

The Effects of Voting Costs on the Democratic Process and Public Finances[†]

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Increasing the attractiveness of voting is often seen as a remedy for unequal participation and the influence of special-interest groups on public policy. However, lower voting costs may also bring less informed citizens to the poll, thereby inviting efforts to sway these voters. We substantiate this argument in a probabilistic voting model with campaign contributions. In an empirical analysis for the 26 Swiss cantons, we find that lower voting costs due to postal voting are related to higher turnout, lower average education and political knowledge of participants as well as lower government welfare expenditures and lower business taxation. (JEL D72, H25, H75, I20, I38)

Democratic decision making in elections and referenda is characterized by unequal turnout as rich and well educated citizens are more likely to participate than their less privileged compatriots.¹ Many students of democracy worry that this unequal participation translates into fiscal policies that are biased towards privileged citizens (see, e.g., Lijphart 1997). Various institutional mechanisms have been proposed to achieve a more equal representation. In these proposals, voting costs figure prominently. Incentives for participation are expected to be higher with postal voting or forms of electronic voting involving lower costs for citizens, or with institutional mechanisms like compulsory voting that increase the costs of abstention.

However, voting costs may also work as a selection device bringing the confident citizens to the poll but not the uncertain ones. Lower voting costs may thus induce more people to vote who only have a diffuse understanding of what their preferred alternative is. The latter circumstances though invite efforts to influence these voters. Special-interest groups may offer more campaign contributions allowing parties

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¹Tingsten (1937, p. 155) was one of the first to provide systematic evidence that “the voting frequency rises with rising social standard.” Lijphart (1997) reviews many studies that document unequal turnout.

to try to sway these voters in exchange for rents or policies tilted towards these groups. Whether lower voting costs contribute to a better serving of citizens' preferences is thus far from clear.

In this paper, we scrutinize the argument that lowering voting costs might have unintended effects on political outcomes. We first analyze theoretically how voting costs affect the political process and, thereby, public finances. We base this analysis on a probabilistic voting model with campaign contributions similar to the models of Baron (1994); Grossman and Helpman (1996, 2001); and Persson and Tabellini (2000). In our model, political candidates choose their policy platform, which consists of taxes and public expenditures directed towards the public and special-interest groups, respectively. The latter can make campaign contributions to political candidates. Informed voters base their decision primarily on policy platforms, while uninformed or impressionable citizens base their decision primarily on political advertisements paid for by campaign contributions. Unlike in standard voting models, in our model citizens decide how much political information to acquire, and whether or not to participate in the election. We assume that the costs of acquiring political information are lower for better educated citizens. Further, citizens have to bear costs when voting, and we follow Matsusaka (1995) in assuming that the citizens' benefits from voting are higher the more confident they are of their vote choice.

In this model, better educated citizens are more likely to make informed decisions when voting, and they are also more likely to participate in the election.² The composition of participants changes if technological innovations in the electoral process like postal voting decrease voting costs. Such innovations increase electoral participation as well as the share of less educated and thus impressionable voters whose vote choice depends on campaigns rather than policy platforms. As a consequence, candidates propose platforms with higher rent payments to special-interest groups (or, alternatively, platforms with lower taxes for groups that lobby politicians).³ The effect of lower voting costs on expenditures targeted towards the public is ambiguous in general, and negative with Cobb-Douglas preferences. Therefore, in contrast to what conventional wisdom suggests, our model shows that lower voting costs benefit special-interest groups, but may well harm all other citizens in society.

We empirically test the predictions of the model for a procedural innovation that significantly reduces voting costs: postal voting. We thereby exploit the quasi-random experiment provided by the staggered introduction of postal voting in the 26 Swiss cantons. Switzerland provides an attractive setting for the empirical analysis for two additional reasons: First, frequent direct democratic decisions at the federal level allow us to observe participation decisions and changes in characteristics of participants at a higher temporal resolution than what is normally possible.

²Lassen (2005) offers evidence from a natural experiment that better-informed people are more likely to vote. According to Shue and Luttmer (2009), citizens with poor education and low incomes are more likely to misvote not only because they are poorly informed, but also because they have difficulties filling out the ballots. In particular, they document that minor candidates' vote shares are much larger when their (random) placement on the ballot is adjacent to a top candidate; and that these vote gains are larger in precincts with a large fraction of people with a low socioeconomic status in terms of education and income.

³These results are consistent with the finding of Wegenast (2010) that interest groups are less influential in US states with highly educated and well-informed citizens. The latter result is also indirect evidence for the idea of impressionable voters.

Second, changes in participation decisions can translate into changes in cantonal fiscal policies due to the cantons' high degree of fiscal autonomy.

The empirical analyses refer to the years 1980/1981 to 2007/2010 depending on data availability. First, we find evidence for a 5 percentage point increase in voter turnout with postal voting at federal ballots. Second, based on a series of post-ballot surveys, we find that postal voting systematically alters the composition of the voting population. On average, voters have fewer years of education and know less on the ballot propositions (i.e., popular initiatives and referenda) they voted on once postal voting is introduced. Finally, we observe postal voting to lower cantons' welfare expenditures and business taxation. While these latter results might come as a surprise, they are consistent with our model allowing for a more favorable treatment of special-interest groups and less government expenditures targeted at the public in response to lower voting costs.

This paper contributes to four different strands of the theoretical and empirical political economy literature. First, it builds on the contributions of Baron (1994); Grossman and Helpman (1996, 2001); and Persson and Tabellini (2000) on the role of campaign contributions in elections. Due to its focus on fiscal policies, our model is probably closest to Persson and Tabellini (2000). The main differences to all these contributions are that we deviate from the assumption of full (or random) voting participation, and that we do not take the share of informed voters as exogenous.⁴ This allows us to show that lower voting costs make campaign contributions more important and, consequently, special-interest groups more powerful.

Second, Meltzer and Richard (1981) contributed one of the most prominent models in political economics linking the composition of the voting population with public finances. Restricting government activities to redistribution financed by a proportional income tax, their model predicts that a stronger representation of low-skilled citizens in the political process leads to more redistribution. Empirical evidence for this prediction, often exploiting different extensions of the franchise, is rather mixed (see, e.g., Husted and Kenny 1997; Rodriguez 1999; Alesina and Glaeser 2004; Gradstein and Milanovic 2004; Stutzer and Kienast 2005). Our model offers a novel explanation for the lack of strong and unambiguous empirical support for the Meltzer-Richard hypothesis: The inclusion of poorer and less educated citizens may have increased the clout of special interests to the detriment of policies benefiting the general population, including the newly enfranchised citizens.

Third, voting costs are a key ingredient in the rational choice model of voting participation (Downs 1957; Riker and Ordeshook 1968). Our results shed light on the quantitative importance of transaction costs related to voting and offer complementary evidence on the consequences of postal voting on turnout (see also Luechinger, Rosinger, and Stutzer 2007; Funk 2010; Gerber, Huber, and Hill 2013). We go, however, beyond the previous literature by documenting the effects of postal voting on the composition of participants and public finances.

⁴Strömberg (2004) endogenizes the share of informed voters in a probabilistic voting model with profit-maximizing media. Prat (2002a, 2002b) and Coate (2004a, 2004b) provide microfoundations for the effect of political advertisement on voting decisions of imperfectly informed voters. We abstract from these interesting aspects of political advertisement as we focus on the effects of voting costs on fiscal policies rather than on why and how political ads work.

Fourth, higher abstention costs may in general have similar effects on voting decisions and fiscal policies as lower voting costs. Hence, our paper is also related to a recent empirical strand of literature that focuses on the effects of compulsory voting.⁵ León (2013) experimentally influences perceptions about fine levels for abstention around a change in voting laws in Peru. He finds that lower perceived fines reduce turnout, especially among voters with little political knowledge. De Leon and Rizzi (2014) exploit the fact that voting is compulsory in Brazil for citizens older than 18 years, but voluntary for the 16 to 18 years old. Using a sample of surveyed students from Sao Paolo, they find that compulsory voting increases turnout, but has no strong effect on political knowledge. The two studies can be linked to our model, which shows that voters' average political knowledge depends on two factors: first the participation decisions of voters with different socioeconomic backgrounds and, hence, information acquisition costs; and second the participating voters' endogenous information acquisition. In the empirical analysis, we thus estimate the total change in voters' average political knowledge due to both of these factors. In contrast, León (2013) focuses on the first factor, and De Leon and Rizzi (2014) study the second factor.

Hidalgo (2010) and Fujiwara (2013) study the introduction of electronic voting machines in Brazil using the fact that electronic voting machines were first introduced in municipalities with a population size exceeding a particular threshold. They both find that electronic voting machines reduce the number of invalid votes and, thereby, increase effective turnout. According to Fujiwara (2013), this effect is more pronounced in municipalities with high illiteracy rates. In addition, Hidalgo (2010) presents evidence that electronic voting machines reduce electoral fraud, and Fujiwara (2013) shows that a higher share of people living in municipalities with electronic voting machines lead to an increase in health care spending and utilization at the state level. Our empirical analysis is probably closest to Fujiwara (2013), as he also studies the effect of a new voting technology on voting patterns as well as government spending. There are, however, some noteworthy differences: Our setting allows us to study the change in the voting population using individual level data, while Fujiwara (2013) investigates a change in the share of valid votes at the municipality level. Moreover, we observe public finances at the subnational level at which the voting technology changed. More generally, our empirical part differs from contributions on compulsory voting in Brazil and Peru by studying a developed country with voluntary voting in which electoral fraud, illiteracy, and invalid votes play a minor role (with the share of

⁵In our model, higher abstention costs and lower voting costs even have identical effects on voting decisions and fiscal policies. Hence, we also contribute to the small *theoretical* literature on compulsory voting. Crain and Leonard (1993) discuss the effects of compulsory voting on public goods provision and rents to special-interest groups in different theoretical frameworks, while we study these effects in a formal and unified model. Börgers (2004) and Krasa and Polborn (2009) compare welfare under compulsory and voluntary voting in costly voting models in which only pivotal voters benefit from voting, thereby abstracting from the way candidates choose their policy platforms and the role of special-interest groups. Krishna and Morgan (2011) argue that compulsory voting has the drawback that preference intensities can no longer affect voting participation and, thereby, voting outcomes. This argument is loosely related to our general point that postal and compulsory voting may reduce the political knowledge of the average voter and, therefore, lead to inferior policy outcomes for the population at large.

invalid votes being 0.3 percent for an average ballot in our sample), and also by looking at unintended side effects.

Section I presents and solves our theoretical model. Section II presents the data and the results of our empirical analysis. Section III offers concluding remarks.

I. The Model

A. Setting

There are two candidates, a lobby group, and a measure-one continuum of citizens. Each candidate $P \in \{A, B\}$ is office-motivated and chooses his policy platform to maximize his winning probability p_P , where $p_A + p_B = 1$. Platforms consist of public expenditures directed towards the public, $g_P \geq 0$, and rent payments to the lobby group, $r_P \geq 0$. These two forms of public expenditures are financed with a linear income tax, and the government budget must be balanced. Hence g_P and r_P determine the tax rate $\tau_P = (g_P + r_P)/y$, where y denotes average income. Candidates may differ in their policy platforms (g_P, r_P) as well as in some predetermined, i.e., exogenous, positions.

