June 2017

Optimal Fiscal Limits with Overrides*

Abstract

This paper studies the optimal design of fiscal limits in the context of a simple political economy model. The model features a single politician and a representative citizen. The politician is responsible for choosing the level of taxation for the citizen but is biased in favor of higher taxes. The citizen sets a tax limit before his/her preferred level of taxation is fully known. The novel feature of the model is that the limit can be overridden, with the citizen's approval. The paper solves for the optimal limit and explores how it depends upon the degree of politician bias and the nature of the uncertainty concerning the citizen's preferred level of taxation. The paper also explains how the possibility of overrides impacts the optimal limit.

Stephen Coate
Department of Economics
Cornell University
Ithaca NY 14853
sc163@cornell.edu

Ross Milton
Department of Economics
Kansas State University
Manhattan, KS 66506
rmilton@ksu.edu

*An earlier version of this paper was entitled "Optimal Fiscal Limits". We thank Yanlei Ma for outstanding research assistance, Marco Battaglini for very helpful comments, and Tim Besley for useful discussions.

1 Introduction

Despite being democratically elected, most state and local governments in the US cannot simply set fiscal policies as they see fit. Rather, tax and spending limits are a common feature of the state and local government fiscal landscape. At the state level, Rose (2010) and Waisanen (2010) report that thirty states operate under a tax or spending limitation.[1] In some states these limits are constitutional and in others they are statutory. They have been implemented both by state legislative bodies and directly by citizens through the initiative process. At the local level, Mullins (2010) reports that all but three states impose some form of constitutional or statutory statewide limitation on the fiscal behavior of their local governments.[2] Moreover, self-imposed limits are quite prevalent at the local level as recently documented by Brooks, Halberstam, and Phillips (2016).[3]

Limits come in many forms and apply to a variety of different fiscal variables. With respect to taxes, there are limits on tax *rates*. In particular, limits on property tax rates are very common at the local level. There are also limits on the total amount of tax that can be raised, so called *tax levy* limits. These can apply to revenue raised from a specific tax or to total tax revenue. With respect to spending, there are limits on the total amount of spending that the government can do. Typically, limits have override provisions which specify when limits may be violated. Violation requires either direct approval of a majority of citizens in a referendum, or a super-majority vote of the governing legislative body.

In light of their practical significance, it is interesting to consider what principles might guide citizens in the setting of fiscal limits. This requires studying the optimal design of limits. To analyze the problem, it is first necessary to frame it. This necessitates taking a stand on why citizens might need limits and specifying the constraints they face in setting them. Regarding the former, it seems natural to assume that elected politicians tend to have a bias towards larger government.[4] Regarding the latter, it is clear that, at the time of setting a limit, citizens

[1] This is a conservative estimate, since Mullins (2010) reports that thirty five states have limitations. Eighteen states have revenue limits, twenty seven have spending limits, and nine have provisions limiting both revenue and spending.

[2] The three exceptions are Connecticut, New Hampshire, and Vermont. The most common type of state-imposed limit on local governments is a property tax rate limitation (forty two states). Tax levy limits are also common (thirty states). Nine states limit spending growth in their local governments and two limit revenue increases. States also regulate what their local governments can tax. See Mullins (2010) for more details.

[3] These researchers find that one in eight of the municipalities in their large-scale survey have self-imposed limits (as distinct from state-imposed limits).

[4] This assumption seems consistent with the history of local tax limitations. Most states adopted their current

face uncertainty in what their preferred fiscal policies are going to be. This uncertainty is what motivates citizens limiting politicians' fiscal authority rather than simply specifying the levels of taxation and spending that they want.

With the problem framed in this way, it is natural to look to the literature on the *delegation problem* for guidance on optimal fiscal limits.[5] This literature considers the interaction between a principal and an agent. The agent has to choose a policy that impacts both the principal and agent's payoffs. The optimal policy for both principal and agent depends on the realization of a state of nature, which, prior to the policy choice, is only observed by the agent. The agent's payoff differs from that of the principal, being biased towards a higher or lower level of the policy. The key assumption of the literature is that policy-contingent transfers between the principal and agent are not possible. Rather, the nature of the interaction is assumed to be that the principal chooses a set of permissible policies for the agent and, given his information on the state of nature, the agent chooses his preferred policy from this set. Thus, the choice is delegated to the agent, but the principal places limits on the agent's discretion. The analytical question of interest is what is the optimal set of permissible policies from the principal's perspective? The literature finds reasonable conditions under which the optimal set is an interval and explores how this interval depends on features of the underlying environment such as the extent of the agent's bias and the degree of uncertainty in the state of nature.

To apply these results to the optimal design of fiscal limits, the principal is interpreted to be a representative citizen and the agent to be a politician.[6] The policy is the level of spending or taxation and the politician is assumed to be biased in favor of larger government. The state of nature represents things that impact the citizen's and politician's preferred level of spending or taxation that are uncertain at the time at which the limit is set. Under the conditions that imply the optimal set of permissible policies is an interval, the upper bound of this interval will be the optimal fiscal limit. The determinants of the optimal limit then follow from the determinants of

property tax limits in the late 1970's and early 1980's during an anti-tax movement following the passage of Proposition 13 in California (Mullins 2010). The literature examining the causes of this 'revolt' commonly credits a perception among voters that taxes were too high, despite being set by democratically elected governments (see, for example, Citrin 1979 and Ladd and Wilson 1982). Why elected politicians might be biased towards larger government will be discussed further in Section 4.2.

[5] The literature on the delegation problem is a sub-branch of the literature on contract theory. It includes Alonso and Matouschek (2008), Amador and Bagwell (2013), Amador, Werning, and Angeletos (2006), Holmstrom (1977), (1984), and Melumad and Shibano (1991). The theory has many interesting applications, including several in the field of political economy. One such application is to the delegation of policy-making from elected politicians to bureaucrats (see, for example, Epstein and O'Halloran 1994 and Huber and Shipan 2006). Another is to the delegation of policy-making from legislatures to standing committees (see, for example, Gilligan and Krehbiel 1987, 1989, and Krishna and Morgan 2001).

[6] The application to "optimal fiscal constitutions" is noted explicitly by Amador, Werning, and Angeletos (2006).

the optimal interval.

There is, however, a discrepancy between this way of formalizing the problem and the way in which fiscal limits are structured in reality: namely, the presence of overrides. The formalization does not allow the politician to deviate from the permissible set of policies with the representative citizen's approval.[7] It is therefore natural to wonder how this impacts the applicability of the results of the delegation literature to the optimal design of fiscal limits. Of course, one possibility is that, while overrides are in principle available, in practice they are hardly ever used, and therefore it is reasonable to simply assume them away. Below we present evidence from three US states on local government property tax limits that this is far from the case. For example, in 2014, 18% of Wisconsin school districts, 4% of Massachusetts municipalities, and 11% of Ohio local governments overrode their tax limits. Given this, it seems worthwhile to incorporate overrides into the analysis and explore how their presence impacts the optimal design of fiscal limits. This is precisely the purpose of this paper.

To introduce overrides into the analysis, the paper assumes that after the state of nature has been revealed, the politician can propose a taxation or spending level that violates the limit. If the representative citizen votes for the politician's proposal, it is implemented. If he votes against, the proposal is not implemented and the politician is required to select an alternative policy that respects the limit. At the time of voting, the citizen is assumed to know the state of nature, meaning that he knows his optimal policy.[8] However, since the politician has agenda setting power, this does not imply that the citizen gets to enjoy this policy.

The paper solves for the optimal limit under this assumption concerning overrides. It explores how the optimal limit depends upon the extent of politician bias and the nature of the uncertainty concerning the citizen's preferred level of the policy. It also explains how the optimal limit with overrides compares to that without.

[7] In the delegation problem setting, Mylovanov (2008) shows that the principal can implement an optimal outcome through *veto-based delegation* with an appropriately chosen default policy. In this implementation, the agent proposes a policy and then the principal approves it or not. If he does not approve it, the default policy is implemented. However, this differs from an override which requires that the politician obtains the citizen's approval only if he exceeds the limit. Moreover, in Mylovanov's scheme the principal is not fully informed when he is voting on the agent's proposal. Rather he makes inferences about what must be true from the agent's proposal.

[8] This may appear similar to the set-up of Epstein and O'Halloran (1994). In their well-known model, a politician must decide how much discretion to provide to a bureaucrat. The bureaucrat makes a policy proposal within an interval of permissible proposals set by the politician. After the bureaucrat has made his proposal, the politician may veto it. If he does so, some default policy is implemented. As in our model, at the time of the veto decision, the politician is fully informed. However, this model differs from ours in that i) the bureaucrat's proposal is always subject to the politician's veto, and ii) the bureaucrat cannot choose from outside the interval of permissible policies. In our model, the voter (who corresponds to the politician in their model) only votes if the politician (who corresponds to the bureaucrat) proposes something outside the permissible set.

When the politician's bias exceeds a threshold, the optimal limit equals the citizen's expected preferred level of the policy. Below this threshold, the limit exceeds this level. For some distributions of the citizen's preferred level, the optimal limit is more permissive the lower is the politician's bias and, as this bias goes to zero, converges to the maximum level of the policy the citizen could desire. For other distributions, the limit remains stringent for low levels of politician bias and can even become more stringent as the politician's bias decreases. Examples suggest that greater uncertainty in the citizen's preferred tax level results in a more permissive limit.

In general, the optimal limit with overrides differs from that without. However, the two limits do coincide in a broad set of circumstances. The key observation is that if, under the optimal limit with overrides, the politician uses his agenda setting power when making override proposals to leave the citizen with the same utility as he would get with policy at the limit, then the optimal limit without overrides is no different from that with. Under these circumstances, while equilibrium will involve overrides, the citizen's utility will be the same as if there were no overrides. As a consequence, the optimal limit must be the same with or without overrides. When making override proposals, the politician will leave the citizen indifferent between the proposal and the limit if his bias is large enough. For smaller levels of bias, however, the citizen may strictly prefer the politician's proposal to the limit. When this happens, the optimal limit with overrides differs from that without. Indeed, it can be shown to be more stringent than that without. Coincidentally, it is precisely in these circumstances that the optimal limit with overrides can become tighter as the politician's bias decreases.

The organization of the remainder of the paper is as follows. Section 2 discusses related literature. To motivate the analysis, Section 3 presents evidence of the empirical importance of the override provision from the US states. Section 4 outlines the model and characterizes the optimal limit. Section 5 compares the optimal limit with and without overrides. Section 6 presents three examples. Section 7 concludes with a brief summary of the findings and suggestions for further research.

2 Related literature

There is a large literature on fiscal limits.[9] This literature can be divided into four branches. The first branch documents the types of limits faced by state and local governments in the US and describes when and how they were introduced (see, for example, Mullins 2010 and Waisanen

[9] Selective reviews are provided by Krol (2007), Mullins and Wallin (2004), and Rose (2010).

2010). This is a difficult and time consuming task because there is a great deal of variation across states and localities and a considerable amount of change over time. The second branch is devoted to understanding how limits impact the fiscal variables they seek to regulate and other related public policies.[10] This is challenging because of the problem of identifying the effect of limits. The third branch studies what citizens think about existing limits and why they were introduced (see, for example, Citrin 1979, Courant, Gramlich and Rubinfeld 1985, Cutler, Elmendorf, and Zeckhauser 1999, and Ladd and Wilson 1982). The fourth branch addresses the normative question of whether limits enhance citizens' welfare and, if so, what should be limited and how should limits be designed.

This paper fits in with this fourth, normative branch of the literature. Other papers in this branch are Brennan and Buchanan (1979), Besley and Smart (2007), and Brooks, Halberstam, and Phillips (2016). Brennan and Buchanan (1979) provide a wide ranging normative discussion of tax limits. They study the issue in the context of a model in which a Leviathan government wastes a fixed fraction of any revenues raised for public good provision. This Leviathan government would like to maximize revenues raised. Brennan and Buchanan discuss a number of different limits: tax rate limits, tax levy limits, and tax base limits.[11] They consider tax levy limits and argue that assessing the appropriate limit will be too complicated for average citizens. Our analysis seeks to provide guidance on exactly this type of question. They also question whether such limits can be effective in restraining government, arguing that the footprint of government in the economy does not equate to the tax revenue it raises. In particular, they point out that government can intervene with non-tax methods such as mandates and regulations. This very reasonable concern is abstracted from in this paper.

Besley and Smart (2007) study the operation of a tax revenue limit in the context of a two period political agency model. The politician holding office in each period chooses taxes and provides a public good, the cost of which is uncertain. Politicians can be good or bad. Good politicians maximize voters' welfare in an unstrategic way. Bad politicians are strategic and get utility from holding office and diverting tax revenues to their own consumption. The important point that Besley and Smart make is that a revenue limit in the first period not only limits the

[10] Papers in this branch of the literature include Bradbury, Mayer, and Case (2001), Brooks, Halberstam, and Phillips (2013), Dye and McGuire (1997), Figlio and Rueben (2001), Knight (2000), Poterba (1994), and Poterba and Rueben (1995, 2001). After surveying the literature, Rose (2010) concludes "tax and expenditure limits appear to be modestly effective in slowing the growth of government, particularly at the municipal level, although the evidence is somewhat mixed".

[11] Base limits correspond to restrictions on what the government may tax. For example, local governments in many states are not allowed to tax income.

choices of the incumbent politician but also impacts how much voters learn about the incumbent. In particular, a revenue limit might induce a pooling equilibrium between good and bad politicians in the first period, which leads to worse selection in the second period. This impact must be taken into account in a full welfare analysis of limits. This interesting point is abstracted from in our analysis which assumes that the politician's bias is independent of the fiscal limit.

