24,187
Democrat	61,296	43,604	33,109	30,041	5,812	3,129	26,489	14,614
Per-capita contributions ($)	0.852	0.497	0.472	0.382	1.389	0.741	1.493	0.885
Private	0.374	0.378	0.294	0.333	0.440	0.617	0.376	0.863
Public	0.478	0.344	0.178	0.185	0.949	0.637	1.117	0.676
Republican	0.520	0.460	0.292	0.335	0.658	0.499	0.730	0.649
Democrat	0.316	0.225	0.172	0.161	0.669	0.361	0.706	0.389
Number of candidates per race	4.89	1.83	2.33	1.07	2.42	0.74	2.51	0.74
Private	2.37	1.73	1.46	1.00	0.94	0.87	0.77	0.86
Public	2.53	1.69	0.87	0.83	1.48	0.91	1.74	0.84
Republican	2.54	1.64	1.09	0.86	1.12	0.49	1.16	0.39
Democrat	2.04	1.57	0.96	0.59	1.14	0.41	1.17	0.46
N	180		180		906		210	

Notes:
Data from FollowTheMoney.org. Contributions and per-capita contributions are reported in constant 2010 dollars.

Table 2: Arizona and Maine election races, by legislative chamber and election year, 2000–2010

	Arizona											
	House						Senate					
	2000	2002	2004	2006	2008	2010	2000	2002	2004	2006	2008	2010
Races	30	30	30	30	30	30	30	30	30	30	30	30
All-private	6	2	4	5	1	1	18	12	14	8	9	11
Private-public	24	23	21	20	24	27	11	16	13	16	12	19
All-public	0	5	5	5	5	2	1	2	3	6	9	0
	Maine											
	House						Senate					
	2000	2002	2004	2006	2008	2010	2000	2002	2004	2006	2008	2010
Races	151	151	151	151	151	151	35	35	35	35	35	35
All-private	85	36	11	4	4	9	8	1	2	0	2	2
Private-public	50	84	74	75	72	81	18	19	14	17	14	16
All-public	16	31	66	72	75	61	9	15	19	18	19	17

Notes:
Data from FollowTheMoney.org.

Table 3: Arizona and Maine election per-capita contributions per race, by legislative chamber and election year, 2000–2010