The lobby group can make campaign contributions $C_A \geq 0$ and $C_B \geq 0$ to candidates A and B at increasing marginal costs, and it receives rents r_P from the elected candidate P . Its utility is $\Pi(r_P, C_A, C_B) = J(r_P) - (C_A + C_B)^2/2$, where $J'(r_P) > 0$ and $J''(r_P) < 0$.

Citizens differ in their skills α^i , which may represent educational attainments or innate abilities. The distribution of α^i is given by $F(\alpha^i)$, with continuous density $f(\alpha^i)$ and mean α . For simplicity we assume $F(0) = 0$, $F(1) = 1$, and $f(\alpha^i) > 0$ for all $\alpha^i \in [0, 1]$. Skills α^i have two effects: First they determine citizen i 's income $y^i = \alpha^i$. Second they determine how costly it is for citizen i to acquire political knowledge $q_i \in [0, 1]$. Citizens are either informed, in which case they understand the candidates' platforms (g_P, r_P) and their predetermined positions, or they are impressionable. The political knowledge q_i of citizen i measures the probability that she is informed rather than impressionable.

If candidate P is elected, the utility of citizen i is

$$(1) \quad W_{i,P} = W(g_P, r_P, \alpha^i, \sigma_P^i, q_i) = U(c_P^i) + H(g_P) + \sigma_P^i \\ + I_i(\beta q_i - \gamma) - \frac{q_i^2}{2\alpha^i}.$$

The first two terms on the right-hand side reflect citizen i 's utility from private consumption $c_P^i = (1 - \tau_P)\alpha^i$ and public expenditures g_P , respectively. We assume $U'(c_P^i) > 0$, $U''(c_P^i) \leq 0$, $H'(g_P) > 0$ and $H''(g_P) < 0$. We further assume that $R(c_P^i) \equiv -c_P^i U''(c_P^i)/U'(c_P^i)$ is constant and satisfies $R(c_P^i) \in [0, 1]$. The third term, σ_P^i , represents her utility from the predetermined positions of the elected candidate P . We assume that $\sigma^i = \sigma_B^i - \sigma_A^i$ is uniformly distributed in $[-1/(2\phi), 1/(2\phi)]$.

The fourth term captures benefits and costs associated with voting. I_i is a dummy variable whose value is 1 if citizen i participates in the election and 0 if she abstains. Some benefits from voting may well depend on the voter's political knowledge, like the satisfaction of being confident to have voted in one's own interest (Matusaka 1995).⁶ These benefits are βq_i . For simplicity, we set $\beta = 1$. The costs of completing and casting one's ballot are denoted by γ . These voting costs are relatively high when ballots must be cast at a polling station, but they decrease if postal voting is introduced. The last term captures the costs of acquiring political knowledge q_i , which are decreasing in skills α_i .

It remains to describe the voters' decisions.⁷ We know that voter i is informed with probability q_i and impressionable with probability $1 - q_i$. Informed voters vote for candidate A if $W_{i,A} \geq W_{i,B}$, and for candidate B otherwise. The electoral decisions of impressionable voters are driven by political advertisements and policy irrelevant candidate characteristics. The share of impressionable voters who vote for candidate A is $1/2 + \psi(\Delta C - \eta)$, where $\Delta C \equiv C_A - C_B$.⁸ The remaining impressionable voters vote for candidate B . Note that $\psi > 0$ measures the effectiveness of advertisements and, therefore, campaign contributions; and η is a popularity shock that is uniformly distributed in $[-1/(2\lambda), 1/(2\lambda)]$.

Timing is as follows: First, the candidates choose their policy platforms. Second, the lobby group can make campaign contributions. Third, elections take place. The elected candidate then implements the announced platform. The appropriate solution concept for this sequential game is subgame perfect Nash equilibrium.

B. Discussion

We now discuss some of the assumptions made. Given utility function (1), the citizens' marginal utilities of additional units of private consumption c_p^i and public expenditures g_p will typically differ. Hence, g_p is not simply a transfer payment, but some publicly provided good.⁹ Moreover, the citizens' utility from c_p^i and g_p is additively separable, and $R(c_p^i)$ is constant. The model could be solved with more general utility functions, but these assumptions simplify the analysis. Furthermore, they still allow for popular specifications such as Cobb-Douglas preferences in log form, or the quasi-linear preferences used by Persson and Tabellini (2000).

In this model the slope of the Engel curve in public expenditures is $\partial g_p^i / \partial \alpha^i = -U'(c_p^i)\theta / [\alpha H''(g_p)]$, where g_p^i is the level of g_p that maximizes citizen i 's

⁶In general, citizens also benefit from political knowledge if they are pivotal with nonzero probability. However, this probability is zero in our model in which there is a continuum of voters.

⁷We use the term "voters" to refer to citizens who participate in the election.

⁸Following Persson and Tabellini (2000) we could assume that impressionable voter i votes for A if and only if $\Delta C > \varepsilon^i + \eta$, with ε^i being uniformly distributed in $[-1/(2\psi), 1/(2\psi)]$.

⁹If g_p were simply a transfer payment, citizens would have extreme policy preferences: All citizens with an income below average would prefer a tax rate of one and all other citizens a tax rate of zero. To avoid such extreme policy preferences one needs either to assume that g_p is not simply a transfer as we do, or to add an endogenous labor-leisure choice as Meltzer and Richard (1981) do.

utility, and where $\theta \equiv R(c_p^i) - 1$.¹⁰ Observe that the slope of the Engel curve has the same sign as θ . The assumption $R(c_p^i) \leq 1$, which implies $\theta \leq 0$, thus ensures a nonpositive relationship between a citizen's skills α^i and her preferred level of g_p .

In our model higher skilled voters will optimally acquire more political knowledge because of lower information acquisition costs, which is consistent with empirical evidence that voters with better education and higher incomes are better informed (e.g., Benz and Stutzer 2004; Lind and Rohner 2013). Other mechanisms ensuring that higher-skilled citizens acquire more political knowledge would serve our purpose equally well (e.g., Larcinese 2005). Similarly, our results do not depend on the perfect correlation between incomes and the costs of acquiring political knowledge. A negative correlation is, however, necessary.

We assume that the opportunity costs of voting are the same across individuals. If these costs were increasing in skills α_i , all our results would hold as long as the effect of political knowledge on voting benefits would be sufficiently large relative to the effect of skills on voting costs (see the analysis in the online Appendix). In the reverse case less skilled individuals would be more likely to vote. This pattern of predicted turnout would be in stark contrast to the turnout pattern observed in reality.

The lobby group receives transfer payments in our model. In reality, lobby groups also get favors in the form of tax breaks. Hence, the rents r_p could represent tax reductions for the lobby group instead of transfer payments. We discuss this alternative interpretation of our model at the end of Section IC.

C. Equilibrium Analysis

In this section, we first derive the decisions of the citizens and the lobby group, which yield the candidates' objective function. We then study how changes in voting costs affect the candidates' policy platforms in two simplified versions of our model. Finally, we look at the complete model introduced above, and discuss how changes in voting costs affect the equilibrium policy platforms as well as the welfare of the citizens.

Decisions of Citizens and Lobby Group.—We start by looking at citizens' decisions of how much political knowledge q_i to acquire, and whether or not to participate in the election. For citizens who abstain from voting, acquiring political knowledge has no benefits. Hence they choose $q_i = 0$. Citizens who participate in the election choose q_i to maximize $q_i - q_i^2/(2\alpha^i)$. Hence they choose $q_i = \alpha^i$. Citizens therefore acquire political knowledge $q_i = \alpha^i$ and participate in the election if $\alpha^i - \gamma - (\alpha^i)^2/(2\alpha^i) = \alpha^i/2 - \gamma \geq 0$, i.e., if $\alpha^i \geq 2\gamma$, while they acquire no political knowledge and abstain from voting otherwise. The election participation threshold 2γ directly determines voter turnout $1 - F(2\gamma)$. We focus on

¹⁰The first-order condition $-U'(c_p^i)(\partial c_p^i/\partial \tau_p)(\partial \tau_p/\partial g_p) + H'(g_p) = 0$, where $\partial c_p^i/\partial \tau_p = -\alpha^i$ and $\partial \tau_p/\partial g_p = 1/\alpha$, determines g_p^i . The implicit function theorem then implies $\partial g_p^i/\partial \alpha^i = -U'(c_p^i)\theta/[\alpha H''(g_p)]$.

cases in which $\gamma \in (0, 1/2)$, such that marginal changes in voting costs γ have an effect on voter turnout and equilibrium policy platforms. It directly follows:

PROPOSITION 1: *Lower voting costs γ increase voter turnout.*

The voters' average skills and their average political knowledge are both equal to $\int_{2\gamma}^1 \alpha^i f(\alpha^i) d\alpha^i / [1 - F(2\gamma)]$. Therefore:

PROPOSITION 2: *Lower voting costs γ reduce voters' average skills and their average political knowledge.*

We next derive the expected election outcome as a function of the candidates' platforms, and the campaign contributions. Informed voters vote for candidate A if $\Delta V(\alpha^i) \equiv U(c_A^i) - U(c_B^i) + H(g_A) - H(g_B) > \sigma^i$ and for B otherwise. Among informed voters with $\alpha^i \geq 2\gamma$, the share voting for A is therefore $1/2 + \phi \Delta V(\alpha^i)$.¹¹ By assumption, the share of impressionable voters voting for A is $1/2 + \psi(\Delta C - \eta)$ for any $\alpha^i \geq 2\gamma$. As the share of voters with skills $\alpha_i \geq 2\gamma$ who is informed equals $q_i = \alpha^i$, the population share who votes for A thus adds up to $\pi_A = \int_{2\gamma}^1 [1/2 + \alpha^i \phi \Delta V(\alpha^i) + (1 - \alpha^i) \psi(\Delta C - \eta)] f(\alpha^i) d\alpha^i$, and the population share who votes for B to $\pi_B = 1 - F(2\gamma) - \pi_A$. Candidate A therefore wins if and only if $\int_{2\gamma}^1 [\alpha^i \phi \Delta V(\alpha^i) + (1 - \alpha^i) \psi(\Delta C - \eta)] f(\alpha^i) d\alpha^i \geq 0$. Hence his winning probability is

$$(2) \quad p_A = \Pr \left\{ \eta \leq \frac{\phi \int_{2\gamma}^1 \alpha^i \Delta V(\alpha^i) f(\alpha^i) d\alpha^i}{\psi \int_{2\gamma}^1 (1 - \alpha^i) f(\alpha^i) d\alpha^i} + \Delta C \right\}$$

$$(3) \quad = \frac{1}{2} + \frac{\lambda \phi \int_{2\gamma}^1 \alpha^i \Delta V(\alpha^i) f(\alpha^i) d\alpha^i}{\psi \int_{2\gamma}^1 (1 - \alpha^i) f(\alpha^i) d\alpha^i} + \lambda \Delta C.$$

We now turn to the lobby group's decision. The lobby group chooses campaign contributions C_A and C_B to maximize its expected utility $p_A J(r_A) + (1 - p_A) J(r_B) - (C_A + C_B)^2/2$, thereby anticipating the effects of C_A and C_B on p_A . The lobby group supports no candidate if rents r_A and r_B coincide, and the candidate promising more generous rents otherwise. It is easy to see that the lobby group chooses $C_A = \max\{0, \lambda[J(r_A) - J(r_B)]\}$ and $C_B = \max\{0, \lambda[J(r_B) - J(r_A)]\}$, such that $\Delta C = \lambda[J(r_A) - J(r_B)]$. Inserting this expression for ΔC into equation (3) leads to

$$(4) \quad p_A = \frac{1}{2} + \frac{\lambda \phi \int_{2\gamma}^1 \alpha^i \Delta V(\alpha^i) f(\alpha^i) d\alpha^i}{\psi \int_{2\gamma}^1 (1 - \alpha^i) f(\alpha^i) d\alpha^i} + \lambda^2 [J(r_A) - J(r_B)].$$

¹¹ More generally, this share is $\min\{\max\{0, 1/2 + \phi \Delta V(\alpha^i)\}, 1\}$, but for simplicity we assume that it is strictly between zero and one. We make similar (implicit) assumptions for all vote shares and winning probabilities below.