As a prelude to their empirical work, Brooks, Halberstam, and Phillips (2016) provide a theoretical analysis of optimal limits that is in the spirit of this paper. Their framework for understanding limits builds on a model of local government elections presented in Coate and Knight (2011). There are two groups of citizens with low and high preferences for public goods. The level of public good is chosen by an elected politician. Politicians are citizens and choose their preferred public good level if elected. However, citizens cannot observe candidates' preferences. A limit is implemented when the majority have low preferences and is intended to constrain high spending politicians. The cost of the public good is uncertain which makes the choice of limit non-trivial. The optimal limit is shown to be more permissive the higher the probability the elected politician is a low type. However, the analysis assumes there is no override. While it does not explicitly incorporate elections, our model is consistent with that of Brooks, Halberstam, and Phillips. Nonetheless, our analysis of optimal limits differs from theirs because we incorporate the reality that limits can be overridden. This changes the calculus of the optimal limit.

More generally, the paper contributes to a broader normative literature on fiscal constitutions. A fiscal constitution is a set of rules and procedures that govern the determination of fiscal policies (see, for example, Brennan and Buchanan 1980). It is distinct from a political constitution which sets up the architecture of government and the rules by which policy-makers are selected. The fiscal constitution literature seeks to understand the effectiveness of various rules and procedures in generating good fiscal policies for citizens. In addition to tax and spending limits, it studies balanced budget rules, budgetary procedures, debt limits, and rainy day funds. Rose (2010) provides a useful review of this literature. Recent theoretical contributions include Azzimonti, Battaglini, and Coate (2016) and Halac and Yared (2014) who study rules regarding government deficits in dynamic economies.

Finally, the model studied here is related to the well-known agenda setter model of Romer-Rosenthal (Romer and Rosenthal 1978 and 1979). The agenda setter model considers the interaction between a politician and a representative voter. The voter's utility depends on the level of public spending and the politician is responsible for choosing the level of this spending. The politician is not only biased in favor of spending in the sense that he always prefers a higher level than the voter, he is in fact a budget maximizer. The politician's proposed spending level must be approved by the voter and, if it is not, then an exogenous reversion level is implemented. In equilibrium, the politician proposes a spending level which leaves the voter indifferent between the proposal and the reversion level. The proposed spending level exceeds the reversion level whenever the latter falls below the voter's preferred spending level. In this paper, the choice of the limit can be thought of as endogenizing the reversion level. Moreover, the fact that the limit must be chosen before the voter's preferences are fully known makes the choice of limit interesting even in the case in which the politician is a budget maximizer and thus heavily biased.

3 The override provision in practice

This section illustrates the significance of overrides in practice. It focuses on local property tax limits, the most prevalent type of fiscal limit in the US. While differing in the details, forty two of the fifty US states have a limit on local property taxes (Lincoln Institute of Land Policy 2016). Thirty five of these states allow local governments to override some or all of their limitations with the approval of a majority of their voters.[12] To provide a feel for how these overrides are used in practice, we have assembled evidence from three states: Massachusetts, Ohio, and Wisconsin. We selected these states because they have data available detailing the tax limits in particular jurisdictions, taxes levied, and overrides of the limits.[13] As we will see, in all three states, overrides are commonplace.

3.1 Massachusetts

In Massachusetts, Proposition $2\frac{1}{2}$ limits the total amount of property tax local municipalities can levy, which is the predominant source of local tax revenue.[14] Starting in 1983, each government's tax limit was set at its 1982 tax level, and increased annually by 2.5% plus an adjustment for increases in property values due to new construction.[15]

[12] This information is obtained from Lincoln Institute for Land Policy (2016) and Mullins (2003), (2010). Of the seven states with limits that do not allow voter overrides, two (Indiana, South Carolina) allow overrides of the limit with supermajority votes of the governing body or with an appeal to the state government and the remaining five (Alaska, Arkansas, Delaware, Utah, and Wyoming) provide no means for local governments to exceed the limit.

[13] It is certainly possible that the availability of data is related to the widespread use of overrides in these states, making them unrepresentative. We doubt this is the case, but have no way to rule it out.

[14] In Massachusetts, municipalities provide nearly all local services and collect over 95% of their tax revenue from the property tax (Urban Institute-Brookings Institution Tax Policy Center 2016).

[15] The same proposition also limited local governments' tax revenues to 2.5% of the total assessed fair market value in the municipality. According to Bradbury and Ladd (1982), the Massachusetts Department of Revenue

To exceed its limit, the governing body of a municipality must propose a dollar amount of additional revenue and its purpose, and then allow the electorate to vote. If the override proposal receives majority approval, the city or town can tax the additional amount. If it does not, the government must stay within the limit. Since the limit grows annually, a successful override relaxes the limit in all subsequent years.

Cities and towns have used the override to significantly increase their taxing authority. Between 1983 and 2016, 74% of the three hundred and fifty one municipalities passed at least one override to exceed their limit.[16] Overrides approved by fiscal year 2016 increased the statewide total levy limit in 2016 by $943 million, relative to if none had ever been passed. This represents 6.2% of the total 2016 levy limit.[17] Limited to only those cities and towns that passed at least one override, the taxes approved via override represent 12.5% of their total 2016 levy limit.

3.2 Ohio

Since 1911, Ohio has limited the ability of local governments to set property tax rates, and allowed voters to override those limits to approve higher taxes. At least in recent years, voters have approved dramatically higher taxes than what would be allowed within the limit.

In Ohio, multiple kinds of jurisdictions, including school districts, counties, municipalities, and special districts, have the authority to levy property taxes.[18] Collectively, all coincident taxing jurisdictions are limited to a property tax rate of 1% of the assessed property value.[19] The allocation of these revenues among jurisdictions is determined by the relative sizes of their tax revenues in 1929-1933, the last five years in which a prior limit was in effect. In order to exceed its revenue allocation, a jurisdiction's governing body must propose the amount of tax revenue it wishes to collect and ask its voters to approve the proposal in a public referendum. Approval

estimated that this limit would bind for approximately half of the state's municipalities in the first year. However, following the marked increase in property values in subsequent years, very few towns and cities faced it as a binding constraint.

[16] Property taxes for capital projects and to repay debt also require voter approval but are not covered under the levy limit. These referenda are not included in these numbers although they are also widely used.

[17] The total 2016 value of overrides in a given jurisdiction is calculated by $\sum_{t=1983}^{2016} override_t 1.025^{2016-t}$, where $override_t$ is the value of the override passed in year t and zero if there was none. This understates the importance of overrides, since in addition to directly changing the levy limit, an override will also make future additions to the limit due to new construction larger. We lack sufficient data to calculate this for the full timespan, but for overrides passed between 1992 and 2016 this impact was approximately $117 million.

[18] Unlike in the other states discussed here, local governments in Ohio can also raise tax revenue with sales and income taxes, and only 65% of local tax revenue comes from the property tax (Urban Institute-Brookings Institution Tax Policy Center 2016). The state also imposes limits for these taxes, though they are not discussed here.

[19] The assessed property value is mandated to be 35% of the fair market value.

requires a majority of votes. Override proposals must specify whether they would be permanent or would expire after a stated number of years.

Since overrides typically last multiple years, the maximum that a government can levy in a given year without an additional override is the sum of its revenue from the 1% levy and that from any outstanding overrides. A government's limit may decrease in years following the expiration of overrides.[20]

Using data from the Ohio Department of Taxation on property tax rates and levies we can determine the prevalence and value of overrides of the 1% limit. In 2014, the three thousand, four hundred and seventeen local jurisdictions that raise property taxes charged a total of approximately 15.5 billion in property taxes. Of this, 13.3 billion (85.9%) came from taxes that required voter approval to exceed the levy limit.[21]

Despite some overrides creating permanent increases in their taxing authority, jurisdictions continue to propose and approve overrides. In 2014, voters in three hundred and eighty seven jurisdictions approved new or modified tax rates. 44.2% of jurisdictions had outstanding overrides in 2014 that were enacted between 2010 and 2014.

3.3 Wisconsin

Wisconsin restricts the ability of local governments to tax their residents, through two separate limits that apply to school districts and to counties and municipalities. The two limits have different structures and voter overrides are more prevalent among school districts.

3.3.1 School districts

Since 1993, Wisconsin has limited the revenues of its school districts to their prior year level of revenue plus a per student increment that is occasionally adjusted by the legislature.[22] The limit covers the combined revenues from both the local property tax levy, which is the source of 94.2% of local tax revenue, and state aid.[23] Thus, the limit on a district's local tax levy is the difference

[20] Prior to 1976, overrides approved a tax rate and the resulting revenue fluctuated with property values, but since then overrides effectively approve an amount of additional revenue.

[21] Some taxing jurisdictions received no revenue from the 1% levy and could only levy property taxes with voter approval. Limited to the two thousand, nine hundred and forty eight jurisdictions that could levy taxes without an override, 82.5% of them also taxed beyond that amount with the approval of their electorate. These jurisdictions represent the overwhelming majority of property taxes. In total they levied 14.3 billion of which 12.2 billion required an override.

[22] While in every other year the increment has been positive, in the 2011-12 school year, the legislature instead reduced each district's revenue limit by 5.5%.

[23] There are also other exceptions that allow districts to exceed their limits without voter approval but for very limited purposes, for instance if they annex a neighboring district, accept transfer students in an open enrollment

between its revenue limit and the amount of state educational aid it will receive. To exceed its limit, a district must specify an amount and duration for the excess.[24] Again, a majority of votes is necessary for approval. We use data on levy limits from the Wisconsin Department of Public Instruction to determine the frequency and effect of overrides.

Each year most districts levy up to their limit. On average, 75% of districts are at their revenue limit and the median school district levied up to their limit in 17 of the 21 years from 1996 to 2016. Voters frequently approve overrides of the limit. Between 1996 and 2016, 59.9% of districts passed at least one override.[25] The combination of permanent and temporary overrides in effect in 2016 resulted in 231 million in higher property taxes, or 5.3% of the total levy limit.[26] Limited to only those districts that passed at least one override, this represents 9.3% of their levy limits.

3.3.2 Counties and municipalities

Beginning in 2006, state law has limited the tax levy of Wisconsin counties and municipalities to the prior year's level plus an allowed increase. Governments can freely increase their levy by the greater of a minimum set by the legislature or the percent increase in the jurisdiction's property values due to new construction.[27] From 2006 through 2010 the minimum was between 2 and 3%, but since 2011 it has been 0%. Since the statewide rate of new construction has also diminished, the limit for many governments has declined in real terms.

To exceed their limit, governments must ask their voters to approve an override. As part of a tradition of direct democracy, towns with small populations (under 3000) can vote to approve an override at their annual town meetings. Larger towns must hold a referendum with votes cast at polling places. Between tax years 2009 and 2015, 16% of municipalities exceeded their limits.[28] Interestingly, these were almost exclusively the small towns allowed to approve overrides at their

program, invest in energy efficiency measures, or lose federal aid.

[24] As in Ohio, overrides can be permanent or last a defined number of years. While time-limited overrides approve a dollar amount of spending each year, due to the way limits are calculated in subsequent years, permanent increases effectively approve a per student increase.

[25] Districts also may have passed overrides between 1993 and 1995, but the Wisconsin Department of Public Instruction no longer has information on these.

[26] Of this, 138 million was due to past and current permanent overrides and the remainder temporary overrides that will eventually expire.

[27] From 2009-2010 and 2013 to present, each year's levy limit was calculated as if they had levied at their limit the prior year.

[28] Counties and municipalities may have also passed referenda between 2006 and 2008 however the Wisconsin Department of Revenue no longer has data covering these years. Most jurisdictions had more room within their limits during these years than subsequent years, making it unlikely that there were a larger number of referenda approved in years not covered by the data.

annual town meetings.[29]

4 Optimal fiscal limits

4.1 The model

A politician is in charge of selecting a level of taxation for a community. A representative citizen has to pay the tax but benefits from the public spending it finances. The citizen desires a certain level of taxation, but this preferred tax is ex ante uncertain. The politician prefers a higher tax than the citizen. The citizen is aware of the politician's bias and, before he knows his preferred tax, imposes a tax limit on the politician. The limit comes with an override provision that allows the politician to violate it with the citizen's approval.

The tax is denoted t. The citizen's preferred tax is τ. The citizen has distance policy preferences $-|t-\tau|$ so that his utility declines linearly and symmetrically as the tax diverges in either direction from his ideal.[30] The citizen's preferred tax τ is the realization of a random variable with range $[\underline{\tau}, \overline{\tau}]$ and cumulative distribution function $H(\tau)$. The associated density function, $h(\tau)$, is assumed to be symmetric around the mean $\tau_m = (\underline{\tau} + \overline{\tau})/2$.[31] In addition, the density is continuous and non-decreasing on $[\underline{\tau}, \tau_m]$. These assumptions imply that the cumulative distribution function is convex on the interval $[\underline{\tau}, \tau_m]$ and concave on the interval $[\tau_m, \overline{\tau}]$. The politician has preferred tax $(1+b)\tau$and preferences $-|t-(1+b)\tau|$ so that the parameter b measures the magnitude of the politician's bias.

The tax limit is denoted ℓ. The limit prevents the politician from implementing a tax in excess of ℓ without the citizen's approval. Without loss of generality, the limit ℓ is assumed to belong to the interval $[\underline{\tau}, \overline{\tau}]$.