	Arizona											
	House						Senate					
	2000	2002	2004	2006	2008	2010	2000	2002	2004	2006	2008	2010
Contributions ($)	0.954	0.914	0.778	0.773	0.868	0.824	0.516	0.480	0.456	0.441	0.485	0.445
	(0.643)	(0.509)	(0.462)	(0.472)	(0.480)	(0.396)	(0.409)	(0.427)	(0.362)	(0.351)	(0.457)	(0.292)
Private	0.664	0.365	0.241	0.278	0.243	0.456	0.422	0.298	0.266	0.203	0.238	0.337
	(0.569)	(0.305)	(0.238)	(0.265)	(0.232)	(0.384)	(0.392)	(0.336)	(0.243)	(0.282)	(0.414)	(0.275)
Public	0.291	0.549	0.537	0.496	0.625	0.368	0.094	0.183	0.189	0.237	0.248	0.118
	(0.258)	(0.368)	(0.375)	(0.372)	(0.35)	(0.239)	(0.131)	(0.196)	(0.217)	(0.176)	(0.215)	(0.104)
Republican	0.594	0.567	0.499	0.499	0.492	0.470	0.301	0.279	0.302	0.272	0.330	0.270
	(0.625)	(0.518)	(0.416)	(0.419)	(0.395)	(0.363)	(0.278)	(0.385)	(0.314)	(0.317)	(0.448)	(0.253)
Democrat	0.332	0.327	0.279	0.269	0.349	0.339	0.215	0.175	0.143	0.167	0.155	0.176
	(0.266)	(0.243)	(0.224)	(0.188)	(0.172)	(0.249)	(0.241)	(0.159)	(0.154)	(0.114)	(0.117)	(0.150)
	Maine											
	House						Senate					
	2000	2002	2004	2006	2008	2010	2000	2002	2004	2006	2008	2010
Contributions ($)	1.191	1.362	1.576	1.706	1.292	1.204	1.357	1.232	1.841	1.622	1.410	1.495
	(0.813)	(0.686)	(0.582)	(0.923)	(0.667)	(0.571)	(1.049)	(0.665)	(1.318)	(0.634)	(0.536)	(0.787)
Private	0.827	0.525	0.362	0.394	0.274	0.255	0.758	0.373	0.586	0.211	0.176	0.153
	(0.818)	(0.598)	(0.506)	(0.709)	(0.424)	(0.325)	(1.231)	(0.547)	(1.489)	(0.393)	(0.228)	(0.166)
Public	0.363	0.837	1.214	1.312	1.018	0.949	0.599	0.859	1.255	1.410	1.234	1.342
	(0.494)	(0.631)	(0.593)	(0.574)	(0.504)	(0.554)	(0.477)	(0.539)	(0.616)	(0.586)	(0.614)	(0.818)
Republican	0.557	0.630	0.759	0.790	0.616	0.599	0.726	0.617	0.932	0.737	0.651	0.716
	(0.543)	(0.460)	(0.356)	(0.670)	(0.495)	(0.360)	(0.892)	(0.301)	(1.106)	(0.339)	(0.389)	(0.392)
Democrat	0.594	0.656	0.713	0.862	0.621	0.568	0.609	0.569	0.825	0.796	0.714	0.725
	(0.460)	(0.372)	(0.308)	(0.339)	(0.247)	(0.330)	(0.333)	(0.468)	(0.403)	(0.285)	(0.325)	(0.443)

Notes:
Data from FollowTheMoney.org. Means are reported (standard deviations in parantheses). All numbers are in constant 2010 dollars.

Table 4: Arizona and Maine candidates per race, by legislative chamber and election year, 2000–2010

	Arizona											
	House						Senate					
	2000	2002	2004	2006	2008	2010	2000	2002	2004	2006	2008	2010
Number of candidates per race	5.1	5.2	4.5	4.6	4.5	5.5	2.6	2.4	1.9	2.2	2.0	2.8
	(2.1)	(1.8)	(1.5)	(1.5)	(1.6)	(2.1)	(1.4)	(1.0)	(0.8)	(0.9)	(0.7)	(1.3)
Private	3.8	2.3	1.8	1.9	1.6	2.8	2.2	1.6	1.2	1.1	0.9	1.9
	(1.9)	(1.8)	(1.1)	(1.4)	(1.1)	(2.0)	(1.2)	(0.9)	(0.6)	(0.9)	(0.7)	(0.9)
Public	1.3	2.9	2.7	2.7	2.9	2.7	0.5	0.9	0.8	1.1	1.1	0.9
	(1.1)	(1.9)	(1.6)	(2.0)	(1.3)	(1.7)	(0.6)	(0.9)	(0.7)	(0.7)	(0.7)	(1.1)
Republican	2.7	2.8	2.3	2.5	2.1	2.9	1.1	1.0	1.0	1.1	1.0	1.3
	(2.0)	(1.7)	(1.5)	(1.3)	(1.1)	(2.0)	(1.0)	(0.9)	(0.7)	(0.7)	(0.7)	(1.1)
Democrat	2.1	2.2	1.9	1.8	2.2	2.1	1.1	1.1	0.7	0.9	0.9	1.0
	(1.9)	(1.8)	(1.4)	(1.2)	(1.4)	(1.8)	(0.6)	(0.8)	(0.6)	(0.4)	(0.3)	(0.7)
	Maine											
	House						Senate					
	2000	2002	2004	2006	2008	2010	2000	2002	2004	2006	2008	2010
Number of candidates per race	2.2	2.5	2.5	2.4	2.4	2.5	2.4	2.5	2.6	2.5	2.6	2.5
	(0.7)	(0.8)	(0.7)	(0.6)	(0.7)	(0.7)	(0.6)	(0.9)	(0.6)	(0.6)	(1.0)	(0.7)
Private	1.6	1.2	0.7	0.7	0.6	0.9	1.2	0.9	0.6	0.6	0.7	0.6
	(0.9)	(0.8)	(0.8)	(0.8)	(0.7)	(0.8)	(0.9)	(1.0)	(0.7)	(0.7)	(0.9)	(0.7)
Public	0.6	1.3	1.8	1.7	1.8	1.7	1.1	1.5	2.0	2.0	1.9	1.9
	(0.8)	(1.0)	(0.9)	(0.6)	(0.7)	(0.8)	(0.8)	(0.8)	(0.8)	(0.6)	(0.9)	(0.8)
Republican	0.9	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.2	1.2	1.1	1.1
	(0.5)	(0.6)	(0.4)	(0.4)	(0.5)	(0.5)	(0.5)	(0.3)	(0.5)	(0.4)	(0.3)	(0.4)
Democrat	1.1	1.1	1.2	1.1	1.1	1.2	1.1	1.1	1.3	1.1	1.3	1.2
	(0.4)	(0.4)	(0.4)	(0.3)	(0.4)	(0.4)	(0.4)	(0.6)	(0.4)	(0.3)	(0.6)	(0.4)