Candidate A anticipates the behavior of the lobby group and the citizens, and chooses his policy platform (g_A, r_A) to maximize his winning probability p_A . Candidate B chooses (g_B, r_B) to maximize $p_B = 1 - p_A$. It follows from equation (4) and the definition of $\Delta V(\alpha^i)$ that each candidate's optimal platform is independent of his opponent's platform, and that each candidate solves the maximization problem

$$(5) \quad \max_{g_P, r_P} \int_{2\gamma}^1 [\alpha^i U(c_P^i) + \alpha^i H(g_P) + (1 - \alpha^i) \Omega J(r_P)] f(\alpha^i) d\alpha^i,$$

where $\Omega \equiv \psi\lambda/\phi$, subject to $g_P \geq 0$, $r_P \geq 0$, $c_P^i = (1 - \tau_P)\alpha^i$ and $\tau_P = (g_P + r_P)/\alpha \leq 1$. We assume throughout that the solution is interior. As it is standard in this type of lobbying models, the two candidates' platforms coincide in equilibrium, such that the lobby group makes no campaign contributions even if the candidates offer rents $r_P > 0$.

Policy Platforms when Rents Are Exogenous (or Absent).—We now look at a simplified version of our model in which rents r_P are exogenous and equal to $\bar{r} \in [0, \alpha)$. This simplified version includes the special case in which there are no rents. The model might be close to the one that some of the proponents of eased voting or compulsory voting have in mind, and it indeed helps to understand why these procedural changes could potentially benefit citizens with low incomes.

In this simplified version of the model, the two endogenous fiscal policy variables, g_P and τ_P , are tied together by the government's budget constraint. Hence candidates have effectively only one choice, and the maximization problem (5) reduces to

$$(6) \quad \max_{g_P} \int_{2\gamma}^1 \alpha^i [U(c_P^i) + H(g_P)] f(\alpha^i) d\alpha^i$$

with $c_P^i = (1 - \tau_P)\alpha^i$ and $\tau_P = (g_P + \bar{r})/\alpha$. It follows:¹²

PROPOSITION 3: *Assume $r_P = \bar{r}$. Then lower voting costs γ increase the expenditures directed towards the public g_P and the tax rate τ_P if $\theta < 0$, but have no effect on g_P and τ_P if $\theta = 0$.*

The intuition is the following. Lower voting costs γ increase voter turnout and lower the average voter's income as well as the average informed voter's income. Since voters with lower incomes prefer higher public expenditures g_P as long as $\theta < 0$, the candidates respond to the lower income of the average informed voter by increasing g_P . This is very similar to the mechanism modeled in Meltzer and Richard (1981).

Policy Platforms when the Tax Rate Is Exogenous.—We now look at a simplified version of our model in which the tax rate is exogenous and equal to $\bar{\tau} \in (0, 1]$,

¹²Proofs of Propositions 3 to 5 are in the Appendix.

reflecting the situation in countries (or cantons) in which governments are substantially less constrained in how they allocate public spending than in the amount they can spend. In addition, it nicely illustrates the main mechanism by which lower voting costs can lead to policy changes that make all citizens worse off.

The two endogenous fiscal policy variables are again tied together by the government's budget constraint. The maximization problem (5) therefore reduces to

$$(7) \quad \max_{g_p} \int_{2\gamma}^1 [\alpha^i H(g_p) + (1 - \alpha^i) \Omega J(r_p)] f(\alpha^i) d\alpha^i$$

with $r_p = \bar{\tau}\alpha - g_p$. It follows:

PROPOSITION 4: *Assume $\tau_p = \bar{\tau}$. Then lower voting costs γ decrease the expenditures directed towards the public g_p , and increase rents r_p .*

To understand these results note that for any given tax rate $\bar{\tau}$, all citizens have the same policy preferences: they want the expenditures directed towards the public g_p to be as high as possible. Hence, lowering voting costs γ would have no effect on equilibrium policies if the new voters were equally well informed as those who participated anyway. However, these new voters are less skilled and, therefore, acquire less political knowledge even when they participate in the election. As a consequence, the average voter's political knowledge decreases. The candidates optimally respond by increasing rents r_p and lowering g_p , as rents serve to win votes from impressionable voters while public expenditures directed towards the public serve to win votes from informed voters. Hence, when the tax rate is exogenous, lower voting costs lead to policy changes that benefit the lobby group at the expense of *all* citizens.

Equilibrium Policy Platform.—In this section, we derive the equilibrium of the complete model introduced in Section IA, in which the fiscal policy variables g_p , r_p , and $\tau_p = (g_p + r_p)/\alpha$ are all endogenous. It follows from the candidates' maximization problem (5):

PROPOSITION 5: *Lower voting costs γ increase the tax rate τ_p , the size of government $g_p + r_p$, and the rents r_p . Further, lower voting costs γ increase the expenditures directed towards the public g_p if $\theta = -1$, but decrease g_p if $\theta = 0$.*

We discuss the effects of lower voting costs γ on the different fiscal policy variables in turn, starting with their effects on the tax rate τ_p , which is proportional to the size of government $g_p + r_p$. There are two reasons why a decrease in γ leads to a higher tax rate τ_p . First, as shown in Proposition 3, for any given r_p , a decrease in γ and the resulting decrease in the average informed voter's income make it optimal for the candidates to choose a higher tax rate τ_p . This puts some upward pressure on τ_p . Second, a decrease in γ reduces the share of informed voters among the voting population. A higher tax rate τ_p has the advantage that it allows to increase g_p or r_p and, thereby, to raise electoral support from informed or impressionable voters, respectively. But a higher τ_p has the disadvantage that it lowers private consumption

c_p^i of all citizens. This, however, only reduces the electoral support from informed voters. Hence, when the share of informed voters decreases, the candidates become less concerned about the disadvantage of high taxes, while the advantage of high taxes remains similarly attractive. This puts additional upwards pressure on τ_p .

We now turn to the effects of lower voting costs γ on the rents r_p paid to the lobby group. We know from Proposition 4 that a decrease in γ and the associated increase in the share of impressionable voters increases rents r_p relative to public expenditures directed towards the public g_p for any tax rate τ_p ; and from above that a decrease in γ increases τ_p . Hence, lower voting costs γ lead to more generous rents r_p , because a higher share of impressionable voters tilts both the size and the composition of public spending to the lobby group's benefit.

It remains to discuss how lower voting costs γ affect expenditures directed towards the public g_p . There are two countervailing effects: First, candidates would like to choose higher g_p when γ decreases, because the average informed voter then earns a lower income and, therefore, prefers higher g_p for given r_p (as seen in Proposition 3). Second, candidates would like to choose lower g_p when γ decreases, because informed voters also care about low tax rates τ_p , with the marginal utility of τ_p being negative and decreasing, and because the decrease in γ already puts upwards pressure on τ_p by increasing rents r_p (as seen above). Any of these two effects may dominate in general.

Proposition 5 however shows that the net effect is unambiguous for some values of the Engel curve parameter θ . Given θ close or equal to zero, as in the case of Cobb-Douglas preferences in log form, citizens with different incomes prefer similar or even the same level of g_p . The first of the countervailing effects discussed above becomes therefore negligible, and the candidates choose lower g_p when γ decreases. Given θ close or equal to minus one, as in the case of quasi-linear preferences, the marginal utility of τ_p is constant. The second of the countervailing effects discussed above becomes therefore negligible, and the candidates choose higher g_p when γ decreases. Given $\theta \in (-1, 0)$, the effect of γ on g_p does not only depend on the Engel curve parameter θ , but, among others, also on the shape of $H(g_p)$ and the costs of knowledge acquisition.¹³

Finally, let us look at the welfare of citizens and the lobby group. The lobby group only cares about high rents r_p . As lower voting costs γ increase r_p , they make the lobby group better off. Lower voting costs γ also have a direct positive effect on the welfare of voters. The indirect effects, however, are less clear-cut: Citizens prefer high expenditures directed towards the public g_p and low tax rates τ_p , and the importance they assign to the former relative to the latter decreases in their income. Lowering γ always increases τ_p , while the effect on g_p is ambiguous. Hence, when lowering γ increases g_p , then the welfare effects of the associated policy changes depend on the citizens' income. Citizens with low incomes are better off as they primarily care about high g_p , while citizens with high incomes are worse off as

¹³The costs of knowledge acquisition, which are inversely proportional to skills α_i , determine how the fraction of impressionable voters changes in response to lower voting costs γ . The change in the fraction of impressionable voters, in turn, is crucial for the strength of the second of the countervailing effects discussed above: The larger the increase in this fraction is, the larger is the increase in r_p and, therefore, the upward pressure on τ_p .

they primarily care about low τ_P . But when lowering γ reduces g_P , then the policy changes in response to lower voting costs make all citizens worse off.

An Alternative Interpretation.—As mentioned in Section IB, the lobby group may receive favors in the form of a tax break rather than transfer payments. We thus provide an alternative interpretation of our model. Assume that the lobbyists need to pay taxes $T - r_P$, where T is exogenous and where r_P represents benefits in the form of tax reductions. In this interpretation of the model, the size of government (measured in terms of public expenditures or revenues) is g_P instead of $g_P + r_P$, and the tax rate on citizens' income $\tau_P = (g_P + r_P - T)/y$ instead of $\tau_P = (g_P + r_P)/y$. It is straightforward to show that Proposition 5 still holds. However, its implications change: it now implies that lower voting costs increase the lobbyists' tax reduction r_P , but have an ambiguous effect on the expenditures directed towards the public g_P and the size of government.