The timing of the interaction between the citizen and the politician is as follows. First, knowing H and b, the citizen selects a limit ℓ from the interval $[\underline{\tau}, \overline{\tau}]$. Second, nature selects the citizen's preferred tax τ which is observed by both players. Third, the politician proposes a tax t. If the proposal does not exceed the limit ℓ, it is implemented. Fourth, if the proposed tax violates the

[29] Only two of the one hundred and ninety cities passed an override. Counties have similarly been infrequent users of overrides; in the same span only three of the seventy two counties passed at least one override. Whether allowing overrides to be approved at town meetings is a good idea for the small towns is an interesting question.

[30] While not without their drawbacks (see, for example, Milyo 2000), distance preferences are very widely used in the political economy literature. They are both analytically tractable and simple to understand. The particular form used here assumes a linear loss of utility for the voter as the tax diverges from his ideal. This is distinct from a quadratic loss which is also commonly assumed.

[31] This means that for any τ below the mean τ_m, $h(\tau)$ is equal to $h(2\tau_m - \tau)$.

limit, an election is held and the citizen votes in favor or against the proposal. If he votes in favor, the proposal is implemented. Fifth, if the citizen votes against the proposal, the politician chooses another tax t' which respects the limit and this is implemented.

4.2 Discussion

The model raises a number of obvious questions which it is useful to briefly discuss. One question is why is the politician biased? In particular, why cannot citizens elect a candidate who shares their tax preferences? Of course, limits would seem unnecessary if elections select the right candidates. Thus, the prevalence of limits at the state and local government level suggests that candidate elections cannot be working perfectly in these environments.[32] To explain this imperfect functioning, it is common to point out that elections at this level of government are small scale affairs and that, as a consequence, citizens are not well informed about candidates' policy preferences. Moreover, the rewards to holding office are not large enough to provide incentives for elected candidates to diverge from their preferences to increase their chances of re-election. But all this only means that, when elected, candidates will likely follow their policy preferences, which may not be congruent with those of the median voter. It does not explain a particular direction of bias. For this, there are (at least) two possible explanations. First, interest groups may put pressure on elected leaders to increase spending above the level preferred by voters. Many stakeholders stand to benefit from public spending. These include public employees, public contractors, and recipients of government grants. By the usual logic of concentrated benefits versus diffuse costs, these stakeholders may form groups to influence politicians. In such environments, politicians may act as if they prefer higher spending even if, as citizens, they share the general voter's preferences (see, for example, Grossman and Helpman 1994 and Besley and Coate 2001). The second explanation is selection. For certain local government offices, it is reasonable to believe that the people most likely to run are those who care intensely about the policies the office controls and thereby have higher preferences for spending on these policies. Good examples might be school board or town and city council.

A related question is how does the citizen know the politician's exact bias? Would it not be more realistic to just assume the citizen was uncertain of the degree of the politician's bias, allowing in effect a continuous distribution of bias? The answer to this question is obviously

[32] This said, it is possible to generate an explanation for the limits states impose on their local governments while assuming that the median voter theorem applies at both the state and local level. See Calabrese and Epple (2011) and Vigdor (2004).

yes. A known level of bias is assumed purely for reasons of tractability.[33] The optimal limit design problem is quite complicated with a known level of politician bias and it makes sense to understand this problem prior to introducing a more general type of uncertainty.

Another question is why is the citizen uncertain about his preferred tax? If there were no such uncertainty, the citizen should just impose a limit equal to his preferred tax and that would be the end of the analysis. In particular, there would be no role for overrides. The ubiquity of override provisions suggests that in the real world there must be uncertainty. Moreover, such uncertainty seems intuitively plausible. The type of uncertainty will depend on the nature of the policies the politician is raising taxes to fund. If the policy is road maintenance (snow plowing, pothole repair, etc), then uncertainty would be created by weather, the prices of inputs like road salt, tarmac, etc. If the policy is police protection then uncertainty would be created by the underlying forces generating crime. If the policy is school spending then uncertainty would be created by the prices of school supplies, wages of teachers, mandates from higher levels of government, and state and federal financial support.

A final question is why the citizen cannot simply implement his preferred tax once uncertainty is resolved? This reflects the assumption that the politician has agenda setting power; that is, the politician has the right to choose the tax proposal and citizens only have the right to veto it if it exceeds the limit. The model makes this assumption because it is an accurate description of reality but does not explain why this arrangement exists.[34] It might be interesting to consider alternative arrangements whereby citizens could propose alternatives to the politician's proposal. Intuitively, the underlying reasons why we do not observe such arrangements likely include the problems that i) if citizens could also propose alternatives, it is not clear how to choose between all the alternatives that might be proposed, and ii) the forces that cause elected politicians to be biased might also be expected to result in biased citizen proposals.

4.3 The limit design problem

We are now ready to consider the problem of choosing a tax limit to maximize the citizen's expected welfare. To pose the limit design problem formally, we must understand the policy implications of any given limit ℓ. Working backwards, consider what policy the politician would

[33] In the literature on the delegation problem, it is standard to assume a known level of bias.

[34] More generally, the analysis does not seek to explain why the institution defined by a fiscal limit and an override process is optimal. It simply focuses on the narrow, but practically relevant, question of what determines the optimal limit given this institution.

choose if he had to satisfy the limit. He will choose a tax equal to the limit ℓ if this is smaller than his preferred tax $(1+b)\tau$. Otherwise, he will choose his preferred tax. Thus his policy choice will be $\min\{\ell,(1+b)\tau\}$. The citizen will recognize that if he votes down any alternative policy proposed by the politician, the tax implemented will be $\min\{\ell,(1+b)\tau\}$. If the citizen's preferred tax τ is less than ℓ he will prefer this policy to any higher level and there is no point in the politician proposing to violate the limit. In this case, therefore, the implemented tax will be $\min\{\ell,(1+b)\tau\}$. If τ exceeds ℓ, the citizen will support taxation in excess of the limit. The optimal policy proposal for the politician solves the standard agenda-setter's problem

$$\begin{gathered} \max_t -|t-(1+b)\tau| \\ s.t. -|t-\tau| \geq -|\ell-\tau| . \end{gathered} \tag{1}$$

The constraint guarantees that the citizen supports the proposal since the politician will choose tax ℓ if his proposal is rejected. From the constraint, the maximum tax the citizen will support is $2\tau-\ell$. The politician will propose this if it is smaller than his preferred tax $(1+b)\tau$. Otherwise, he will choose his preferred tax. In summary, therefore, the policy implemented under limit ℓ will be $\min\{\ell,(1+b)\tau\}$ if the citizen's preferred tax τ is less than ℓ and $\min\{2\tau-\ell,(1+b)\tau\}$ otherwise. Putting all this together, it follows that with limit ℓ, the citizen's expected welfare will be given by

$$-\left(\int_{\underline{\tau}}^{\ell}\left[\min\{\ell,(1+b)\tau\}-\tau\right]h(\tau)d\tau+\int_{\ell}^{\overline{\tau}}\left[\min\{2\tau-\ell,(1+b)\tau\}-\tau\right]h(\tau)d\tau\right). \tag{2}$$

The limit design problem is to choose a limit from the interval $[\underline{\tau},\overline{\tau}]$ to maximize this function. Since the constraint set is compact and the objective function continuous, the problem has a solution.

Rearranging, the limit design problem can be restated as choosing a limit to maximize the objective function:

$$V(\ell)=\int_{\max\{\underline{\tau},\frac{\ell}{1+b}\}}^{\ell}\left[(1+b)\tau-\ell\right]h(\tau)d\tau+\int_{\ell}^{\min_+\{\overline{\tau},\frac{\ell}{1-b}\}}\left[\ell-(1-b)\tau\right]h(\tau)d\tau-\int_{\underline{\tau}}^{\overline{\tau}}b\tau h(\tau)d\tau, \tag{3}$$

where $\min_+\{\overline{\tau},\ell/(1-b)\}$ denotes the smallest positive number of the two.[35] The third term in this expression measures the citizen's loss of welfare if there was no limit and the politician were to just choose his preferred level $(1+b)\tau$. The first two terms represent the surplus the citizen can

[35] If b exceeds 1, $\ell/(1-b)$ will be negative and hence $\min\{\overline{\tau},l/(1-b)\}$ equals $\ell/(1-b)$ while $\min_+\{\overline{\tau},\ell/(1-b)\}$ equals $\overline{\tau}$.

claw back through the limit. The limit design problem is then to find the limit ℓ that maximizes these first two terms.

4.4 The optimal limit with large politician bias

When the politician's bias is large, the limit design problem is straightforward to solve. In particular, suppose that it were the case that b exceeded $(\overline{\tau}-\underline{\tau})/\underline{\tau}$. Then $\ell/(1+b)$ would be less than $\underline{\tau}$ for any limit ℓ in the range $[\underline{\tau},\overline{\tau}]$. Moreover, if it were positive, $\ell/(1-b)$ would exceed $\overline{\tau}$ for any limit ℓ in the range $[\underline{\tau},\overline{\tau}]$. Accordingly, from (3), the objective function $V(\ell)$ would be

$$V(\ell)=\int_{\underline{\tau}}^{\ell}\left[(1+b)\tau-\ell\right]h(\tau)d\tau+\int_{\ell}^{\overline{\tau}}\left[\ell-(1-b)\tau\right]h(\tau)d\tau-\int_{\underline{\tau}}^{\overline{\tau}}b\tau h(\tau)d\tau. \tag{4}$$

Differentiating this expression, we obtain

$$V'(\ell)=1-2H(\ell). \tag{5}$$

Recall that H is assumed to have a density that is symmetric around the mean and hence $H(\tau_m)$ is equal to $1/2$. Thus, the citizen's welfare is increasing in the limit as long as it is less than τ_m and decreasing thereafter. The optimal limit is therefore equal to τ_m - the citizen's *expected* preferred tax.

The intuition here is equally transparent. When the politician's bias exceeds $(\overline{\tau}-\underline{\tau})/\underline{\tau}$, then, even if the citizen's preferred tax were at its lowest level ($\tau=\underline{\tau}$), the politician's preferred tax would still exceed $\overline{\tau}$. As a result, whatever the limit, he will always choose a tax equal to the limit (ℓ) when the citizen's preferred tax is less than the limit ($\tau<\ell$). Moreover, when the citizen's preferred tax exceeds the limit ($\tau>\ell$), the politician will choose a tax that provides the citizen with exactly the same payoff as he would get from the limit (ℓ). As a result, the citizen's payoff is exactly that which would arise if the policy were just set equal to the limit (ℓ). The optimal limit is therefore the tax which, if committed to ex ante, would yield the citizen the highest expected payoff. This is the expected preferred tax, τ_m.

In fact, we can weaken the requirement on bias and still keep the conclusion that the limit should equal the expected preferred tax. As the following proposition shows, it is sufficient that the degree of bias b exceeds $(\overline{\tau}-\tau_m)/\underline{\tau}$.

Proposition 1 *If the politician's bias b exceeds $(\overline{\tau}-\tau_m)/\underline{\tau}$, the optimal limit is τ_m.*

With a level of bias between $(\overline{\tau}-\tau_m)/\underline{\tau}$ and $(\overline{\tau}-\underline{\tau})/\underline{\tau}$, it remains the case that the citizen's payoff from limit τ_m is exactly that which would arise if the tax were set equal to τ_m ex ante.

However, for a limit ℓ in excess of τ_m, it could be the case that the politician would choose his preferred tax $(1+b)\tau$ rather than ℓ for sufficiently small τ.[36] If so, the payoff from such a limit would strictly exceed that associated with just choosing tax ℓ ex ante. Similarly, for a limit ℓ less than τ_m, it could be the case that the politician would choose $(1+b)\tau$ rather than $2\tau - \ell$ for sufficiently large τ. It therefore becomes less obvious that the optimal limit is τ_m because the payoff from alternative limits may have improved. However, the proof of the Proposition shows that, under the conditions on the density function h, τ_m remains optimal.

A graphical interpretation of the result is provided in Figure 1. In each panel, the range of values for the citizen's preferred tax τ is measured on the horizontal axis. The three upward sloping lines are $(1+b)\tau$, τ, and $(1-b)\tau$ respectively. The parameters are chosen so that b is exactly equal to $(\overline{\tau} - \tau_m)/\underline{\tau}$. In Panel A, the shaded area represents the surplus that the citizen would lose if the politician were to choose his preferred tax $(1+b)\tau$. This area is the third term in (3). In Panel B, the shaded area represents the surplus generated for the citizen by the limit τ_m, which corresponds to the first two terms of (3). Panel C illustrates the surplus generated for the citizen by a limit ℓ larger than τ_m. Notice that with this limit, the politician chooses his preferred level $(1+b)\tau$ when τ is sufficiently low. The difference in surplus from limit τ_m as opposed to limit ℓ is illustrated in Panel D. In the proof of Proposition 1, this difference is shown to equal the difference between twice the striped area $(\int_{\tau_m}^{\ell} [\ell - \tau]\, h(\tau) d\tau)$ less the shaded area $(\int_{\underline{\tau}}^{\frac{\ell}{1+b}} [\ell - (1+b)\tau]\, h(\tau) d\tau)$. The assumptions on the distribution function H and bias parameter b imply that this difference is positive.

4.5 The optimal limit with small politician bias

We now turn to the more challenging case in which b is smaller than $(\overline{\tau} - \tau_m)/\underline{\tau}$. We first prove that, under our assumptions on the distribution function H, the optimal limit is never smaller than τ_m.