Notes:
Data from FollowTheMoney.org. Means are reported (standard deviations in parantheses).

Table 5: Difference-in-difference estimates of the effects of eliminating matching funds on per-capita contributions per race, by legislative chamber

	House					Senate				
	Total contrib.	Private contrib.	Public contrib.	Rep. contrib.	Dem. contrib.	Total contrib.	Private contrib.	Public contrib.	Rep. contrib.	Dem. contrib.
AZ	-0.457^{***}	-0.147^{*}	-0.310^{***}	-0.136^{*}	-0.307^{***}	-1.051^{***}	-0.140	-0.912^{***}	-0.446^{***}	-0.547^{***}
	(0.086)	(0.083)	(0.063)	(0.074)	(0.032)	(0.078)	(0.096)	(0.070)	(0.068)	(0.038)
2002	0.137^{*}	-0.301^{***}	0.438^{***}	0.056	0.051	-0.083	-0.264^{*}	0.181^{**}	-0.069	-0.040
	(0.080)	(0.071)	(0.055)	(0.048)	(0.047)	(0.130)	(0.135)	(0.066)	(0.098)	(0.055)
2004	0.292^{***}	-0.458^{***}	0.751^{***}	0.152^{***}	0.090^{**}	0.233	-0.164^{***}	0.398^{***}	0.111	0.083
	(0.076)	(0.072)	(0.059)	(0.050)	(0.043)	(0.190)	(0.195)	(0.057)	(0.155)	(0.055)
2006	0.400^{***}	-0.425^{***}	0.825^{***}	0.178^{***}	0.213^{***}	0.108	-0.395^{***}	0.503^{***}	-0.008	0.078
	(0.097)	(0.082)	(0.062)	(0.066)	(0.047)	(0.142)	(0.131)	(0.065)	(0.108)	(0.054)
2008	0.070	-0.531^{***}	0.601^{***}	0.032	0.025	0.015	-0.398^{***}	0.413^{***}	-0.027	0.029
	(.0086)	(0.070)	(0.056)	(0.061)	(0.042)	(0.149)	(0.129)	(0.066)	(0.122)	(0.051)
2010	-0.041	-0.564^{***}	0.523^{***}	0.012	-0.045	0.058	-0.512^{***}	0.569^{***}	-0.015	0.052
	(0.086)	(0.070)	(0.065)	(0.054)	(0.050)	(0.220)	(0.144)	(0.150)	(0.139)	(0.103)
AZ$\times$2010	0.187^{*}	0.319^{***}	-0.132	0.012	0.149^{***}	-0.024	0.320^{***}	-0.343^{**}	-0.010	-0.017
	(0.104)	(0.079)	(0.081)	(0.067)	(0.054)	(0.151)	(0.089)	(0.137)	(0.088)	(0.085)
N	1,086	1,086	1,086	1,086	1,086	390	390	390	390	390
R^2	0.184	0.164	0.338	0.160	0.185	0.342	0.058	0.546	0.121	0.448