II. Empirical Analysis

In the following, we test the predictions of our theoretical model and study how a reduction in voting costs due to the introduction of unrestricted optional postal voting affected the political process and fiscal outcomes in the 26 Swiss cantons.

A. Empirical Strategy

For the identification of the effects of postal voting, we exploit the quasi-random experiment provided by the staggered introduction of postal voting in the cantons. Importantly, the cantons' regulations of the voting process are also applicable for votes on the federal level. This allows us to draw on sources of information on the political process at the cantonal and the federal level to test our theoretical predictions. Our key identifying assumption is that cantons that introduced postal voting would have experienced the same changes in voter turnout, voter characteristics, and public finances as other cantons, had they not introduced postal voting. We deal with this key assumption in three ways. First, newspaper articles chronicling the debates on postal voting in Swiss cantons do not suggest that there were specific events facilitating or concurring with the adoption of postal voting. Proponents of postal voting generally argued with the need to increase participation and improve representation, while opponents worried about the loss of the social and ceremonial aspects of voting at the ballot. However, we were not able to reconstruct any reasons as to why some cantons introduced postal voting earlier than others. Exceptions are the two latecomers Ticino and Valais where worries about ballot secrecy and administrative costs, respectively, prevailed.¹⁴

Second, the timing of the introduction of postal voting seems unrelated to other institutional reforms and cantonal characteristics. Table A2 in the online Appendix

¹⁴ See, e.g., *Neue Zürcher Zeitung*, "Kantonale Volksabstimmungen vom 28. November;" November 20, 1993; *Neue Zürcher Zeitung*, "Sorge um das Wahlgeheimnis im Kanton Tessin," June 20, 1995; and *Neue Zürcher Zeitung*, "Chronisch stimmüde Walliser;" February 13, 2003.

indicates that none of the other democratic institutions considered important in our context (and taken into account in the empirical analyses below) were reformed in many cantons in the years around the introduction of postal voting. Table A3 in the online Appendix reports the result of a survival analysis. We use the same variables as in our main analysis, and subsequently augment the model with the share of citizens speaking a Latin language and the seat share of left-wing parties in the cantonal parliament, lagged by one year. The language variable proxies for many stable cultural differences and captures the fact that predominantly French and Italian speaking cantons belong to the latecomers. The inclusion of the lagged left-wing parties' seat share assesses whether changes in the political orientation of legislatures are related to the adoption of postal voting. A concern might be that our results for the fiscal variables could be driven by stronger right-wing parties introducing postal voting and reducing welfare spending. The results suggest that, once we control for stable cultural differences, only being in an election year seems to increase the hazard that a canton adopts postal voting at any point in time.

Third, we relax the common trend assumption to deal with potential unobserved forces. In particular, we estimate models with canton-specific time trends (both linear and quadratic) for all outcomes of interest. Moreover, when looking at education, our dependent variable is the difference in education between participants and the general population. This allows us to control in a very flexible way for trends in education in the general population that might be correlated with the introduction of postal voting.

Effects on voting participation are tested at the federal level. To test Proposition 1, we estimate the effect of postal voting on turnout on 90 different ballot dates involving 260 federal ballot propositions. To test Proposition 2, we use postvote surveys for part of these same federal ballots and isolate the effect of postal voting on participants' average years of education and ballot-specific knowledge.

We do not test Propositions 3 and 4 as they prepare for Proposition 5. Lacking a measure of rents to special interests, this latter proposition is difficult to test empirically though. We still explore aspects of Proposition 5 as formulated in our model and concentrate on welfare expenditures. We now refer to the cantonal level as we want to draw inference on variation in aggregate fiscal outcomes.¹⁵ Cantonal welfare expenditures are interesting in our context for three reasons. First, they offer limited opportunities for discretionary spending and for targeting funds towards specific regions, industries, or groups. They are therefore unlikely to include rents to special-interest groups (see Funk and Gathmann 2013 for a similar approach). This aspect differentiates welfare expenditures from other important cantonal spending categories such as spending on education or health, which benefit the general population but also serve the interests of well-organized groups such as teachers and the health care industry. In Swiss cantons, welfare expenditures include primarily social assistance, means-tested health insurance premium reduction, and supplementary benefits to the old age pensions and the disability pensions, but not expenditures for federal programs

¹⁵ These outcomes are not directly related to the participation decision in the federal votes and the content of the federal ballots. However, they are shaped by the same forces of lower voting costs. Moreover, we expect that the voting population closely resembles the one at the federal level as cantonal elections and referendums are often held simultaneously with federal ones.

like unemployment insurance. Thus, by using government welfare expenditures, we explore the possibility that lower voting costs result in lower government expenditures targeted towards the public rather than towards special interests. Second, welfare expenditures benefit poor people, the supposed beneficiaries of reduced voting costs and higher voting participation. Welfare expenditures are, therefore, well suited to differentiate between our model and alternative theories, such as the Meltzer-Richard model, which predict that higher turnout should be associated with policy changes supporting poorer citizens. Moreover, potential effects on other spending categories benefiting the general population may be consistent with simpler explanations. For example, a reduction in education expenditures may simply result due to the fact that less educated individuals are mobilized. Finally, welfare expenditures amount to 14 percent of all cantonal expenditures on average. Thus, it is an important spending category, in contrast to, for example, expenditures on the environment and land-use planning amounting to 3 percent of cantonal expenditures on average. As discussed at the end of Section IC, rents to special-interest groups may also take the form of reduced business taxes. Therefore, we additionally look at business tax rates.¹⁶

To summarize, we estimate variants of the following model:

$$(8) \quad y_{it} = \alpha \textit{Postal voting}_{it} + \beta X_{it} + \gamma f_i(t) + \mu_i + \nu_t + \varepsilon_{it},$$

where y_{it} are our outcomes of interest, $\textit{Postal voting}_{it}$ is a dummy variable with value one for cantons and periods with postal voting and zero otherwise, X_{it} is a vector of time-variant covariates, $f_i(t)$ are canton-specific linear or quadratic time trends, μ_i and ν_t are canton- and time-specific effects, respectively, and ε_{it} is an error term. The time-specific effects are ballot dummies when studying the voting process, and year dummies when analyzing welfare expenditures and business tax rates.

For the education and political knowledge regressions, our dependent variables are averages (or differences of averages) based on a varying number of respondents. Therefore, we use weighted least squares regressions with weights proportional to the number of observations used to calculate the dependent variable. To account for serial correlation, we allow for clustering at the cantonal level. The respective standard errors are reported in parentheses. Due to the relatively small number of cluster units (26 cantons), we also estimate standard errors using the wild cluster bootstrap procedure (using the ado-file provided by Malde 2012, which we slightly adapt for the weighted least squares regressions). The respective p -values for the coefficient on postal voting are reported in brackets. In simulations of Cameron, Gelbach, and Miller (2008) with 20 cluster units, this procedure even slightly under-rejects the null hypothesis.

¹⁶In supplementary analyses included in the online Appendix, we also study the correlations between postal voting and participants' income as well as total government expenditures and specific categories other than welfare. A useful line for further research would be the relationship to campaign spending. Given the available data, a convincing empirical test for Switzerland is not feasible though.

B. Data

Our dependent variables are voter turnout, the difference in average education of participants and the general population, participants' average ballot-specific knowledge, welfare expenditures in percent of cantonal GDP, and business tax rates. Data for these variables comes from various sources.

The data on voter turnout comes from the Swiss Federal Statistical Office (FSO). As there are usually several propositions at a particular date, we calculate average turnout per canton and ballot date.¹⁷ Voter turnout between 1980 and 2010 was 44 percent on average and ranged from 14 percent to 87 percent.

Years of education and knowledge on a specific proposition are captured on the basis of postvote surveys. Different Swiss universities together with the private research institute GFS carry out postvote surveys after each ballot (VOX surveys). They are based on phone interviews within three weeks of the vote with representative samples of roughly 1,000 eligible voters (no voter registration is required in Switzerland). We use the standardized cumulative file VoxIt by Brunner et al. (2013). The sample period starts in 1981 and ends in 2010. The postvote surveys contain information on whether and how respondents voted, their knowledge about ballot proposals and their socioeconomic characteristics.

Respondents' level of education is captured by the highest degree they attained. Based on information provided by the Swiss Conference of Cantonal Ministers of Education, we translate the degrees into years of education. Respondents' knowledge on the ballot proposition is expressed on a three-point scale. The respective variable takes value 0 for respondents who remember neither the title nor the content of the proposition, value 1 for respondents who remember one of these and value 2 for respondents who remember both title and content of the ballot.¹⁸

We use the postvote survey data to calculate the differences in average years of education between voters and the general population for all cantons and ballot dates. Thereby, we can account for general cantonal developments in education in a flexible way. We also calculate the participants' average knowledge on propositions. We do not take the difference to the average knowledge of all respondents since knowledge is endogenous to the participation decision (as theoretically modeled) whereas education is exogenous to the participation decision. For some cantons and dates there are no respondents in the survey or, alternatively, no respondents who voted.

As can be seen from the descriptive statistics in Table 1, voters have a slightly higher level of education than the general population. The difference amounts to 0.264 years (with the mean level of education being 12.605 years). Average knowledge of participants is 1.619 on the three-point scale ranging from 0 to 2.

Annual data on welfare expenditures in cantons are from the annual publications of the Swiss Federal Finance Administration (FFA) on public finances (Öffentliche

¹⁷ For a complete list of federal ballots, see the webpage of the Swiss federal chancellery at http://www.admin.ch/ch/d/pore/va/vab_2_2_4_1.html (August 26, 2013).

¹⁸ Knowledge of the proposition title is assessed based on the following question: "On [date], i.e., last or the week before last, there were federal votes. What were the issues, could you state them?" Detailed knowledge of the propositions is coded based on responses to the question: "[Number] votes were on the ballot, i.e., [title of the propositions]. Could you briefly describe what was called for?"

TABLE 1—DESCRIPTIVE STATISTICS

	Observations	Mean	SD	Min.	Max.
<i>Panel A. Turnout 1980–2010</i>					
Turnout	2,340	0.437	0.114	0.138	0.872
Postal voting	2,340	0.572	0.495	0	1
<i>Panel B. Education 1981–2010</i>					
Difference in years of education between participants and the general population	1,780	0.264	0.322	−3.750	5.200
Postal voting	1,780	0.668	0.471	0	1
<i>Panel C. Knowledge 1981–2010</i>					
Average knowledge on propositions of participants	1,780	1.619	0.248	0.000	2.000
Postal voting	1,780	0.684	0.465	0	1
<i>Panel D. Welfare expenditures and business tax rates 1980–2007</i>					
Welfare expenditures (percent of GDP)	728	2.056	0.948	0.505	4.970
Business tax rate	728	19.0	4.2	6.7	32.8
Postal voting	728	0.505	0.500	0	1
Population in 1,000,000	728	0.268	0.280	0.013	1.323
Share under 20	728	0.247	0.033	0.157	0.337
Share over 64	728	0.150	0.021	0.103	0.210
GDP p.c. in 100,000	728	0.463	0.173	0.161	1.413
Unemployment rate	728	1.657	1.442	0.000	6.210
Election year	728	0.317	0.466	0	1
Fiscal rule index	728	0.429	0.913	0	3
Mandatory fiscal referendum	728	0.663	0.473	0	1
Signature requirement initiative, relative	728	1.469	0.981	0.003	3.851
Cabinet size	728	6.316	1.177	5	9
Parliament size	728	113.846	46.473	46	200

Notes: Observations in panels A, B, and C are at the canton-ballot date level while those in panel D are at the canton-year level. The descriptive statistics in panels B and C are for weighted data with weights proportional to the square root of the number of observations on which the differences/averages are based.