Lemma 1 *The optimal limit is always at least as big as τ_m.*

We now characterize the solution when the politician's bias is smaller than $(\overline{\tau} - \tau_m)/\underline{\tau}$ but larger than $(\overline{\tau} - \tau_m)/\overline{\tau}$. In this range of bias levels, with a limit equal to τ_m, the politician will choose his preferred tax $(1+b)\tau$ when τ is sufficiently low but will always choose the tax $2\tau - \tau_m$ when τ exceeds τ_m.

[36] This requires that $(1+b)\underline{\tau}$ is less than ℓ.

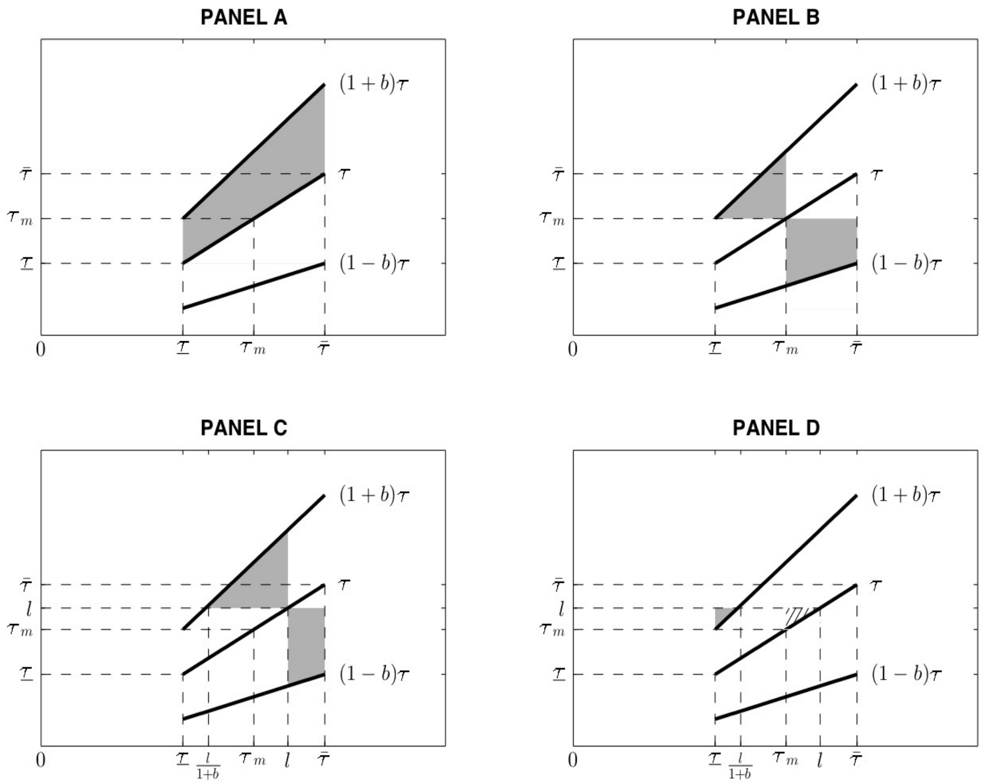

Figure 1: Graphical Interpretation of Proposition 1

Proposition 2 *If the politician's bias b lies between $(\overline{\tau} - \tau_m)/\overline{\tau}$ and $(\overline{\tau} - \tau_m)/\underline{\tau}$, the optimal limit solves the equation*

$$1 + H\left(\frac{\ell}{1+b}\right) = 2H(\ell). \tag{6}$$

It is straightforward to show that there must exist a solution to equation (6) on the interval $(\tau_m, \overline{\tau}]$.[37] While there is no guarantee that this solution is unique, it is difficult to come up with examples satisfying our assumptions in which there are multiple solutions. Figure 2 illustrates a situation in which there exists a unique solution. The Figure depicts the curves $2H(\ell)$ and $1 + H(\ell/(1+b))$ on the interval $[\tau_m, \overline{\tau}]$. The curve $2H(\ell)$ must be concave since, under our assumptions, H is concave on $[\tau_m, \overline{\tau}]$. The curve $1 + H(\ell/(1+b))$ is convex on the interval $[\tau_m, (1+b)\tau_m]$ and concave thereafter. This follows from the fact that H is convex on $[\underline{\tau}, \tau_m]$. As illustrated, the end points and shapes of the two curves guarantee they intersect, with $2H(\ell)$

[37] This is shown in the proof of Proposition 2.

intersecting $1 + H(\ell/(1+b))$ from below.[38]

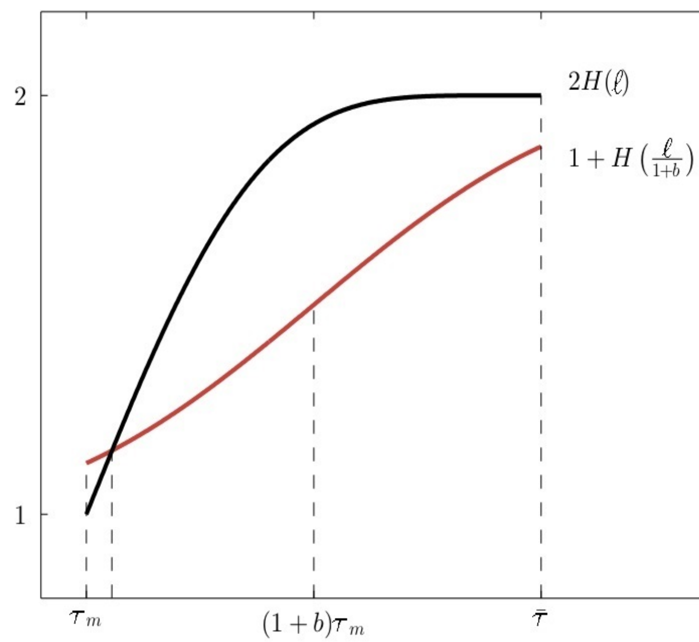

Figure 2: Illustration of Proposition 2

In the case covered by Proposition 2, the optimal limit becomes more stringent as the politician's bias increases. An increase in b shifts down the curve $1 + H(\ell/(1+b))$. If there is a single intersection point, it must shift to the left, implying a lower optimal limit.[39]

Finally, we tackle the case in which the politician's bias is smaller than $(\bar{\tau} - \tau_m)/\bar{\tau}$. In this range of bias levels, with a limit equal to τ_m, the politician will not only choose his preferred tax $(1+b)\tau$ when τ is sufficiently low but will also do so when τ is sufficiently high.

Proposition 3 *If the politician's bias b is smaller than $(\bar{\tau} - \tau_m)/\bar{\tau}$, the optimal limit is* ***either*** *bigger than $(1-b)\bar{\tau}$ and solves equation (6)* ***or*** *is smaller than $(1-b)\bar{\tau}$ and solves the equation*

$$H\left(\frac{\ell}{1-b}\right) + H\left(\frac{\ell}{1+b}\right) = 2H(\ell). \tag{7}$$

[38] If there is more than one solution to equation (6), the end points and shapes of the two curves imply that there must be three. The optimal limit is either the smallest or the largest intersection point, where $2H(\ell)$ intersects $1 + H(\ell/(1+b))$ from below.

[39] If there are multiple intersection points, both the smallest and largest shift down. The only way that an increase in b could increase the optimal limit, therefore, is if it caused a shift from the smallest intersection point to the largest. But it is easy to see that an increase in b makes a move from the smallest intersection point to the largest less attractive.

As noted above, there must exist a solution to equation (6) on the interval $(\tau_m, \overline{\tau}]$. We show in the proof of Proposition 3, that if this solution is smaller than $(1-b)\overline{\tau}$, then there must be a solution to equation (7) which is also smaller than $(1-b)\overline{\tau}$. Again, there is no guarantee that there exists a unique solution, but multiple solutions do not arise in examples.

Figure 3 graphs the three curves $2H(\ell)$, $1+H(\ell/(1+b))$ and $H(\ell/(1-b))+H(\ell/(1+b))$. The curve $H(\ell/(1-b))+H(\ell/(1+b))$ coincides with $1+H(\ell/(1+b))$ at limits higher than $(1-b)\overline{\tau}$ and lies below it for lower limits. Over this range, it has a steeper slope. The Figure illustrates a situation in which the solution to equation (6) is smaller than $(1-b)\overline{\tau}$. The optimal limit is therefore found where the curves $2H(\ell)$ and $H(\ell/(1-b))+H(\ell/(1+b))$ intersect.

It would be useful to know exactly when each of the two possibilities described in Proposition 3 arise. The possibility that both equations (6) and (7) have solutions in the relevant ranges make it difficult to fully characterize when each of the two cases will arise.[40] However, our next Proposition provides a sufficient condition for the solution to adhere to equation (7).

Proposition 4 *If the politician's bias b is smaller than $(\overline{\tau}-\tau_m)/\overline{\tau}$ and if*

$$1-H((1-b)\overline{\tau}) < H((1-b)\overline{\tau}) - H\left(\frac{\overline{\tau}}{1+2b}\right), \tag{8}$$

the optimal limit is smaller than $(1-b)\overline{\tau}$ and solves equation (7).

The proof of this Proposition establishes that, when the condition holds, there cannot be a solution to (6) on the interval $[(1-b)\overline{\tau}, \overline{\tau}]$. The condition requires that it is less likely that the citizen's preferred tax lies in the interval $[(1-b)\overline{\tau}, \overline{\tau}]$ than in the interval $[\overline{\tau}/(1+2b), (1-b)\overline{\tau}]$.[41] The latter interval is non-empty for values of b in the interval $(0, 1/2)$. Note also that the former interval has length $b\overline{\tau}$, while the latter has length $b\overline{\tau}(1-2b)/(1+2b)$. Thus, the condition requires that the distribution has less mass in its tails and will not be satisfied for the uniform distribution. Intuitively, the condition reveals that when it is relatively unlikely that the citizen's preferred tax is close to the top of the distribution, it is better to set a lower limit that will bind in more likely scenarios and allow the politician to set his preferred tax (through the override) when the citizen's preferred tax ends up being very large.

[40] Since equations (6) and (7) coincide when ℓ is greater than $(1-b)\overline{\tau}$, this possibility can only occur when equation (7) has multiple solutions.

[41] For distributions for which equation (7) has only one solution over the range $[\tau_m, \overline{\tau}]$ (and as a result, only one of equations (6) and (7) has a solution in the relevant range), like the examples described in Section 6, a more permissive sufficient condition is available. This condition requires that it is less likely that the citizen's preferred tax lies in the interval $[(1-b)\overline{\tau}, \overline{\tau}]$ than in the interval $[(1-b)\overline{\tau}/(1+b), (1-b)\overline{\tau}]$. Under this condition, decreasing the limit marginally from $(1-b)\overline{\tau}$ will improve the citizen's welfare. The proof of Proposition 3 shows that in this case there must be a solution to equation (7) at a limit less than $(1-b)\overline{\tau}$.

Finally, it is important to note that in the case in which the optimal limit solves equation (7), it is not necessarily the case that increasing the politician's bias will make the optimal limit more stringent. This is because an increase in b has ambiguous effects on the curve $H(\ell/(1-b)) + H(\ell/(1+b))$. While an increase in b reduces $H(\ell/(1+b))$ for all ℓ, it increases $H(l/(1-b))$. The net effect is ambiguous.[42] Following the discussion of the override provision, Section 6 provides examples which illustrate that the stringency of the optimal limit can be both decreasing and increasing in bias.

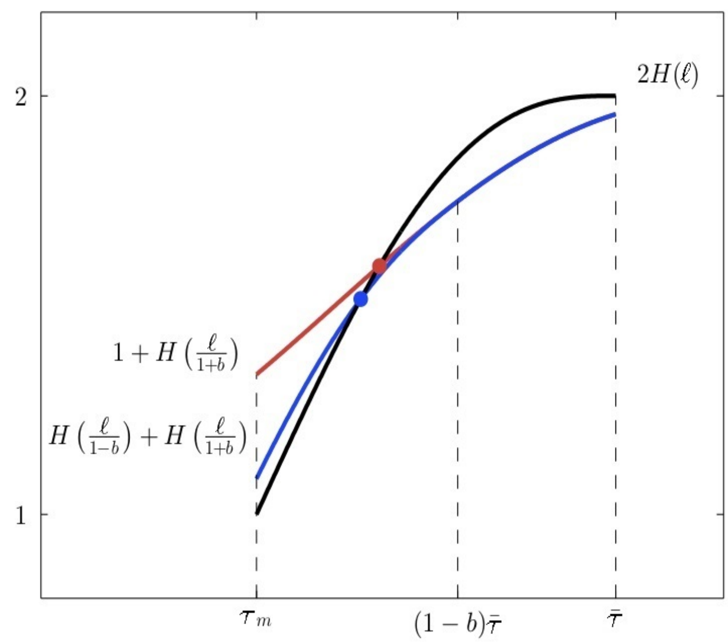

Figure 3: Illustration of Proposition 3

[42] The derivative of the function implicitly defined by equation (7) is given by

$$\frac{d\ell}{db} = \frac{h(\frac{\ell}{1-b})\frac{\ell}{(1-b)^2} - h\left(\frac{\ell}{1+b}\right)\frac{\ell}{(1+b)^2}}{2h(\ell) - \frac{h(\frac{\ell}{1-b})}{1-b} - \frac{h\left(\frac{\ell}{1+b}\right)}{1+b}}.$$

Assuming that $2H(\ell)$ intersects $H(l/(1-b)) + H(\ell/(1+b))$ from below, the denominator in this expression will be positive. However, the sign of the numerator is ambiguous.