Notes:
Data from FollowTheMoney.org. All regressions include district fixed effects. Numbers in parantheses are robust standard errors adjusted for clustering on districts. Stars denote statistical significance: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Difference-in-difference estimates of the effects of eliminating matching funds on per-capita contributions per race, controlling for number of candidates per race, by legislative chamber

	House					Senate				
	Total contrib.	Private contrib.	Public contrib.	Rep. contrib.	Dem. contrib.	Total contrib.	Private contrib.	Public contrib.	Rep. contrib.	Dem. contrib.
Candidates	0.080***	0.074***	0.158***	0.109***	0.080***	0.210***	0.070	0.139***	0.072**	0.087***
	(0.014)	(0.022)	(0.021)	(0.022)	(0.014)	(0.034)	(0.042)	(0.028)	(0.031)	(0.020)
AZ	−0.509***	−0.335***	−0.709***	−0.411***	−0.509***	−0.992***	−0.120	−0.872***	−0.426***	−0.522***
	(0.041)	(0.095)	(0.062)	(0.079)	(0.041)	(0.079)	(0.103)	(0.070)	(0.074)	(0.037)
2002	0.032	−0.318***	0.402***	0.031	0.032	−0.077	−0.262*	0.185***	−0.066	−0.037
	(0.045)	(0.069)	(0.052)	(0.045)	(0.045)	(0.117)	(0.132)	(0.064)	(0.096)	(0.050)
2004	0.076*	−0.471***	0.723***	0.133***	0.076*	0.278	−0.149	0.428***	0.127	0.102*
	(0.041)	(0.070)	(0.056)	(0.047)	(0.041)	(0.179)	(0.191)	(0.057)	(0.151)	(0.053)
2006	0.206***	−0.431***	0.813***	0.170***	0.206***	0.134	−0.386***	0.520***	0.001	0.089
	(0.046)	(0.081)	(0.060)	(0.065)	(0.046)	(0.127)	(0.128)	(0.063)	(0.103)	(0.053)
2008	0.024	−0.532***	0.599***	0.030	0.024	0.054	−0.385***	0.439***	−0.014	0.045
	(0.039)	(0.068)	(0.053)	(0.058)	(0.039)	(0.141)	(0.129)	(0.062)	(0.122)	(0.048)
2010	−0.064	−0.582***	0.487***	−0.013	−0.064	0.080**	−0.504***	0.584***	−0.008	0.061
	(0.048)	(0.068)	(0.064)	(0.052)	(0.048)	(0.206)	(0.143)	(0.144)	(0.136)	(0.101)
AZ×2010	0.098*	0.272***	−0.232**	−0.058	0.098*	−0.141	0.280***	−0.421***	−0.050	−0.066
	(0.052)	(0.078)	(0.090)	(0.071)	(0.052)	(0.156)	(0.102)	(0.141)	(0.097)	(0.086)
N	1,086	1,086	1,086	1,086	1,086	390	390	390	390	390
R^2	0.229	0.179	0.399	0.206	0.299	0.389	0.065	0.578	0.132	0.484

Notes:
Data from FollowTheMoney.org. All regressions include district fixed effects. Numbers in parantheses are robust standard errors adjusted for clustering on districts. Stars denote statistical significance: * Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Difference-in-difference estimates of the effects of eliminating matching funds on the number of candidates per race, by legislative chamber