Sources: Année politique Suisse, BAK Basel, cantonal constitutions, Feld et al. (2011), Funk and Gathmann (2011), Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Finance Administration, Swiss Federal Statistical Office, Swiss Federal Tax Authority, Swiss State Secretariat for Economic Affairs, and Brunner et al. (2013)

Finanzen der Schweiz, various years). The data is available until 2007. Expenditure data is based on new accounting standards thereafter and, therefore, not comparable to the earlier data. On average, welfare expenditures amount to 2 percent of cantonal GDP.

From the Swiss Federal Tax Administration (FTA), we have data on the effective taxes a limited liability company has to pay to the canton and the municipality where it is headquartered. We use the effective taxes for capital and reserves of CHF 2 millions and net profits of CHF 400,000 (implying returns before taxes of 20 percent). For this combination of capital and profits, comparable data from 1983 to 2007 are available. For the years 1980 to 1982, we use the effective taxes for capital and reserves of CHF 1 million and net profits of CHF 200,000. To calculate the cantonal tax rates on net profits and capital, we divide the effective taxes by the net profits. On average, this tax rate is 19 percent.

Our main regressor is a dummy variable for postal voting (Luechinger, Rosinger, and Stutzer 2007).¹⁹ With postal voting, eligible citizens receive the ballot forms unsolicited per mail. To participate, they can then choose between voting at the ballot box or sending the ballot forms back per mail. The dummy variable builds on cantonal laws, information from the federal chancellery, and a survey conducted with the cantonal chancelleries. Since the late 1970s, Swiss cantons successively introduced postal voting for all citizens without request, starting with Basel-Landschaft in 1978 and ending with Ticino and Valais in 2005. Table A1 in the online Appendix provides the introduction dates. In 23 out of the 26 cantons, the introduction of postal voting falls into our sample period. In regressions with annual data, the dummy variable for postal voting is coded as one starting in the year of adoption if postal voting was introduced in the first half of the year, and starting in the year after the adoption if postal voting was introduced in the second half of the year.

Control variables are the cantonal GDP per capita, the population of a canton, the fraction of those below the age of 20 and those above the age of 64, and the number of registered unemployed as a share of the population aged 20 to 64. The GDP data is from the consultancy BAK Basel, the cantonal population data from the FSO, and the cantonal unemployment data from the State Secretariat for Economic Affairs (SECO). In the welfare expenditures and the business tax rate regressions, we also include institutional and political variables that have been argued to affect fiscal policies. The variables are the cabinet size and parliament size, a dummy for election years (from the *Année politique Suisse* and the FSO), a fiscal rule index (from Feld et al. 2011), the signature requirement to launch a voter initiative, and a dummy for mandatory fiscal referendums (from Funk and Gathmann 2011 and the cantonal constitutions). The fiscal rule index captures the stringency of balanced budget rules, which differ in terms of deficit ceilings, sanctions, escape clauses, and other aspects (Feld et al. 2011). Mandatory fiscal referendums subject all new cantonal expenditures above a certain threshold to a popular vote.

C. Estimation Results

In the following, we present our results on voter turnout, the voters' education and political knowledge, and public finances.

Voter Turnout.—Table 2 shows the partial correlation between unrestricted optional postal voting and voter turnout at the level of Swiss cantons between 1980 and 2010. Based on an ordinary least squares estimate including canton-specific and ballot date-specific effects as well as a set of time variant control variables, we find that postal voting leads to an average increase in voting participation of 4.7 percentage points, or 10.8 percent relative to the average turnout of 43.7 percent in our sample. Specifications II and III additionally control for canton-specific linear and quadratic time trends to relax the common trend assumption. For postal voting,

¹⁹Luechinger, Rosinger, and Stutzer (2007) provide a detailed description of the introduction of postal voting in Swiss cantons, the construction of the respective dummy variable, and estimates on the effect of postal voting on turnout. The discussion in this section abbreviates the discussion in Luechinger, Rosinger, and Stutzer (2007).

TABLE 2—POSTAL VOTING AND VOTER TURNOUT
IN FEDERAL BALLOTS IN SWITZERLAND FOR 1980 TO 2010

	(I)	(II)	(III)
Postal voting	0.047*** (0.010) [0.000]	0.054*** (0.009) [0.000]	0.050*** (0.009) [0.000]
Population in 1,000,000	0.072 (0.301)	−0.112 (0.125)	−0.030 (0.513)
Share under 20	0.694 (0.623)	−0.133 (0.571)	−0.635 (1.024)
Share over 64	−0.102 (0.603)	−0.792 (0.758)	0.662 (1.212)
GDP p.c. in 100,000	−0.013 (0.052)	−0.162* (0.087)	−0.032 (0.076)
Unemployment rate	0.006 (0.005)	−0.000 (0.004)	0.005 (0.005)
Canton-specific effects	Yes	Yes	Yes
Ballot date-specific effects	Yes	Yes	Yes
Canton-specific time trends	No	linear	quadratic
Observations	2,340	2,340	2,340
Number of clusters	26	26	26
R ²	0.74	0.78	0.79

Notes: Dependent variable: Turnout [0–1]. OLS estimations. Average turnout amounts to 0.437. Standard errors in parentheses are adjusted for clustering at the level of cantons. *p*-values based on wild cluster bootstrap are reported in square brackets.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Sources: BAK Basel, Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, and Swiss State Secretariat for Economic Affairs

the partial correlations remain robust, if anything they get slightly larger. All estimates for postal voting are statistically highly significant whereby standard errors are adjusted for clustering at the cantonal level.²⁰

Figure 1 visualizes the effect of postal voting on turnout. The figure shows the voting participation in the years before and after the adoption of postal voting. The estimates are based on regressions analogous to specification III in Table 2. The pattern clearly indicates that there is a sharp increase in participation with adoption rather than a preexisting upward trend. The evidence supports Proposition 1 and indicates that the reduction in voting costs due to the introduction of postal voting significantly increased turnout.

Education and Political Knowledge.—We estimate the effect on voters' education with three specifications analogous to the ones of the turnout regressions. Since our dependent variable is the difference in average years of education between voters

²⁰In most of the reported estimations, the *p*-values for postal voting based on clustering at the cantonal level and those based on the wild cluster bootstrap are close. Exceptions are the significant estimates for knowledge that become marginally insignificant with wild cluster bootstrap.

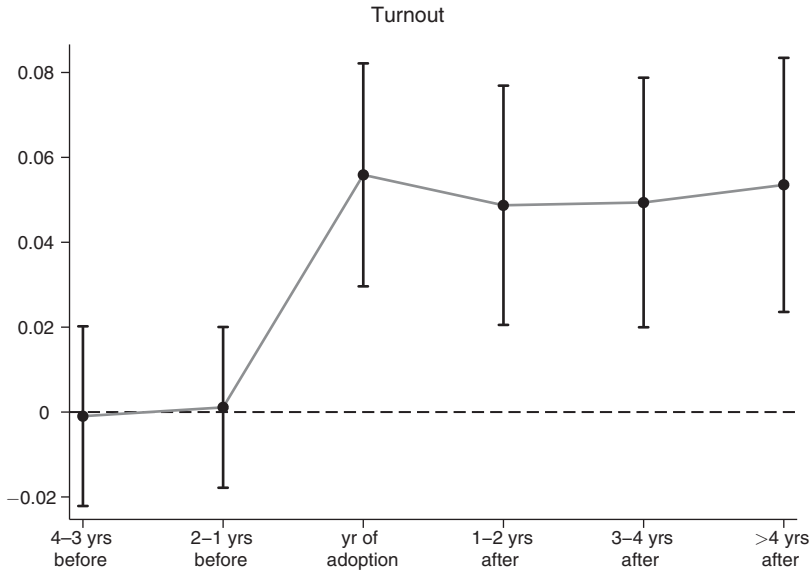


FIGURE 1. VOTER TURNOUT BEFORE AND AFTER THE ADOPTION OF POSTAL VOTING

Notes: Coefficients (dots) and 95 percent confidence intervals (vertical lines) from an OLS regression of turnout on dummies for 6 different time periods relative to the introduction of postal voting and a set of controls for the years 1980 to 2010. The dummies have the value one for the time period indicated on the *x*-axis and zero otherwise, with the time period five or more years prior to the introduction of postal voting normalized to zero (dashed line). The set of controls is the same as in specification III of Table 2. Confidence intervals are based on a cluster-robust estimator for the variance-covariance matrix with clustering allowed at the cantonal level. Based on a Wald test, it is clearly rejected that the mean of the two coefficients capturing the four years prior to the adoption of postal voting are equal to the mean of the two coefficients for the four years after ($p = 0.000$).

Sources: BAK Basel, Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, and Swiss State Secretariat for Economic Affairs

and the general population, we also account for general cantonal developments in education.

According to the results in Table 3, postal voting is related, on average, to a lower education level of the participants in federal ballots. In specification I, the difference in average education is reduced by 0.067 years. While the effect of postal voting may seem small in absolute terms, it implies a sizeable effect of the treatment on the treated. As an illustration, if participation increases by 10.8 percent with postal voting (as seen before), and the difference in average education thereby decreases by 0.067 years, the 10.8 percent extra voters must be characterized by $0.067/0.108 = 0.620$ fewer years of education than the previous voters. The coefficient for postal voting is of similar magnitude with canton-specific linear time trends, but is reduced by roughly two thirds and imprecisely estimated with canton-specific quadratic time trends.

Figure 2 indicates that the education level of voters relative to the general population drops in the years after the introduction of postal voting. Ideally, we would like to see immediate changes in differences in education levels with the introduction of postal voting, matching the immediate increase in turnout documented in Figure 1.