5 The impact of the override provision

The results of the previous section describe the optimal limit when overrides are possible. To understand the impact of allowing overrides, this section characterizes the optimal limit without overrides and compares the results.

With no overrides and limit ℓ, the politician will choose a tax ℓ if this is smaller than his preferred tax $(1+b)\tau$. Otherwise, he will choose his preferred tax. Thus his policy choice will be $\min\{\ell,(1+b)\tau\}$. As a result, the citizen's expected welfare will be given by

$$-\left(\int_{\underline{\tau}}^{\overline{\tau}} |\min\{\ell,(1+b)\tau\}-\tau|h(\tau)d\tau\right). \tag{9}$$

The limit design problem without overrides is then to choose a limit from the interval $[\underline{\tau},\overline{\tau}]$ to maximize this function.

To make this comparable with our earlier analysis, we can rewrite the problem as choosing a limit to maximize the objective function

$$V_N(\ell)=\int_{\max\{\underline{\tau},\frac{\ell}{1+b}\}}^{\ell}[(1+b)\tau-\ell]h(\tau)d\tau+\int_{\ell}^{\overline{\tau}}[\ell-(1-b)\tau]h(\tau)d\tau-\int_{\underline{\tau}}^{\overline{\tau}}b\tau h(\tau)d\tau. \tag{10}$$

As in the override case (see, in particular, (3)), the last term in (10) represents the welfare loss if the politician just chooses his preferred tax and the first two terms represent the surplus the citizen can claw back through the limit. The limit design problem is then to find the limit that maximizes the first two terms. Let ℓ_N^o denote the optimal limit without overrides and ℓ^o the optimal limit with overrides.

To understand the relationship between the problems with and without overrides, it is helpful to observe that

$$V_N(\ell)=V(\ell)-\int_{\min_+\{\overline{\tau},\frac{\ell}{1-b}\}}^{\overline{\tau}}[(1-b)\tau-\ell]h(\tau)d\tau, \tag{11}$$

where $V(\ell)$ is the objective function for the case with overrides defined in (3). This expression reflects the fact that the only benefit from overrides for the citizen comes when the citizen's preferred tax exceeds the limit and the politician's preferred tax $(1+b)\tau$ is smaller than the maximum tax the citizen will support $2\tau-\ell$. In this scenario, $(1-b)\tau$ is larger than ℓ and hence the second term on the right hand side of (11) will be positive. This scenario occurs with positive probability only if $(1+b)\overline{\tau}$ is smaller than $2\overline{\tau}-\ell$. If this condition is not satisfied, while overrides are used in equilibrium, they do not benefit the citizen, because the politician uses his agenda setting power to leave the citizen with the same utility as he would get from the limit (henceforth, his "limit utility").

Given that the citizen's expected welfare with no overrides can be no larger than that with overrides, if $V_N(\ell^o)$ is equal to $V(\ell^o)$, then it must be the case that the optimal limit with no overrides is equal to that with overrides. From (11), $V_N(\ell^o)$ will equal $V(\ell^o)$ if $(1+b)\overline{\tau}$ is greater than or equal to $2\overline{\tau} - \ell^o$ or equivalently if ℓ^o is greater than or equal to $(1-b)\overline{\tau}$. In this case, at the optimal limit with overrides, whenever the state τ exceeds ℓ^o and overrides are used, the politician exploits his agenda setting power to leave the citizen with his limit utility. Accordingly, the citizen obtains the exact same utility with an identical limit and no overrides. We record this important observation as:

Proposition 5 *If the optimal limit with overrides is greater than or equal to* $(1-b)\overline{\tau}$*, then the optimal limit without overrides is equal to that with overrides.*

Recall that Lemma 1 tells us that ℓ^o is always at least as big as τ_m. It therefore follows from Proposition 5, that there is no difference between the optimal limit with and without overrides if the politician's bias is greater than or equal to $(\overline{\tau} - \tau_m)/\overline{\tau}$. The optimal limit without overrides is then described by Propositions 1 and 2. This leaves the case when the politician's bias is smaller than $(\overline{\tau} - \tau_m)/\overline{\tau}$. Proposition 3 suggests that the optimal limit with overrides can be smaller than $(1-b)\overline{\tau}$, in which case the optimal limit without overrides will not necessarily equal that with overrides. In this case, it turns out that the optimal limit without overrides must satisfy equation (6). Thus, we have:

Proposition 6 *Without overrides, if the politician's bias b is greater than* $(\overline{\tau} - \tau_m)/\underline{\tau}$*, the optimal limit is* τ_m*. If the politician's bias is less than* $(\overline{\tau} - \tau_m)/\underline{\tau}$*, the optimal limit solves equation (6).*

Comparing Propositions 3 and 6, the optimal limit with overrides differs from that without when the former is smaller than $(1-b)\overline{\tau}$ and solves equation (7). Proposition 4 provides us with a sufficient condition for this to be the case. In this scenario, the optimal limit with overrides is *more stringent* than that without. To see why, consider that at any solution to equation (7) that is less than $(1-b)\overline{\tau}$, equation (6) will not be satisfied since $1 + H(\ell/(1+b)) - 2H(\ell)$ will be positive. By the logic of the proof to Proposition 3, equation (6) must have a solution at a higher tax level. This finding makes good sense intuitively, since imposing a more stringent limit will be less costly when it can be overridden and the politician's override proposal provides the citizen with more than his limit utility.

We can draw on the literature on the delegation problem to help us understand all these findings. Consider first Proposition 6. The literature tells us that the optimal limit without overrides will maximize the citizen's expected welfare given what he can infer about the state of nature from the fact that the politician is bound by the limit.[43] In the large bias case, the politician setting taxes at the limit provides no information about the state, since the politician would do this regardless. Accordingly, the limit is set to maximize the citizen's expected welfare with no additional information on the state. In the small bias case, the politician setting taxes at the limit provides the information that $(1+b)\tau$ is greater than ℓ. The optimal limit is set to maximize the citizen's expected welfare conditional on this information. Given the assumptions on preferences, this is the median of the posterior distribution. To see why, imagine decreasing the limit slightly. In states where τ is less than $\ell/(1+b)$, it would make no difference; in states where τ is between $\ell/(1+b)$ and ℓ, the voter would be made better off; while in states where τ exceeds ℓ, the voter would be made worse off. The optimal limit will equate the probability of the latter two events. If $\hat{\tau}$ is the median of this range, it is defined by $2H(\hat{\tau}) = 1 + H(\ell/(1+b))$. Equation (6) defines the solution at which ℓ equals $\hat{\tau}$.

Turning to Propositions 1 and 2, the logic underlying Proposition 6 continues to apply despite the fact that there are overrides because the agenda setting power of the politician leaves the citizen with his limit utility. The case covered by Proposition 3 is more interesting.In this case, when the optimal limit is smaller than $(1-b)\overline{\tau}$, the politician may not set taxes such that the citizen receives his limit utility when an override occurs. Thus, the fact that the politician sets taxes such that the citizen receives his limit utility provides more information about the state. Specifically, $(1+b)\tau$ is greater than ℓ but less than $2\tau - \ell$. Again, the optimal limit is at the tax level that, conditional on this information, the citizen would prefer, which is the median of the posterior distribution. Equation (7) defines the solution where the median is the limit. The same intuition that explains the optimal limit without overrides, therefore explains the optimal limit with overrides, even when they differ.

[43] Holmstrom (1984) shows this for an example with quadratic distance preferences and Kartik, Van Weelden, and Wolton (2015) make a similar intuitive description of the result for interval delegation sets.

6 Examples

This section presents three examples involving different distributions of the citizen's preferred tax. These examples are used to illustrate how the optimal limit with overrides depends on the politician's bias and the extent of uncertainty in the citizen's preferred tax. They are also used to shed light on the key issue of how the optimal limit with overrides differs from that without.

6.1 Uniform distribution

Suppose that the distribution of the citizen's preferred tax is uniform; i.e., $H(\tau)$ equals $(\tau - \underline{\tau}) / (\overline{\tau} - \underline{\tau})$. Then, when the politician's bias b is greater than 0 but less than $(\tau_m - \underline{\tau}) / \underline{\tau}$, the optimal limit with or without overrides is

$$\ell^o(b) = \ell_N^o(b) = \overline{\tau}\left(\frac{1+b}{1+2b}\right). \tag{12}$$

To see this, note first that equation (7) has no solution in the uniform case unless $b = 0$.[44] It therefore follows from Proposition 2 and 3 that the optimal limit with overrides must satisfy equation (6) and solving this equation yields (12). From (12), note that this limit is greater than $(1-b)\overline{\tau}$. It therefore follows from Proposition 5 that the optimal limit without overrides is also equal to (12).[45] Intuitively, while overrides occur under the optimal limit, the politician's proposal is always such as to leave the citizen with his limit utility.

Equation (12) implies that as b approaches 0, the limit converges to $\overline{\tau}$ and so the politician is completely unconstrained in the limit. Without overrides, this is natural, because the politician is becoming a perfect agent for the citizen and there is little gain from constraining him. With overrides, the limit is irrelevant when the politician is a perfect agent of the citizen and therefore it is not clear to what point the limit will converge. Thus, the result is a little more surprising.

Note also from (12) that the limit gets progressively tighter as we increase b, until the point at which b equals $(\tau_m - \underline{\tau}) / \underline{\tau}$ and the limit equals the expected preferred tax, τ_m. Further increases in bias have no impact on the limit beyond this point. Figure 4 illustrates the optimal limit as a function of b for the case in which $(\underline{\tau}, \overline{\tau})$ equals $(0.1, 0.3)$. The solution is the curve that takes on the value of 0.3 when b is equal to 0 and equals 0.2 for b greater than 0.1.

To understand the impact of changing the distribution of preferred tax levels, it is instructive to consider a parameterization in which $(\underline{\tau}, \overline{\tau})$ equals $(\eta - z, \eta + z)$. As we increase z, we hold

[44] For equation (7) to be satisfied $H(\ell) - H(\ell/(1+b))$ must equal $H(\ell/(1-b)) - H(\ell)$. In the uniform case, this is not possible since $\ell - \ell/(1+b)$ cannot be equal to $\ell/(1-b) - \ell$, unless $b = 0$.

[45] This also follows directly from Proposition 6.

constant the citizen's expected preferred level but increase the dispersion. We therefore implement a mean preserving spread. Propositions 1 and 5, and (12) tell us that the optimal limit with and without overrides is

$$\ell^o(b) = \ell^o_N(b) = \begin{cases} \frac{(\eta+z)(1+b)}{1+2b} & \text{if } b \in [0, \frac{2z}{2(\eta-z)}] \\ \eta & \text{if } b > \frac{2z}{2(\eta-z)} \end{cases}. \tag{13}$$

These limits are illustrated in Figure 4 for η equal to 0.2 and various values of z. The main point to take away is that with a mean preserving spread, the limit becomes more permissive when the bias of the politician is not too large.

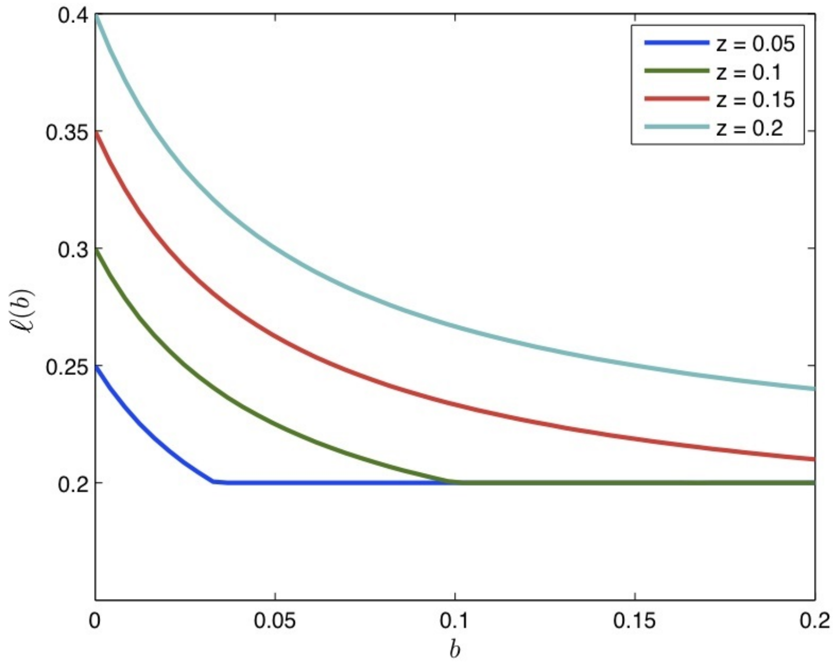

Figure 4: Optimal Limits for the Uniform Distribution

6.2 Tent distribution

Suppose that the distribution of the citizen's preferred tax is a tent distribution; i.e.,

$$H(\tau) = \begin{cases} \frac{(\tau-\underline{\tau})^2}{2(\tau_m-\underline{\tau})^2} & \text{if } \tau \in [\underline{\tau}, \tau_m] \\ \frac{1}{2} + \frac{(\tau-\tau_m)[2\overline{\tau}-(\tau+\tau_m)]}{2(\tau_m-\underline{\tau})^2} & \text{if } \tau \in [\tau_m, \overline{\tau}] \end{cases}. \tag{14}$$

The density associated with this distribution rises linearly from 0 to $1/(\tau_m - \underline{\tau})$ over the interval $[\underline{\tau}, \tau_m]$ and comes back down the other side. Despite its simplicity, this case turns out to be very complicated. Thus, to simplify and permit comparison with the uniform case, we set $(\underline{\tau}, \overline{\tau})$ equal to $(0.1, 0.3)$.