	House					Senate				
	Total candid.	Private candid.	Public candid.	Rep. candid.	Dem. candid.	Total candid.	Private candid.	Public candid.	Rep. candid.	Dem. candid.
AZ	2.522***	1.303***	1.219***	1.468***	0.860***	−0.282**	0.606***	−0.888***	−0.118	−0.214**
	(0.176)	(0.199)	(0.212)	(0.193)	(0.192)	(0.130)	(0.149)	(0.132)	(0.099)	(0.087)
2002	0.227**	−0.597***	0.823***	0.232**	0.028	−0.031	−0.431**	0.400***	−0.062	0.031
	(0.115)	(0.117)	(0.106)	(0.101)	(0.088)	(0.173)	(0.163)	(0.144)	(0.128)	(0.114)
2004	0.177*	−1.044***	1.221***	0.160*	−0.022	−0.215	−0.815***	0.600***	−0.062	−0.046
	(0.100)	(0.111)	(0.106)	(0.083)	(0.082)	(0.171)	(0.144)	(0.117)	(0.135)	(0.097)
2006	0.077	−1.077***	1.155***	0.193**	−0.072	−0.123	−0.862***	0.738***	0.031	−0.062
	(0.102)	(0.109)	(0.101)	(0.085)	(0.081)	(0.164)	(0.145)	(0.110)	(0.123)	(0.080)
2008	0.017	−1.188***	1.204***	0.028	0.017	−0.185	−0.908***	0.723***	−0.077	0.015
	(0.116)	(0.114)	(0.103)	(0.092)	(0.093)	(0.191)	(0.141)	(0.134)	(0.128)	(0.092)
2010	0.232**	−0.875***	1.107***	0.222***	0.010	−0.105	−0.769***	0.664***	−0.051	0.022
	(0.097)	(0.118)	(0.103)	(0.083)	(0.080)	(0.179)	(0.175)	(0.164)	(0.117)	(0.116)
AZ×2010	0.634	0.614	0.020	0.294	0.007	0.561**	0.732***	−0.171	0.310	0.052
	(0.394)	(0.418)	(0.369)	(0.302)	(0.260)	(0.267)	(0.230)	(0.178)	(0.202)	(0.162)
N	1,086	1,086	1,086	1,086	1,086	390	390	390	390	390
R^2	0.480	0.345	0.307	0.366	0.220	0.014	0.273	0.288	0.074	0.042

Notes:
Data from FollowTheMoney.org. All regressions include district fixed effects. Numbers in parantheses are robust standard errors adjusted for clustering on districts. Stars denote statistical significance: * Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Difference-in-difference estimates of the effects of eliminating matching funds on the number of private and public candidates per race, controlling for the number of candidates per race

	House		**Senate**	
	Private candidates	Public candidates	Private candidates	Public candidates
Candidates	0.508***	0.492***	0.549***	0.451***
	(0.057)	(0.057)	(0.047)	(0.047)
AZ	0.023	−0.023	0.761***	−0.761***
	(0.191)	(0.191)	(0.124)	(0.124)
2002	−0.712***	0.712***	−0.414***	0.414***
	(0.096)	(0.096)	(0.127)	(0.127)
2004	−1.134***	1.134***	−0.697***	0.697***
	(0.100)	(0.100)	(0.098)	(0.098)
2006	−1.117***	1.117***	−0.794***	0.794***
	(0.092)	(0.092)	(0.098)	(0.098)
2008	−1.196***	1.196***	−0.806***	0.806***
	(0.092)	(0.092)	(0.099)	(0.099)
2010	−0.993***	0.993***	−0.711***	0.711***
	(0.102)	(0.102)	(0.142)	(0.142)
AZ×2010	0.292	−0.292	0.424***	−0.424***
	(0.338)	(0.338)	(0.149)	(0.149)
N	1,086	1,086	390	390
R^2	0.521	0.485	0.524	0.475

Notes:
Data from FollowTheMoney.org. All regressions include district fixed effects. Numbers in parantheses are robust standard errors adjusted for clustering on districts. Stars denote statistical significance: * Significant at 10%; ** significant at 5%; *** significant at 1%.

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