TABLE 3—POSTAL VOTING AND THE DIFFERENCE IN THE LEVEL OF EDUCATION
BETWEEN PARTICIPANTS AND THE GENERAL POPULATION
IN FEDERAL BALLOTS IN SWITZERLAND FOR 1981 TO 2010

	(I)	(II)	(III)
Postal voting	−0.067*** (0.023) [0.006]	−0.061** (0.026) [0.031]	−0.023 (0.036) [0.504]
Population in 1,000,000	1.165*** (0.244)	1.016 (0.927)	1.065 (2.043)
Share under 20	−2.987** (1.431)	−1.454 (3.667)	−3.137 (12.535)
Share over 64	−0.457 (1.270)	−9.916 (8.968)	−24.748 (15.333)
GDP p.c. in 100,000	0.119 (0.157)	−0.320 (0.650)	−0.174 (1.254)
Unemployment rate	−0.013 (0.019)	−0.005 (0.022)	−0.010 (0.029)
Canton-specific effects	Yes	Yes	Yes
Ballot date-specific effects	Yes	Yes	Yes
Canton-specific time trends	No	linear	quadratic
Observations	1,780	1,780	1,780
Number of clusters	26	26	26
R ²	0.13	0.14	0.15

Notes: Dependent variable: Difference in the average years of education. Weighted LS estimations. Average years of education in the sample population amount to 12.605 years. Weights are proportional to the number of observations used to calculate the dependent variable. Standard errors in parentheses are adjusted for clustering at the level of cantons. *p*-values based on wild cluster bootstrap are reported in square brackets. The regressions based on the survey data have fewer observations than the turnout regressions in Table 2 because the sample starts only in 1981, postvote surveys are missing for four ballot dates in this period, information on residence canton is missing for two ballot dates, and surveys do not contain respondents or participants from all cantons for some ballot dates.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Sources: BAK Basel, Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, Swiss State Secretariat for Economic Affairs, and Brunner et al. (2013)

However, the estimates for individual years are based on few observations and are, thus, relatively noisy. Nevertheless, the findings of Table 3 and Figure 2 provide considerable support for Proposition 2 that the average skill level of participants is lower with lower voting costs.

Table 4 reports the effect of postal voting on participants' average knowledge on propositions. In specification I, we find that knowledge is statistically insignificantly lower by around 0.021 points on the three point scale, whereby the mean value of this variable is 1.619. Including canton-specific linear and quadratic time trends increases the magnitude of the coefficients to -0.034 and -0.057 , respectively. Figure 3 suggests that there is no preexisting trend in voters' knowledge before the introduction of postal voting. However, voters' knowledge is reduced with the intro-

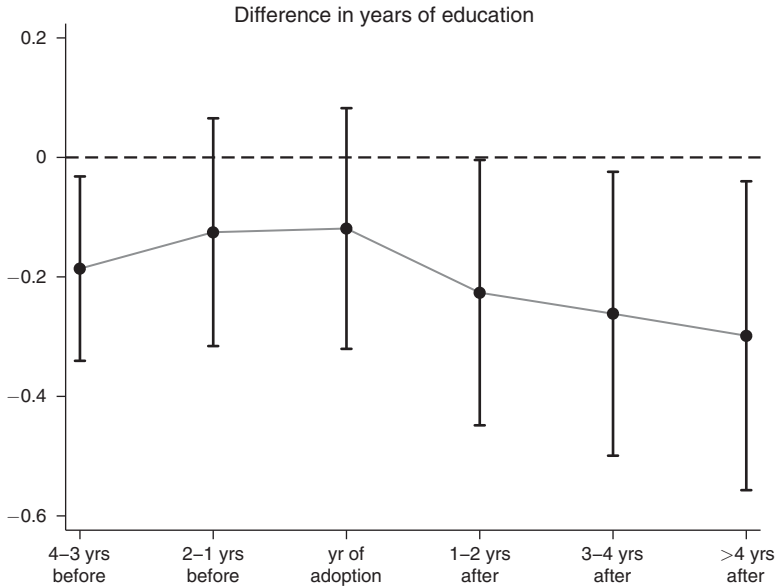


FIGURE 2. POSTAL VOTING AND THE DIFFERENCE IN THE LEVEL OF EDUCATION BETWEEN PARTICIPANTS AND THE GENERAL POPULATION

Notes: Coefficients (dots) and 95 percent confidence intervals (vertical lines) from a weighted LS regression of the difference in average years of education between voters and the general population on dummies for 6 different time periods relative to the introduction of postal voting and a set of controls for the years 1981 to 2010. The dummies have the value one for the time period indicated on the x -axis and zero otherwise, with the time period five or more years prior to the introduction of postal voting normalized to zero (dashed line). The set of controls is the same as in specification III of Table 3. Weights are proportional to the number of observations used to calculate the dependent variable. Confidence intervals are based on a cluster-robust estimator for the variance-covariance matrix with clustering allowed at the cantonal level. Based on a Wald test, it is rejected that the mean of the two coefficients capturing the four years prior to the adoption of postal voting are equal to the mean of the two coefficients for the four years after ($p = 0.051$).

Sources: BAK Basel, Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, Swiss State Secretariat for Economic Affairs, and Brunner et al. (2013)

duction of postal voting. This finding supports Proposition 2 of our model. It shows that lower voting costs can have unintended side effects.²¹

In additional regressions reported in the online Appendix, we find no differential effects of postal voting on the participation behavior of citizens with age 65 or older, men, or people from rural areas. Thus, our results for the main variables of interest do not seem to be driven by any of these sociodemographic factors.

Public Finances.—Tables 5 and 6 present the results for the effects of postal voting on welfare expenditures in percent of cantonal GDP and for business tax rates.

²¹Our theoretical model further predicts that political knowledge increases with education (or skills) conditional on voting. This is indeed what we find: The average knowledge of voters monotonically increases from 1.54 for individuals with nine years of education to 1.69 for individuals with 17 years.

TABLE 4—POSTAL VOTING AND THE POLITICAL KNOWLEDGE OF PARTICIPANTS IN FEDERAL BALLOTS IN SWITZERLAND FOR 1981 TO 2010

	(I)	(II)	(III)
Postal voting	−0.021 (0.017) [0.255]	−0.034* (0.018) [0.112]	−0.057** (0.027) [0.114]
Population in 1,000,000	0.448*** (0.131)	0.123 (0.344)	1.336 (1.505)
Share under 20	−0.791 (1.132)	0.112 (1.388)	−2.067 (5.344)
Share over 64	−0.897 (1.296)	−6.293** (2.297)	−3.935 (7.366)
GDP p.c. in 100,000	−0.003 (0.110)	0.252 (0.244)	0.327 (0.324)
Unemployment rate	−0.002 (0.012)	0.007 (0.010)	0.016 (0.012)
Canton-specific effects	Yes	Yes	Yes
Ballot date-specific effects	Yes	Yes	Yes
Canton-specific time trends	No	linear	quadratic
Observations	1,780	1,780	1,780
Number of clusters	26	26	26
R ²	0.75	0.76	0.76

Notes: Dependent variable: Average knowledge on propositions of participants [0–2]. Weighted LS estimations. Average knowledge on propositions of participants amounts to 1.619. Weights are proportional to the number of observations used to calculate the dependent variable. Standard errors in parentheses are adjusted for clustering at the level of cantons. *p*-values based on wild cluster bootstrap are reported in square brackets. The regressions based on the survey data have fewer observations than the turnout regressions in Table 2 because the sample starts only in 1981, post-vote surveys are missing for four ballot dates in this period, information on residence canton is missing for two ballot dates, and surveys do not contain respondents or participants from all cantons for some ballot dates.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Sources: BAK Basel, Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, Swiss State Secretariat for Economic Affairs, and Brunner et al. (2013)

Welfare expenditures in percent of cantonal GDP seem to decrease after the adoption of postal voting. A negative partial correlation holds in all three specifications in Table 5, but it is only statistically significant in specification III. The point estimates suggest that welfare expenditures are lower by between 0.072 and 0.144 percentage points. With welfare expenditures amounting to 2 percent of cantonal GDP on average, postal voting decreases welfare expenditures by 4 to 7 percent. Figure 4 shows that welfare expenditures gradually decrease starting in the year postal voting is introduced until they reach a permanent reduced level 3 to 4 years after the introduction. This suggests that changes in the composition of voters induced by changes in voting institutions need some time to work through the political process to affect policy outcome and, therefore, that political outcomes gradually adapt to new equilibrium levels. Given that welfare expenditures are an important spending category and one that is directed towards the public but unlikely to include rents for special-interest groups, we see the evidence as consistent with the—probably most

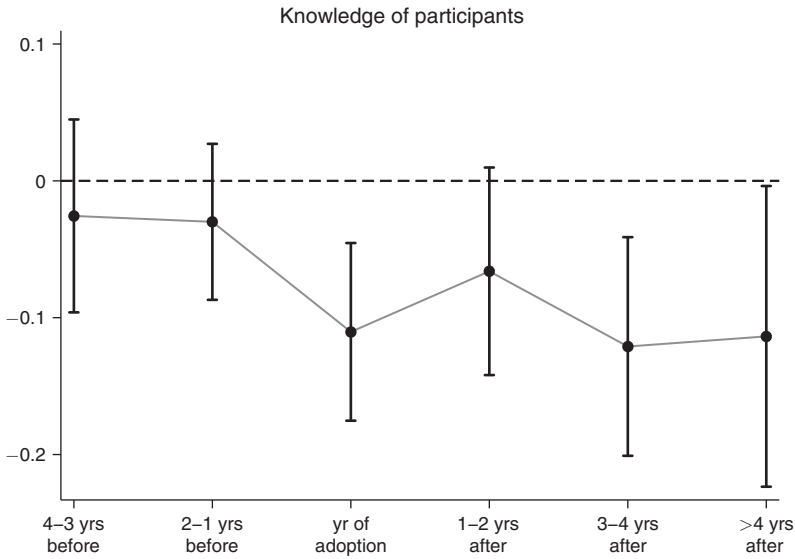


FIGURE 3. POSTAL VOTING AND PARTICIPANTS' AVERAGE KNOWLEDGE ON PROPOSITIONS

Notes: Coefficients (dots) and 95 percent confidence intervals (vertical lines) from a weighted LS regression of the average political knowledge of voters on dummies for 6 different time periods relative to the introduction of postal voting and a set of controls for the years 1981 to 2010. The dummies have the value one for the time period indicated on the x-axis and zero otherwise, with the time period five or more years prior to the introduction of postal voting normalized to zero (dashed line). The set of controls is the same as in specification III of Table 4. Weights are proportional to the number of observations used to calculate the dependent variable. Confidence intervals are based on a cluster-robust estimator for the variance-covariance matrix with clustering allowed at the cantonal level. Based on a Wald test, it is rejected that the mean of the two coefficients capturing the four years prior to the adoption of postal voting are equal to the mean of the two coefficients for the four years after ($p = 0.043$).

Sources: BAK Basel, Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, Swiss State Secretariat for Economic Affairs, and Brunner et al. (2013)

controversial—second case in Proposition 5 that lower voting costs decrease public expenditures net of rents.

The results for business tax rates in Table 6 indicate that postal voting is related to a lower tax rate of between -0.55 and -1.25 percentage points. Compared to an average business tax rate in the sample of around 19 percent, this amounts to a reduction of between 3 and 7 percent. While the overall pattern of the estimation results is consistent and in line with the alternative interpretation of our model, the partial correlations are imprecisely measured in most specifications. This is also reflected in Figure 5, which indicates a fall in business tax rates after the adoption of postal voting with point estimates characterized by wide confidence intervals. Nevertheless, the pattern fits the overall picture that the introduction of postal voting tends to favor well-organized interest groups, in our case business interests.