With overrides, for levels of bias less than 0.3 the optimal limit solves equation (7).[46] For higher levels of bias, the optimal limit solves (6). Solving the appropriate quadratic equations reveals that the optimal limit is

$$\ell^o(b) = \begin{cases} \frac{12+\frac{2}{1+b}-\frac{6}{1-b}-\sqrt{\left(12+\frac{2}{1+b}-\frac{6}{1-b}\right)^2-32\left(2+\frac{1}{(1+b)^2}-\frac{1}{(1-b)^2}\right)}}{20\left(2+\frac{1}{(1+b)^2}-\frac{1}{(1-b)^2}\right)} & \text{if } b \in (0, 0.3) \\ \frac{\frac{2}{1+b}+12-\sqrt{8+\frac{48}{1+b}-\frac{64}{(1+b)^2}}}{40+\frac{20}{(1+b)^2}} & \text{if } b \in (0.3, 1) \end{cases}. \tag{15}$$

Without overrides, Proposition 6 tells us that the optimal limit solves equation (6) for bias levels less than 1. Accordingly, when bias is larger than 0.3 the optimal limit is the same with or without overrides, but when it is less than 0.3 they diverge. Solving the implied quadratic equation reveals that

$$\ell^o_N(b) = \begin{cases} \frac{\frac{30}{1+b}-60+\frac{30\sqrt{2}b}{1+b}}{100\left(\frac{1}{(1+b)^2}-2\right)} & \text{if } b \in (0, \frac{1}{4}(2-\sqrt{2})) \\ \frac{\frac{2}{1+b}+12-\sqrt{8+\frac{48}{1+b}-\frac{64}{(1+b)^2}}}{40+\frac{20}{(1+b)^2}} & \text{if } b \in (\frac{1}{4}(2-\sqrt{2}), 1) \end{cases}. \tag{16}$$

The optimal limits are graphed in Figure 5. The optimal limit with overrides is the solid green curve, the higher of the two curves that take on the value 0.2 when b is equal to 0. The optimal limit without overrides is the dotted green curve that diverges from the solid curve when b is equal to 0.3. Without overrides, the limit is qualitatively similar to that under the uniform distribution, the limit converges to $\overline{\tau}$ as b approaches zero and equals τ_m when b exceeds 1/3. With overrides, the limit does not converge to $\overline{\tau}$ as b approaches zero. In fact, the optimal limit does not necessarily become more permissive as the politician becomes less biased. To the contrary, it becomes more stringent over some part of the range! This illustrates the theoretical ambiguity we noted earlier when equation (7) determines the optimal limit.

The behavior of the optimal limit with overrides as a function of bias turns out to depend on the range of the distribution. Figure 5 illustrates the optimal limits, with and without overrides, for the cases in which $(\underline{\tau}, \overline{\tau})$ equals $(0.2 - z, 0.2 + z)$ for various values of z. When the distribution

[46] The sufficient condition provided in Proposition 4 holds when bias is less than 0.2. However, the limits diverge when bias is below 0.3, illustrating that the condition is not necessary. When bias is below 0.3, the more permissive condition discussed in footnote 41 on page 19 is satisfied, which is sufficient in this case because equation (7) has only one solution over the range $[\tau_m, \overline{\tau}]$.

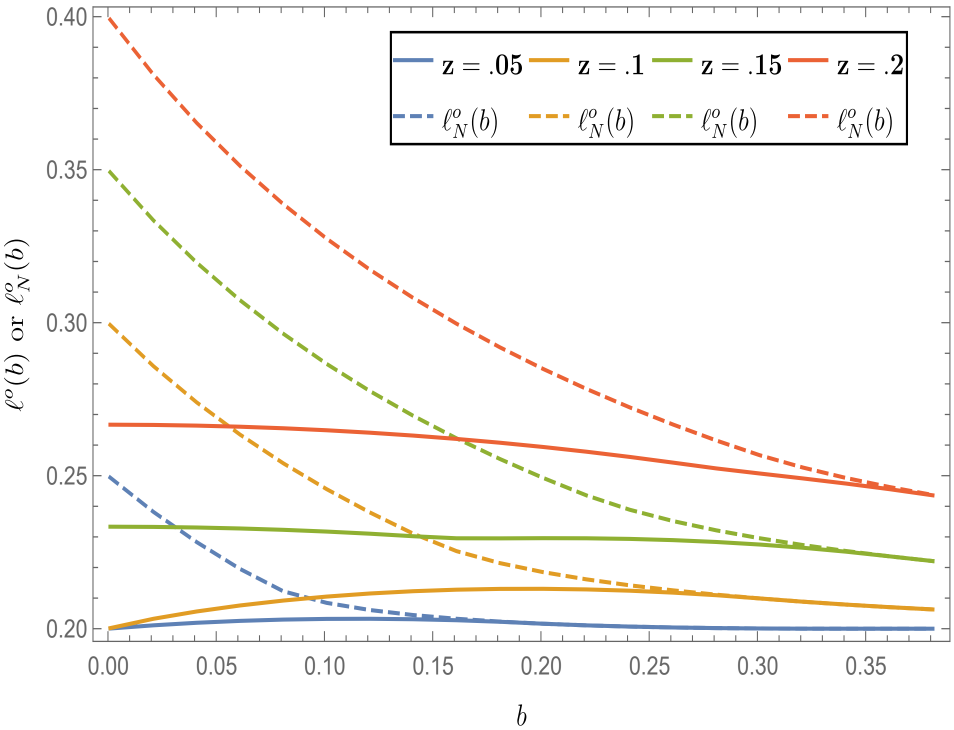

Figure 5: Optimal Limits for the Tent Distribution

is sufficiently spread, the optimal limit with overrides is decreasing in b over the relevant range.[47]

For distributions with z larger than 0.1, the optimal limit no longer converges to τ_m as b approaches zero, but neither does it converge to $\overline{\tau}$. Moreover, while the optimal limit without overrides is relaxed at an increasing rate as bias falls, this is not the case with overrides.

One important lesson from the uniform case does remain. With and without overrides, a mean preserving spread results in the optimal limit becoming more permissive when the bias of the politician is not too large.

6.3 Symmetric Beta distribution

Suppose that $[\underline{\tau}, \overline{\tau}]$ equals $[0, 0.2]$ and that the distribution of the preferred level is a symmetric Beta distribution

$$H(\tau; v) = \frac{\int_0^{\tau} x^{v-1}(0.2-x)^{v-1}dx}{\int_0^{0.2} x^{v-1}(0.2-x)^{v-1}dx}, \tag{17}$$

[47] Using the expression for the derivative given in footnote 40 on page 20, we can see that for $z < 0.19$, the optimal limit is increasing in b at some values of b.

for v greater than or equal to 1. Recall that when v equals 1 this distribution is just the uniform distribution and when v equals 2 it is the parabolic distribution. As we continue to increase v, probability mass becomes more and more concentrated around the mean 0.1.

Figure 8 graphs the optimal limits as a function of b for various values of v.[48] There are two general points that apply to the with and without overrides cases. First, for given v, the optimal limit is decreasing and approaches the expected preferred tax 0.1. It does not quite reach this level because $\underline{\tau}$ equals 0 and so b is never greater than $(\overline{\tau} - \tau_m)/\underline{\tau}$. Second, for given b, as v becomes higher, the optimal limits become smaller. Thus, less discretion is provided to the politician as uncertainty is reduced. This is consistent with the findings from the two previous examples, because a move from a symmetric Beta distribution with a higher to a lower v amounts to implementing a mean preserving spread.

Comparing the optimal limits with and without overrides, it is only in the uniform case that the two coincide. In all other cases, the limit with overrides is more stringent at low levels of bias.[49] Moreover, while both limits are relaxed as bias falls, it is only the limit without overrides that is relaxed at an increasing rate. As in the tent case, the optimal limit with overrides does not approach $\overline{\tau}$ as b approaches zero, except in the uniform case.

6.4 Discussion

There are three main points to take away from these examples. First, the optimal limit with overrides does differ from that without. It is only in the case of the uniform distribution, that the two limits coincide. In the two other examples, the limits differ significantly over a large range of the parameter space. Differences occur for low levels of bias, and when they do, the limit without overrides is less stringent than that with.

Second, as we increase the uncertainty in the citizen's preferred level, the optimal limit with overrides becomes more permissive at least for bias levels that are not too large. This is also true for the case without overrides and related comparative static findings are highlighted in a number of papers in the literature on the delegation problem. Indeed, Huber and Shipan (2006) refer to the idea that the optimal permissible set of actions for the agent is increased when the principal faces more uncertainty as the *Uncertainty Principle*. It is note-worthy that this principle continues

[48] Closed form solutions are not available for this case, so the optimal limits are obtained numerically.

[49] For v equal to 2 or more, the sufficient condition given by Proposition 4 holds for some ranges of bias. For example, with v equal to 3, the condition holds when bias is less than 0.253. Note, however, that the optimal limit with overrides differs from that without, when bias is less than 0.398, again illustrating that the condition is a long way from necessary.

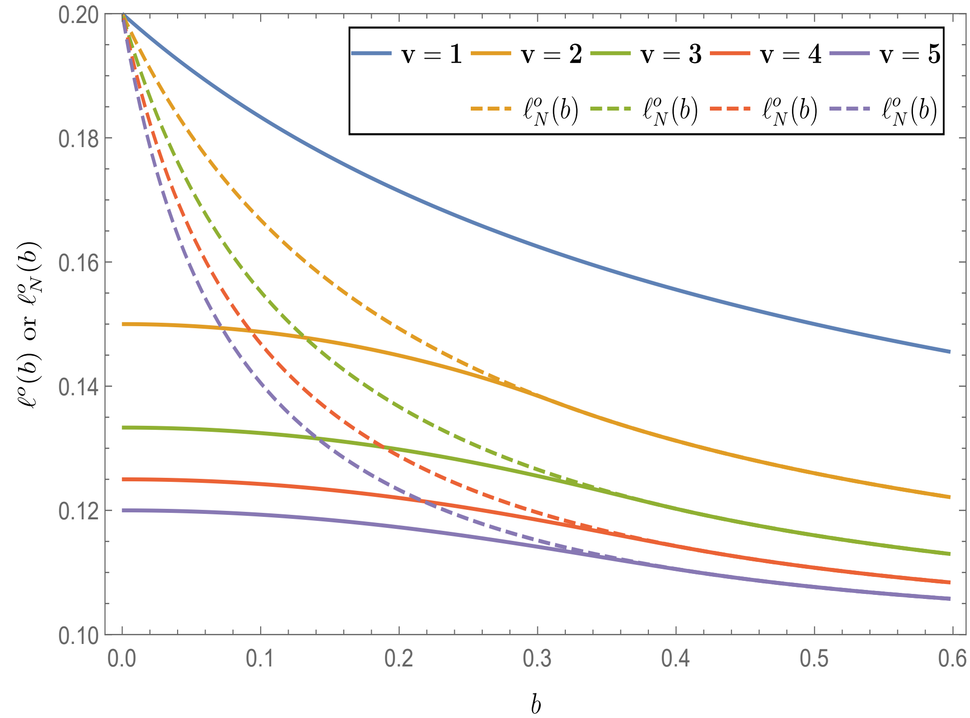

Figure 6: Optimal Limits for the Beta Distribution

to hold even though the agent can opt out of the permissible set of actions with the principal's approval.

Third, as we reduce the politician's bias it is not always the case that the optimal limit with overrides becomes more permissive. This contrasts with findings in the literature on the delegation problem which show that the optimal permissible set of actions for the agent is increased when bias is reduced (the so-called *Ally Principle*). Moreover, even when the optimal limit is relaxed when bias falls, overrides impact the way in which the limit changes: without overrides the optimal limit is relaxed at an increasing rate, while that with overrides is relaxed at a decreasing rate.

7 Conclusion

Fiscal limits are commonplace in state and local government in the US. It is therefore important to understand how they should be designed. The contract theory literature on the delegation problem is a natural place to look for guidance. However, this literature ignores a key feature of how limits are structured in reality: namely, the possibility of overrides. As we have shown, overrides are not only possible in principle, but are widely used in practice. Accordingly, this paper has studied the optimal design of fiscal limits in a model that extends the standard framework of the delegation problem to incorporate the possibility of overrides.

The analysis of the model sheds light on how the optimal limit depends on the possibility of overrides, the level of bias towards larger government in the political system, and the nature of uncertainty concerning citizens' policy preferences. When the level of bias is high, the optimal limit is the same with or without overrides and equals the level of spending or taxation the representative citizen expects to desire. For smaller levels of bias, more permissive limits are optimal and the optimal limit with overrides can differ from that without. A necessary condition for a difference to emerge is that override proposals leave citizens with some benefits relative to their payoffs from the limit level of the policy. When there is a difference, optimal limits with overrides are more stringent than those without. In addition, the way in which the optimal limit responds to changes in bias is impacted. Most notably, with overrides, it is not necessarily the case that the optimal limit becomes more permissive as the level of bias falls. This will depend on the distribution of preferred tax levels. Our examples suggest that, for low bias levels, more uncertainty in the citizen's preferred policy level results in a more permissive limit.

There is considerable scope for further work on the practically important and theoretically interesting problem of designing fiscal limits. Extensions of the model readily suggest themselves.

It would be interesting to go beyond the simple preferences assumed here by, for example, introducing convexity into the citizen's loss function. We could then understand how greater convexity influences the permissiveness of the limit. Relaxing the assumptions on the distribution of preferred tax levels may also prove instructive. Richer uncertainty in the degree of politician bias could also be introduced. Finally, recognizing that it is costly to hold an override election might yield interesting results.

In addition, there are interesting questions that a static model like that presented here cannot answer. Most fundamentally, how should the limit evolve from one period to the next? Current limits differ in at least two ways. First, some limits are based on the previous year's policy while others are based on the previous year's limit. How does this difference affect the behavior of politicians and the optimal limit? Second, some limits allow politicians to propose both temporary and permanent increases in their limit. How does this additional choice effect the citizen's welfare?

Beyond these extensions, considering optimal limits in a legislative setting would be interesting. In such a setting, taxation is determined by the collective decisions of legislators rather than the decision of a single politician. Consistent with practice, it would be natural to consider override provisions which allow the limit to be overridden by a super-majority of legislators rather than by direct appeal to the citizens. Continually undertaking referenda is likely to prove administratively costly and it may be that the same function can be achieved by appropriate choice of super-majority override.

Of course, even if all these extensions were undertaken, the analysis would only provide insight into what limits should depend on *in principle*. Moving in the direction of being able to say what limits should be in concrete situations would require effort in two directions. First, developing models like the ones presented here into credible models for thinking about limits empirically. This requires developing models whose testable implications are consistent with the data. Second, with such models in hand, trying to measure the key determinants of the optimal limit. For example, how could we measure the extent of politicians' bias and the nature of uncertainty in citizens' preferred tax levels?

References

Alonso, Ricardo and Niko Matouschek, 2008, "Optimal Delegation," *Review of Economic Studies*, 75(1), 259-293.

Amador, Manuel and Kyle Bagwell, 2013, "The Theory of Optimal Delegation with an Application to Tariff Caps," *Econometrica*, 81(4), 1541-1599.

Amador, Manuel, Werning, Ivan and George-Marios Angeletos, 2006, "Commitment vs. Flexibility," *Econometrica*, 74(2), 365-396.

Azzimonti, Marina, Battaglini, Marco and Stephen Coate, 2016, "The Costs and Benefits of Balanced Budget Rules: Lessons from a Political Economy Model of Fiscal Policy," *Journal of Public Economics*, 136, 45-61.

Besley, Timothy and Stephen Coate, 2001, "Lobbying and Welfare in a Representative Democracy," *Review of Economic Studies*, 68(1), 67-82.

Besley, Timothy and Michael Smart, 2007, "Fiscal Restraints and Voter Welfare," *Journal of Public Economics*, 91(3-4), 755-773.

Bradbury, Katherine and Helen Ladd, 1982. Proposition $2\frac{1}{2}$: initial impacts Part 1, *New England Economic Review*, 14(1), 13-24

Bradbury, Katherine, Mayer, Christopher and Karl Case, 2001, "Property Tax Limits, Local Fiscal Behavior, and Property Values: Evidence from Massachusetts under Proposition 2 1/2," *Journal of Public Economics*, 80, 287-311.

Brennan, Geoffrey and James Buchanan, 1979, "The Logic of Tax Limits: Alternative Constitutional Constraints on the Power to Tax," *National Tax Journal*, 32(2), 11-22.

Brennan, Geoffrey and James Buchanan, 1980, *The Power to Tax: Analytical Foundations of a Fiscal Constitution,* Cambridge University Press: Cambridge, UK.

Brooks, Leah, Halberstam, Yosh and Justin Phillips, 2016, "Spending within Limits: Evidence from Municipal Fiscal Restraints," *National Tax Journal*, 69, 315-352.

Calabrese, Stephen and Dennis Epple, 2011, "On the Political Economy of Tax Limits," Carnegie Mellon University Working Paper.

Citrin, Jack, 1979, "Do People Want Something for Nothing: Public Opinion on Taxes and Spending," *National Tax Journal*, 32(2), 113-129.

Coate, Stephen and Brian Knight, 2011, "Government Form and Public Spending: Theory and Evidence from U.S. Muncipalities," *American Economic Journal: Economic Policy,* 3(3), 82-112.

Courant, Paul, Gramlich, Edward and Daniel Rubinfeld, 1985, "Why Voters Support Tax Limitations: the Michigan Case," *National Tax Journal*, 38(1), 1-20.

Cutler, David, Elmendorf, Douglas and Richard Zeckhauser, 1999, "Restraining the Leviathan: Property Tax Limitation in Massachusetts," *Journal of Public Economics*, 71(3), 313-334.

Dye, Richard and Therese McGuire, 1997, "The Effect of Property Tax Limitation Measures on Local Government Fiscal Behavior," *Journal of Public Economics*, 66(3), 469-487.

Epstein, David and Sharyn O'Halloran, 1994, "Administrative Procedures, Information, and Agency Discretion," *American Journal of Political Science*, 38(3), 697-722.

Figlio, David and Kim Rueben, 2001, "Tax Limits and Qualifications of New Teachers," *Journal of Public Economics*, 80(1), 49-71.

Gilligan, Thomas and Keith Krehbiel, 1987, "Collective Decision-Making and Standing Committees: An Informational Rationale for Restrictive Amendment Procedures," *Journal of Law, Economics, and Organization*, 3(2), 287-335.

Gilligan, Thomas and Keith Krehbiel, 1989, "Asymmetric Information and Legislative Rules with a Heterogeneous Committee," *American Journal of Political Science*, 33(2), 459–490.

Grossman, Gene and Elhanan Helpman, 1994, "Protection for Sale," *American Economic Review*, 84(4), 833-850.

Halac, Marina and Pierre Yared, 2014, "Fiscal Rules and Discretion under Persistent Shocks," *Econometrica*, 82(5), 1557-1614.

Hamilton, Howard and Sylvan Cohen, 1974, *Policy Making by Plebiscite: School Referenda,* Lexington Books: Lexington, MA.

Holmstrom, Bengt, 1977, "On Incentives and Control in Organizations," Ph.D. Thesis, Stanford University.

Holmstrom, Bengt, 1984, "On the Theory of Delegation," in Boyer, Marcel and Richard Kihlstrom (eds), *Bayesian Models in Economic Theory*, North Holland: New York, NY.

Huber, John and Charles Shipan, 2006, "Politics, Delegation, and Bureaucracy," in Weingast, Barry and Donald Wittman (eds), *The Oxford Handbook of Political Economy*, Oxford University Press: Oxford, UK.

Kartik, Navin, Van Weelden, Richard and Stephane Wolton, 2015, "Electoral Ambiguity and Political Representation," London School of Economics and Political Science Working Paper.

Knight, Brian, 2000, "Supermajority Voting Requirements for Tax Increases: Evidence from the States," *Journal of Public Economics*, 78(1), 41-67.

Krishna, Vijay and John Morgan, 2001, "Asymmetric Information and Legislative Rules with a Heterogeneous Committee," *American Journal of Political Science*, 33(2), 459-460.

Krol, Robert, 2007, "The Role of Fiscal and Political Institutions in Limiting the Size of State Government," *Cato Journal*, 27(3), 431-445.

Ladd, Helen and Julie Wilson, 1982, "Why Voters Support Tax Limitations: Evidence from Massachusetts' Proposition 2 1/2," *National Tax Journal* 35(2), 121-148.

Lincoln Institute of Land Policy, 2016, "Significant Features of the Property Tax".

Melumad, Nahum and Toshiyaki Shibano, 1991, "Communication in Settings with no Transfers," *Rand Journal of Economics*, 22(2), 173-198.

Milyo, Jeffrey, 2000, "A Problem with Euclidean Preferences in Spatial Models of Politics," *Economics Letters*, 66, 179-182.

Mullins, Daniel, 2003, "Popular Processes and the Transformation of State and Local Government Finance " in Sjoquist, David (ed), *State and Local Finance Under Pressure*, Edward Elgar: Northampton, MA.

Mullins, Daniel, 2010, "Fiscal Limitations on Local Choice: the Imposition and Effects of Local Government Tax and Expenditure Limitations," in Wallace, Sally (ed), *State and Local Fiscal Policy: Thinking Outside the Box?*, Edward Elgar: Northampton, MA.

Mullins, Daniel and Bruce Wallin, 2004, "Tax and Expenditure Limitations: Introduction and Overview," *Public Budgeting and Finance*, 24, 1-43.

Mylovanov, Tymofiy, 2008, "Veto-based Delegation," *Journal of Economic Theory*, 138, 297-307.

Poterba, James, 1994, "State Responses to Fiscal Crises: The Effects of Budgetary Institutions and Politics," *Journal of Political Economy*, 102(4), 799-821.

Poterba, James and Kim Rueben, 1995, "The Effect of Property-Tax Limits on Wages and Employment in the Local Public Sector," *American Economic Review*, 85(2), 384-389.

Poterba, James and Kim Rueben, 2001, "Fiscal News, State Budget Rules, and Tax-Exempt Bond Yields," *Journal of Urban Economics*, 50(3), 537-562.

Romer, Thomas and Howard Rosenthal, 1978, "Political Resource Allocation, Controlled Agendas, and the Status Quo," *Public Choice*, 33, 27-43.

Romer, Thomas and Howard Rosenthal, 1979, "Bureacrats versus Voters: On the Political Economy of Resource Allocation by Direct Democracy," *Quarterly Journal of Economics*, 93, 563-587.

Rose, Shanna, 2010, "Institutions and Fiscal Sustainability," *National Tax Journal*, 63(4), 807-838.

Urban Institute-Brookings Institution Tax Policy Center, 2016, "Local Property Taxes as a Percentage of Local Tax Revenue".

Vigdor, Jacob, 2004, "Other People's Taxes: Nonresident Voters and Statewide Limitation of Local Government," *Journal of Law and Economics*, 47(2), 453-476.

Waisanen, Bert, 2010, "State Tax and Expenditure Limits - 2010," National Conference of State Legislatures Research Paper.

8 Appendix

8.1 Proof of Proposition 1

We need to show that $V(\tau_m)$ exceeds $V(\ell)$ for any limit ℓ in the range $[\underline{\tau}, \tau_m)$ or $(\tau_m, \overline{\tau}]$. Since b exceeds $(\overline{\tau} - \tau_m)/\underline{\tau}$, $\ell/(1+b)$ is less than $\underline{\tau}$ for any limit ℓ in the range $[\underline{\tau}, \tau_m]$ and, if b is less than 1, $\ell/(1-b)$ exceeds $\overline{\tau}$ for any limit ℓ in the range $[\tau_m, \overline{\tau}]$. Thus, from (3), we have that

$$V(\tau_m) = \int_{\underline{\tau}}^{\tau_m} [(1+b)\tau - \tau_m]\, h(\tau)d\tau + \int_{\tau_m}^{\overline{\tau}} [\tau_m - (1-b)\tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau. \tag{18}$$

Recall from the analysis in the text, that we know already that for any ℓ in the range $[\underline{\tau}, \tau_m)$ or $(\tau_m, \overline{\tau}]$ we have that

$$V(\tau_m) > \int_{\underline{\tau}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} [\ell - (1-b)\tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau. \tag{19}$$

Consider a limit ℓ in the range $[\underline{\tau}, \tau_m)$. If b exceeds 1 or if $\ell/(1-b)$ exceeds $\overline{\tau}$, then from (3), $V(\ell)$ is equal to the right hand side of (19) and thus the desired inequality holds. If $\ell/(1-b)$ is less than $\overline{\tau}$, then from (3), we have that

$$V(\ell) = \int_{\underline{\tau}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau + \int_{\ell}^{\frac{\ell}{1-b}} [\ell - (1-b)\tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau. \tag{20}$$

From (18) and (20), we have that

$$\begin{aligned} V(\tau_m) - V(\ell) \quad = \quad & \int_{\underline{\tau}}^{\tau_m} [(1+b)\tau - \tau_m]\, h(\tau)d\tau + \int_{\tau_m}^{\overline{\tau}} [\tau_m - (1-b)\tau]\, h(\tau)d\tau \\ & - \int_{\underline{\tau}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau - \int_{\ell}^{\frac{\ell}{1-b}} [\ell - (1-b)\tau]\, h(\tau)d\tau. \end{aligned}$$

We can write this difference as

$$\begin{aligned} V(\tau_m) - V(\ell) \quad = \quad & \int_{\underline{\tau}}^{\ell} [(1+b)\tau - \tau_m]\, h(\tau)d\tau + \int_{\ell}^{\tau_m} [(1+b)\tau - \tau_m]\, h(\tau)d\tau + \\ & \int_{\tau_m}^{\frac{\ell}{1-b}} [\tau_m - (1-b)\tau]\, h(\tau)d\tau + \int_{\frac{\ell}{1-b}}^{\overline{\tau}} [\tau_m - (1-b)\tau]\, h(\tau)d\tau \\ & - \int_{\underline{\tau}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau - \int_{\ell}^{\frac{\ell}{1-b}} [\ell - (1-b)\tau]\, h(\tau)d\tau, \end{aligned}$$

which simplifies to

$$\begin{aligned} V(\tau_m) - V(\ell) \quad = \quad & \int_{\underline{\tau}}^{\ell} [\ell - \tau_m]\, h(\tau)d\tau + \int_{\ell}^{\tau_m} [2\tau - (\tau_m + \ell)]\, h(\tau)d\tau + \\ & \int_{\tau_m}^{\frac{\ell}{1-b}} [\tau_m - \ell]\, h(\tau)d\tau + \int_{\frac{\ell}{1-b}}^{\overline{\tau}} [\tau_m - (1-b)\tau]\, h(\tau)d\tau. \end{aligned}$$