III. Conclusions

There is a common concern that voting costs with traditional voluntary voting at the poll put many citizens off participating in the process of democratic decision

TABLE 5—POSTAL VOTING AND WELFARE EXPENDITURES OF SWISS CANTONS FOR 1980 TO 2007

	(I)	(II)	(III)
Postal voting	-0.102 (0.064) [0.143]	-0.072 (0.074) [0.379]	-0.144** (0.061) [0.029]
Population in 1,000,000	-3.493** (1.693)	-0.945 (2.694)	-2.028 (4.065)
Share under 20	4.963 (3.642)	-6.406 (4.623)	20.972** (8.100)
Share over 64	0.509 (3.636)	-5.374 (5.530)	-43.449** (17.187)
GDP p.c. in 100,000	-2.576*** (0.343)	-4.251*** (0.837)	-2.085** (0.820)
Unemployment rate	0.094** (0.039)	0.065 (0.042)	0.073 (0.044)
Election year	0.010 (0.010)	0.001 (0.010)	0.003 (0.009)
Fiscal rule index	0.027 (0.044)	0.081 (0.060)	0.039 (0.056)
Mandatory fiscal referendum	0.026 (0.104)	0.108 (0.095)	0.100 (0.072)
Signature requirement initiative, relative	-0.057 (0.057)	-0.007 (0.104)	-0.022 (0.100)
Cabinet size	-0.029 (0.053)	0.027 (0.066)	-0.019 (0.069)
Parliament size	0.000 (0.001)	0.002 (0.002)	-0.003 (0.002)
Canton-specific effects	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes
Canton-specific time trends	No	linear	quadratic
Observations	728	728	728
Number of clusters	26	26	26
R ²	0.92	0.94	0.95

Notes: Dependent variable: Welfare expenditures in percent of GDP. OLS estimations. Average welfare expenditures in percent of GDP amount to 2.056. Standard errors in parentheses are adjusted for clustering at the level of cantons. *p*-values based on wild cluster bootstrap are reported in square brackets.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Sources: *Année politique Suisse*, BAK Basel, cantonal constitutions, Feld et al. (2011), Funk and Gathmann (2011), Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Finance Administration, Swiss Federal Statistical Office, and Swiss State Secretariat for Economic Affairs

making. Moreover, these costs contribute to an unequal representation with the better educated being more likely to participate. Accordingly, the plea is for lower voting costs (or compulsory voting). However, lower voting costs involve a trade-off: While they may reduce the representation bias, they may simultaneously lower the average participants' political knowledge and increase the bias from interest-group politics.

We substantiate this argument offering a theoretical model and empirical evidence. In particular, we study how lower voting costs affect public goods provision

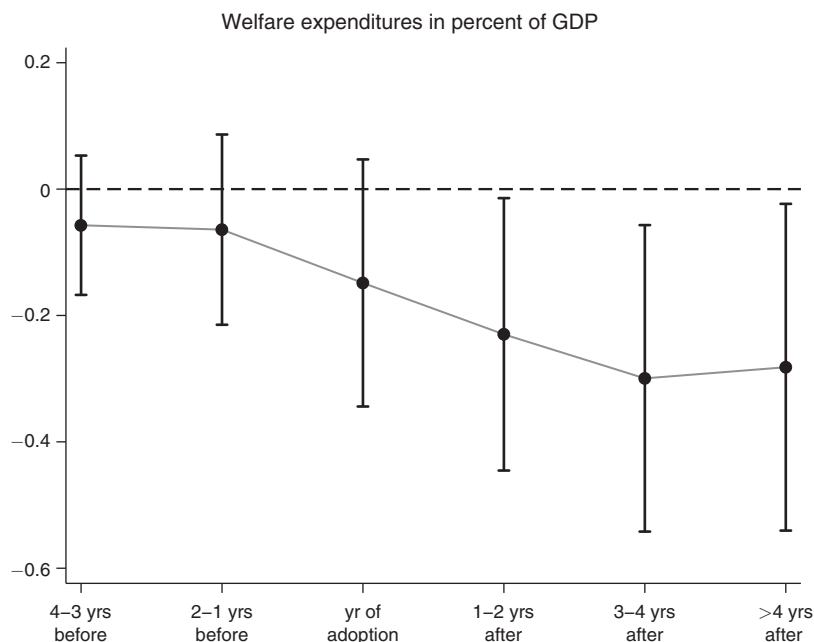


FIGURE 4. POSTAL VOTING AND WELFARE EXPENDITURES OF SWISS CANTONS

Notes: Coefficients (dots) and 95 percent confidence intervals (vertical lines) from an OLS regression of cantonal welfare expenditures in percent of cantonal GDP on dummies for 6 different time periods relative to the introduction of postal voting and a set of controls for the years 1980 to 2007. The dummies have the value one for the time period indicated on the x-axis and zero otherwise, with the time period five or more years prior to the introduction of postal voting normalized to zero (dashed line). The set of controls is the same as in specification III of Table 5. Confidence intervals are based on a cluster-robust estimator for the variance-covariance matrix with clustering allowed at the cantonal level. Based on a Wald test, it is rejected that the mean of the two coefficients capturing the four years prior to the adoption of postal voting are equal to the mean of the two coefficients for the four years after ($p = 0.015$).

Sources: Année politique Suisse, BAK Basel, cantonal constitutions, Feld et al. (2011), Funk and Gathmann (2011), Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Finance Administration, Swiss Federal Statistical Office, and Swiss State Secretariat for Economic Affairs

and rents to special-interest groups in a probabilistic voting model with campaign contributions. Consistent with the main propositions of our model, we find in an empirical analysis for 26 Swiss cantons that lower voting costs due to postal voting are related to higher turnout and lower average education of participants as well as lower knowledge on the political issues they were deciding on. Moreover, we observe that the introduction of postal voting seems related to lower—and not higher—government welfare expenditures as well as to lower business tax rates.

Overall, we want to submit that high participation in democratic decision making is not a value in itself. Rather participants' knowledge on the political decisions at stake is crucial. Lowering voting costs to increase participation might have rather negative side effects when special-interest groups are attracted that try to influence the less well informed in the voting population. Therefore, the focus should not only be on reducing voting costs, but also on motivating voters to acquire more political knowledge.

TABLE 6—POSTAL VOTING AND BUSINESS TAX RATES IN SWISS CANTONS FOR 1980 TO 2007

	(I)	(II)	(III)
Postal voting	−0.548 (0.632) [0.422]	−1.246** (0.595) [0.074]	−0.729 (0.602) [0.280]
Population in 1,000,000	−13.246 (13.879)	4.752 (43.503)	−77.436** (28.748)
Share under 20	51.674* (27.380)	122.587*** (39.720)	82.535 (110.900)
Share over 64	45.122 (42.139)	−53.026 (86.301)	−26.440 (133.377)
GDP p.c. in 100,000	3.303 (3.671)	2.680 (6.305)	−3.880 (4.438)
Unemployment rate	−0.070 (0.307)	0.302 (0.279)	0.152 (0.190)
Election year	−0.088 (0.091)	−0.055 (0.093)	−0.071 (0.102)
Fiscal rule index	−1.002 (0.594)	−0.258 (0.625)	−0.154 (0.686)
Mandatory fiscal referendum	0.683 (0.797)	0.174 (1.143)	−0.377 (0.537)
Signature requirement initiative, relative	0.224 (0.573)	−0.337 (0.614)	0.156 (0.509)
Cabinet size	0.262 (0.433)	0.473 (0.409)	0.060 (0.324)
Parliament size	−0.022 (0.015)	−0.032** (0.014)	0.004 (0.017)
Canton-specific effects	Yes	Yes	Yes
Year-specific effects	Yes	Yes	Yes
Canton-specific time trends	No	linear	quadratic
Observations	728	728	728
Number of clusters	26	26	26
R ²	0.68	0.81	0.87

Notes: Dependent variable: Tax rate on net profits and capital (for net profits of CHF 400,000 and a capital of CHF 2 millions). OLS estimations. Average business tax rates amount to 19.0. Standard errors are adjusted for clustering at the level of cantons. *p*-values based on wild cluster bootstrap are reported in square brackets.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Sources: Année politique Suisse, BAK Basel, cantonal constitutions, Feld et al. (2011), Funk and Gathmann (2011), Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, Swiss Federal Tax Authority, and Swiss State Secretariat for Economic Affairs

MATHEMATICAL APPENDIX

PROOF OF PROPOSITION 3:

The interior solution of maximization problem (6) must satisfy the first-order condition

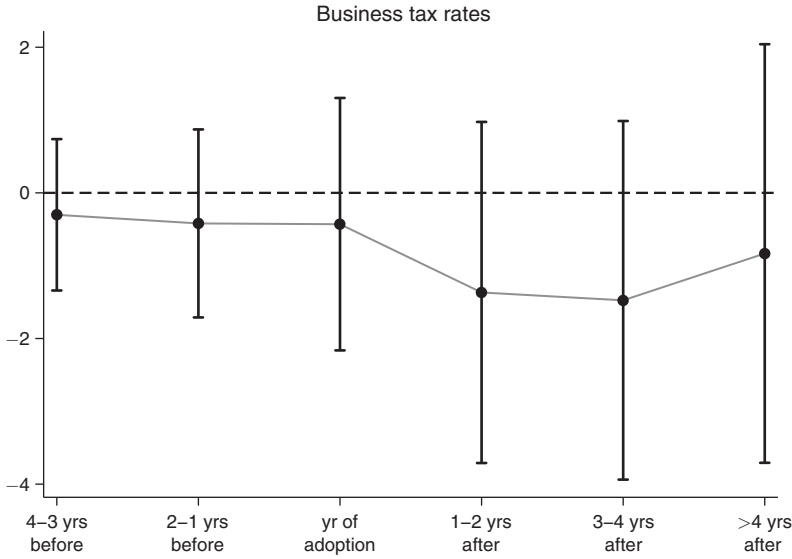


FIGURE 5. POSTAL VOTING AND BUSINESS TAX RATES IN SWISS CANTONS

Notes: Coefficients (dots) and 95 percent confidence intervals (vertical lines) from an OLS regression of cantonal business tax rates on dummies for 6 different time periods relative to the introduction of postal voting and a set of controls for the years 1980 to 2007. The dummies have the value one for the time period indicated on the x -axis and zero otherwise, with the time period five or more years prior to the introduction of postal voting normalized to zero (dashed line). The set of controls is the same as in specification III of Table 6. Confidence intervals are based on a cluster-robust estimator for the variance-covariance matrix with clustering allowed at the cantonal level. Based on a Wald test, it cannot be rejected that the mean of the two coefficients capturing the four years prior to the adoption of postal voting are equal to the mean of the two coefficients for the four years after ($p = 0.190$).

Sources: Année politique Suisse, BAK Basel, cantonal constitutions, Feld et al. (2011), Funk and Gathmann (2011), Luechinger, Rosinger, and Stutzer (2007), Swiss Federal Statistical Office, Swiss Federal Tax Authority, and Swiss State Secretariat for Economic Affairs

$$(A1) \quad \int_{2\gamma}^1 \alpha^i \left[\frac{-\alpha^i}{\alpha} U'(c_p^i) + H'(g_p) \right] f(\alpha^i) d\alpha^i = 0,$$

where $c_p^i = (1 - \tau_p)\alpha^i$ and $\tau_p = (g_p + \bar{r})/\alpha$. It is straightforward to show that the second-order condition holds. Denote the left-hand side of (A1) by k_r . Taking the derivative yields $\partial k_r / \partial g_p = \int_{2\gamma}^1 \alpha^i \left[(-\alpha^i/\alpha)^2 U''(c_p^i) + H''(g_p) \right] f(\alpha^i) d\alpha^i < 0$. It follows from Leibniz's rule that $\partial k_r / \partial \gamma = -4\gamma \left[(-2\gamma/\alpha) U'(\hat{c}_p) + H'(g_p) \right] f(2\gamma)$, where $\hat{c}_p = (1 - \tau_p)2\gamma$. Observe further that $\partial \left[-(\alpha^i/\alpha) U'(c_p^i) + H'(g_p) \right] / \partial \alpha^i = -(1/\alpha) \left[U'(c_p^i) + c_p^i U''(c_p^i) \right] = (1/\alpha) U'(c_p^i) \theta$, which is strictly negative if $\theta < 0$, and equal to zero if $\theta = 0$. Therefore, we need to distinguish two cases. First, if $\theta < 0$, it follows from (A1) and $2\gamma < 1$ that $\left[(-2\gamma/\alpha) U'(\hat{c}_p) + H'(g_p) \right] > 0$ and, consequently, $\partial k_r / \partial \gamma < 0$. The implicit function theorem then implies $\partial g_p / \partial \gamma = -(\partial k_r / \partial \gamma) / (\partial k_r / \partial g_p) < 0$, which implies $\partial \tau_p / \partial \gamma < 0$.

Second, if $\theta = 0$, it follows that $[-(2\gamma/\alpha)U'(\hat{c}_p) + H'(g_p)] = 0$, $\partial k_r/\partial\gamma = 0$, $\partial g_p/\partial\gamma = 0$, and $\partial\tau_p/\partial\gamma = 0$. ■

PROOF OF PROPOSITION 4:

The interior solution of maximization problem (7) must satisfy the first-order condition

$$(A2) \quad \int_{2\gamma}^1 [\alpha^i H'(g_p) - (1 - \alpha^i)\Omega J'(r_p)] f(\alpha^i) d\alpha^i = 0.$$

It is straightforward to show that the second-order condition holds. Denote the left-hand side of (A2) by k_τ . Note that $\partial k_\tau/\partial g_p = \int_{2\gamma}^1 [\alpha^i H''(g_p) + (1 - \alpha^i)\Omega J''(r_p)] f(\alpha^i) d\alpha^i < 0$. It then follows from Leibniz's rule that $\partial k_\tau/\partial\gamma = -2f(2\gamma)[2\gamma H'(g_p) - (1 - 2\gamma)\Omega J'(r_p)]$. Furthermore, observe that $\partial [\alpha^i H'(g_p) - (1 - \alpha^i)\Omega J'(r_p)]/\partial\alpha^i = H'(g_p) + \Omega J'(r_p) > 0$. It thus follows from (A2) and $2\gamma < 1$ that $[2\gamma H'(g_p) - (1 - 2\gamma)\Omega J'(r_p)] < 0$ and, consequently, $\partial k_\tau/\partial\gamma > 0$. The implicit function theorem then implies $\partial g_p/\partial\gamma > 0$. It follows that $\partial r_p/\partial\gamma < 0$. ■

PROOF OF PROPOSITION 5:

The interior solution of maximization problem (5) must satisfy the first-order conditions

$$(A3) \quad \int_{2\gamma}^1 \left[\frac{-(\alpha^i)^2}{\alpha} U'(c_p^i) + \alpha^i H'(g_p) \right] f(\alpha^i) d\alpha^i = 0$$

and

$$(A4) \quad \int_{2\gamma}^1 \left[\frac{-(\alpha^i)^2}{\alpha} U'(c_p^i) + (1 - \alpha^i)\Omega J'(r_p) \right] f(\alpha^i) d\alpha^i = 0.$$

It is straightforward to show that the second-order conditions hold. Denote the left-hand side of (A3) by k_1 , and the left-hand side of (A4) by k_2 . It follows that $\partial k_1/\partial g_p = K_U + K_H$, $\partial k_2/\partial g_p = \partial k_1/\partial r_p = K_U$, and $\partial k_2/\partial r_p = K_U + K_J$, where $K_U \equiv \int_{2\gamma}^1 [(\alpha^i)^3/\alpha^2] U''(c_p^i) f(\alpha^i) d\alpha^i \leq 0$, $K_H \equiv H''(g_p) \int_{2\gamma}^1 \alpha^i f(\alpha^i) d\alpha^i < 0$, and $K_J \equiv \Omega J''(r_p) \int_{2\gamma}^1 (1 - \alpha^i) f(\alpha^i) d\alpha^i < 0$. Further it holds that $\partial k_1/\partial\Omega = 0$ and $\partial k_2/\partial\Omega > 0$; and it follows from Leibniz's rule that $\partial k_1/\partial\gamma = -2[(-4\gamma^2/\alpha)U'(\hat{c}_p) + 2\gamma H'(g_p)] f(2\gamma)$ and $\partial k_2/\partial\gamma = -2[(-4\gamma^2/\alpha)U'(\hat{c}_p) + (1 - 2\gamma)\Omega J'(r_p)] f(2\gamma)$, where $\hat{c}_p = (1 - \tau_p)2\gamma$.

The implicit function theorem states that

$$\begin{pmatrix} \frac{\partial g_P}{\partial \gamma} \\ \frac{\partial r_P}{\partial \gamma} \end{pmatrix} = -B \begin{pmatrix} \frac{\partial k_2}{\partial r_P} & -\frac{\partial k_1}{\partial r_P} \\ -\frac{\partial k_2}{\partial g_P} & \frac{\partial k_1}{\partial g_P} \end{pmatrix} \begin{pmatrix} \frac{\partial k_1}{\partial \gamma} \\ \frac{\partial k_2}{\partial \gamma} \end{pmatrix}, \quad \text{with } B \equiv \left[\frac{\partial k_1}{\partial g_P} \frac{\partial k_2}{\partial r_P} - \frac{\partial k_1}{\partial r_P} \frac{\partial k_2}{\partial g_P} \right]^{-1}.$$

Hence,

$$(A5) \quad \frac{\partial g_P}{\partial \gamma} = 2Bf(2\gamma) \left\{ K_U [2\gamma H'(g_P) - (1 - 2\gamma)\Omega J'(r_P)] + K_J \left[\frac{-4\gamma^2}{\alpha} U'(\hat{c}_P) + 2\gamma H'(g_P) \right] \right\},$$

$$(A6) \quad \frac{\partial r_P}{\partial \gamma} = 2Bf(2\gamma) \left\{ K_U [(1 - 2\gamma)\Omega J'(r_P) - 2\gamma H'(g_P)] + K_H \left[\frac{-4\gamma^2}{\alpha} U'(\hat{c}_P) + (1 - 2\gamma)\Omega J'(r_P) \right] \right\},$$

and, consequently,

$$(A7) \quad \frac{\partial(g_P + r_P)}{\partial \gamma} = 2Bf(2\gamma) \left\{ K_J \left[\frac{-4\gamma^2}{\alpha} U'(\hat{c}_P) + 2\gamma H'(g_P) \right] + K_H \left[\frac{-4\gamma^2}{\alpha} U'(\hat{c}_P) + (1 - 2\gamma)\Omega J'(r_P) \right] \right\}.$$

We first prove the results on $g_P + r_P$ and τ_P . We know that $K_J < 0$ and $K_H < 0$, and it is easy to show that $B > 0$. Hence it remains to determine whether the two terms in square brackets in (A7) are positive or negative. As shown in the proof of Proposition 3, it holds that $\partial[-(\alpha^i/\alpha)U'(c_P^i) + H'(g_P)]/\partial\alpha^i \leq 0$. It then follows from (A3) and $2\gamma < 1$ that $[(-4\gamma^2/\alpha)U'(\hat{c}_P) + 2\gamma H'(g_P)] \geq 0$. It further holds that $\partial[-((\alpha^i)^2/\alpha)U'(c_P^i) + (1 - \alpha^i)\Omega J'(r_P)]/\partial\alpha^i = -(\alpha^i/\alpha)[2U'(c_P^i) + c_P^i U''(c_P^i)] - \Omega J'(r_P) < 0$, where the inequality holds because our assumption $\theta \leq 0$ implies $U'(c_P^i) + c_P^i U''(c_P^i) \geq 0$. It then follows from (A4) and $2\gamma < 1$ that $[(-4\gamma^2/\alpha)U'(\hat{c}_P) + (1 - 2\gamma)\Omega J'(r_P)] > 0$. Together with (A7), these results imply $\partial(g_P + r_P)/\partial\gamma < 0$ and, consequently, also $\partial\tau_P/\partial\gamma < 0$.

We now prove the results on r_P . We know from above that $B > 0$, $K_U \leq 0$, $K_H < 0$, and $[(-4\gamma^2/\alpha)U'(\hat{c}_P) + (1 - 2\gamma)\Omega J'(r_P)] > 0$. It then follows from (A6) that $\partial r_P/\partial\gamma < 0$ if $[(1 - 2\gamma)\Omega J'(r_P) - \gamma H'(g_P)] \geq 0$. Conditions (A3) and (A4) imply

$$(A8) \quad \int_{2\gamma}^1 [(1 - \alpha^i)\Omega J'(r_P) - \alpha^i H'(g_P)] f(\alpha^i) d\alpha^i = 0.$$

Observe that $\partial[(1 - \alpha^i)\Omega J'(r_p) - \alpha^i H'(g_p)]/\partial\alpha^i = -\Omega J'(r_p) - H'(g_p) < 0$. Therefore condition (A8) and $2\gamma < 1$ imply $[(1 - 2\gamma)\Omega J'(r_p) - 2\gamma H'(g_p)] > 0$. Consequently, $\partial r_p/\partial\gamma < 0$.

We finally prove the results on g_p . We know from above that $B > 0$, $K_J < 0$, and $K_U \leq 0$. In particular, it must hold that $K_U < 0$ if $\theta > -1$, and $K_U = 0$ if $\theta = -1$. Further, we show above that $[2\gamma H'(g_p) - (1 - 2\gamma)\Omega J'(r_p)] < 0$; and in the proof of Proposition 3 that $[(-2\gamma/\alpha)U'(\hat{c}_p) + H'(g_p)] > 0$ if $\theta < 0$, and $[(-2\gamma/\alpha)U'(\hat{c}_p) + H'(g_p)] = 0$ if $\theta = 0$. Hence it follows from (A5) that $\partial g_p/\partial\gamma < 0$ if $\theta = -1$, and $\partial g_p/\partial\gamma > 0$ if $\theta = 0$. ■

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