This in turn can be rewritten as

$$\begin{aligned} V(\tau_m) - V(\ell) \quad &= \quad \int_{\underline{\tau}}^{\tau_m} [\ell - \tau_m]\, h(\tau)d\tau + \int_{\ell}^{\tau_m} [2\tau - (\tau_m + \ell) - \ell + \tau_m]\, h(\tau)d\tau + \\ &\quad \int_{\tau_m}^{\overline{\tau}} [\tau_m - \ell]\, h(\tau)d\tau + \int_{\frac{\ell}{1-b}}^{\overline{\tau}} [\tau_m - (1-b)\tau - \tau_m + \ell]\, h(\tau)d\tau, \end{aligned}$$

which simplifies to

$$V(\tau_m) - V(\ell) = 2\int_{\ell}^{\tau_m} [\tau - \ell]\, h(\tau)d\tau - \int_{\frac{\ell}{1-b}}^{\overline{\tau}} [(1-b)\tau - \ell]\, h(\tau)d\tau.$$

Thus, we need to show that

$$2\int_{\ell}^{\tau_m} [\tau - \ell]\, h(\tau)d\tau > \int_{\frac{\ell}{1-b}}^{\overline{\tau}} [(1-b)\tau - \ell]\, h(\tau)d\tau.$$

Because $h(\tau)$ is non-decreasing on $[\ell, \tau_m]$, we know that

$$2\int_{\ell}^{\tau_m} [\tau - \ell]\, h(\tau)d\tau \geq 2\left[\frac{\tau_m + \ell}{2} - \ell\right] \int_{\ell}^{\tau_m} h(\tau)d\tau = (\tau_m - \ell)\int_{\ell}^{\tau_m} h(\tau)d\tau.$$

Similarly, because $h(\tau)$ is non-increasing on $[\frac{\ell}{1-b}, \overline{\tau}]$, we know that

$$\int_{\frac{\ell}{1-b}}^{\overline{\tau}} [(1-b)\tau - \ell]\, h(\tau)d\tau \leq \left[(1-b)\left(\frac{\overline{\tau} + \frac{\ell}{1-b}}{2}\right) - \ell\right] \int_{\frac{\ell}{1-b}}^{\overline{\tau}} h(\tau)d\tau = \left(\frac{(1-b)\overline{\tau} - \ell}{2}\right)\int_{\frac{\ell}{1-b}}^{\overline{\tau}} h(\tau)d\tau.$$

Since $\tau_m \geq (1-b)\overline{\tau}$, it therefore suffices to show that

$$\int_{\ell}^{\tau_m} h(\tau)d\tau \geq \int_{\frac{\ell}{1-b}}^{\overline{\tau}} h(\tau)d\tau.$$

Given the assumed properties of h, a sufficient condition for this is that

$$\tau_m - \ell \geq \overline{\tau} - \frac{\ell}{1-b} \Leftrightarrow \frac{b\ell}{1-b} > \overline{\tau} - \tau_m.$$

But we know that

$$\frac{b\ell}{1-b} \geq \frac{b\underline{\tau}}{1-b} \geq \frac{(\overline{\tau} - \tau_m)}{1-b} > \overline{\tau} - \tau_m.$$

Now consider a limit ℓ in the range $(\tau_m, \overline{\tau}]$. If $\ell/(1+b)$ is less than $\underline{\tau}$, then from (3), $V(\ell)$ is equal to the right hand side of (19) and thus the desired inequality holds. If $\ell/(1+b)$ exceeds $\underline{\tau}$, then from (3), we have that

$$V(\ell) = \int_{\frac{\ell}{1+b}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} [\ell - (1-b)\tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau. \qquad (21)$$

Note that $\ell/(1+b) < \tau_m$ and thus using (18) and (21) we can write

$$\begin{aligned} V(\tau_m) - V(\ell) &= \int_{\underline{\tau}}^{\frac{\ell}{1+b}} [(1+b)\tau - \tau_m]\, h(\tau)d\tau + \int_{\frac{\ell}{1+b}}^{\tau_m} [(1+b)\tau - \tau_m]\, h(\tau)d\tau \\ &+ \int_{\tau_m}^{\ell} [\tau_m - (1-b)\tau]\, h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} [\tau_m - (1-b)\tau]\, h(\tau)d\tau \\ &- \int_{\frac{\ell}{1+b}}^{\tau_m} [(1+b)\tau - \ell]\, h(\tau)d\tau - \int_{\tau_m}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau - \int_{\ell}^{\overline{\tau}} [\ell - (1-b)\tau]\, h(\tau)d\tau. \end{aligned}$$

This equals

$$\begin{aligned} V(\tau_m) - V(\ell) &= \int_{\underline{\tau}}^{\frac{\ell}{1+b}} [(1+b)\tau - \tau_m]\, h(\tau)d\tau + \int_{\frac{\ell}{1+b}}^{\tau_m} [\ell - \tau_m]\, h(\tau)d\tau + \int_{\tau_m}^{\ell} [\tau_m + \ell - 2\tau]\, h(\tau)d\tau \\ &+ \int_{\ell}^{\overline{\tau}} [\tau_m - \ell]\, h(\tau)d\tau, \end{aligned}$$

which simplifies to

$$V(\tau_m) - V(\ell) = 2\int_{\tau_m}^{\ell} [\ell - \tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\frac{\ell}{1+b}} [\ell - (1+b)\tau]\, h(\tau)d\tau.$$

This is the difference illustrated in Panel D of Figure 1. Thus, we need to show that

$$2\int_{\tau_m}^{\ell} [\ell - \tau]\, h(\tau)d\tau > \int_{\underline{\tau}}^{\frac{\ell}{1+b}} [\ell - (1+b)\tau]\, h(\tau)d\tau.$$

Because $h(\tau)$ is non-increasing on $[\tau_m, \ell]$, we know that

$$2\int_{\tau_m}^{\ell} [\ell - \tau]\, h(\tau)d\tau \geq 2\left[\frac{\ell + \tau_m}{2} - \tau_m\right] \int_{\tau_m}^{\ell} h(\tau)d\tau = [\ell - \tau_m] \int_{\tau_m}^{\ell} h(\tau)d\tau.$$

Similarly, because $h(\tau)$ is non-decreasing on $[\underline{\tau}, \frac{\ell}{1+b}]$, we know that

$$\int_{\underline{\tau}}^{\frac{\ell}{1+b}} [\ell - (1+b)\tau]\, h(\tau)d\tau \leq \left[\ell - (1+b)\left(\frac{\frac{\ell}{1+b} + \underline{\tau}}{2}\right)\right] \int_{\underline{\tau}}^{\frac{\ell}{1+b}} h(\tau)d\tau = \left(\frac{\ell - (1+b)\underline{\tau}}{2}\right) \int_{\underline{\tau}}^{\frac{\ell}{1+b}} h(\tau)d\tau.$$

We know that $\tau_m \leq (1+b)\underline{\tau}$, so it suffices to show that

$$\int_{\tau_m}^{\ell} h(\tau)d\tau \geq \int_{\underline{\tau}}^{\frac{\ell}{1+b}} h(\tau)d\tau.$$

Given the assumed properties of h, a sufficient condition for this is that

$$\ell - \tau_m \geq \frac{\ell}{1+b} - \underline{\tau} \Leftrightarrow \frac{b\ell}{1+b} > \tau_m - \underline{\tau}.$$

But we know that

$$\frac{b\ell}{1+b} \geq \frac{b\underline{\tau}}{1+b} \geq \frac{(\overline{\tau} - \tau_m)}{1+b} > \tau_m - \underline{\tau}.$$

■

8.2 Proof of Lemma 1

Proposition 1 implies that the result is true for b larger than $(\overline{\tau}-\tau_m)/\underline{\tau}$. Thus, we just need to show that the result is true for b smaller than $(\overline{\tau}-\tau_m)/\underline{\tau}$. Consider some limit $\ell<\tau_m$. We will show that marginally increasing ℓ will increase the citizen's payoff.

Suppose first that $\ell \geq (1-b)\overline{\tau}$. If $\ell \geq (1+b)\underline{\tau}$, then, from (3), we have that

$$V(\ell)=\int_{\frac{\ell}{1+b}}^{\ell}[(1+b)\tau-\ell]\,h(\tau)d\tau+\int_{\ell}^{\overline{\tau}}[\ell-(1-b)\tau]\,h(\tau)d\tau-\int_{\underline{\tau}}^{\overline{\tau}}b\tau h(\tau)d\tau.$$

Note that

$$V'(\ell)=-\int_{\frac{\ell}{1+b}}^{\ell}h(\tau)d\tau+\int_{\ell}^{\overline{\tau}}h(\tau)d\tau=1+H(\frac{\ell}{1+b})-2H(\ell)>0,$$

which implies that raising the limit slightly will increase the citizen's payoff. If $\ell<(1+b)\underline{\tau}$, then, from (3), we have that

$$V(\ell)=\int_{\underline{\tau}}^{\ell}[(1+b)\tau-\ell]\,h(\tau)d\tau+\int_{\ell}^{\overline{\tau}}[\ell-(1-b)\tau]\,h(\tau)d\tau-\int_{\underline{\tau}}^{\overline{\tau}}b\tau h(\tau)d\tau.$$

Note that

$$V'(\ell)=-\int_{\underline{\tau}}^{\ell}h(\tau)d\tau+\int_{\ell}^{\overline{\tau}}h(\tau)d\tau=1-2H(\ell)>0,$$

which again implies that raising ℓ marginally benefits the citizen.

Now suppose that $\ell<(1-b)\overline{\tau}$. If $\ell \geq (1+b)\underline{\tau}$, then, from (3), we have that

$$V(\ell)=\int_{\frac{\ell}{1+b}}^{\ell}[(1+b)\tau-\ell]\,h(\tau)d\tau+\int_{\ell}^{\frac{\ell}{1-b}}[\ell-(1-b)\tau]\,h(\tau)d\tau-\int_{\underline{\tau}}^{\overline{\tau}}b\tau h(\tau)d\tau.$$

Note that

$$V'(\ell)=-\int_{\frac{\ell}{1+b}}^{\ell}h(\tau)d\tau+\int_{\ell}^{\frac{\ell}{1-b}}h(\tau)d\tau.$$

Given that $\frac{\ell}{1+b}<\ell<\tau_m$ and that

$$\ell-\frac{\ell}{1+b}=\frac{b\ell}{1+b}<\frac{b\ell}{1-b}=\frac{\ell}{1-b}-\ell,$$

the assumption that h is symmetric and non-decreasing on $[\underline{\tau},\tau_m]$ implies that

$$\int_{\ell}^{\frac{\ell}{1-b}}h(\tau)d\tau>\int_{\frac{\ell}{1+b}}^{\ell}h(\tau)d\tau.$$

To see this, note that for any $\tau\in[\frac{\ell}{1+b},\ell]$ we can associate a unique $\tau'\in[\ell,\frac{\ell}{1-b}]$ (e.g., $\tau'=2l-x$) which has a higher density. Thus, it must be the case that $V'(\ell)>0$ which implies that raising the limit slightly will increase the citizen's payoff. If $\ell<(1+b)\underline{\tau}$, then, from (3), we have that

$$V(\ell)=\int_{\underline{\tau}}^{\ell}[(1+b)\tau-\ell]\,h(\tau)d\tau+\int_{\ell}^{\frac{\ell}{1-b}}[\ell-(1-b)\tau]\,h(\tau)d\tau-\int_{\underline{\tau}}^{\overline{\tau}}b\tau h(\tau)d\tau.$$

Note that

$$V'(\ell) = -\int_{\underline{\tau}}^{\ell} h(\tau)d\tau + \int_{\ell}^{\frac{\ell}{1-b}} h(\tau)d\tau.$$

Given that $\underline{\tau} < \ell < \tau_m$ and that

$$\ell - \underline{\tau} < l - \frac{\ell}{1+b} = \frac{b\ell}{1+b} < \frac{b\ell}{1-b} = \frac{\ell}{1-b} - \ell,$$

the assumption that h is symmetric and non-decreasing on $[\underline{\tau}, \tau_m]$ implies that

$$\int_{\ell}^{\frac{\ell}{1-b}} h(\tau)d\tau > \int_{\underline{\tau}}^{\ell} h(\tau)d\tau.$$

Again, to see this note that for any $\tau \in [\underline{\tau}, \ell]$ we can find a unique $\tau' \in [\ell, \frac{\ell}{1-b}]$ (e.g., $\tau' = 2l - x$) which has a higher density. Thus, $V'(\ell) > 0$ which again implies that raising ℓ marginally benefits the citizen. ■

8.3 Proof of Proposition 2

For limits $\ell \in [\tau_m, \overline{\tau}]$, we have that $\ell/(1+b)$ is greater than or equal to $\tau_m/(1+b)$ which, since b is less than $(\tau_m - \underline{\tau})/\underline{\tau}$, exceeds $\underline{\tau}$. In addition, if $b < 1$, we have that $\ell/(1-b)$ is greater than or equal to $\tau_m/(1-b)$ which, since b exceeds $(\overline{\tau} - \tau_m)/\overline{\tau}$, exceeds $\overline{\tau}$. Thus, for limits $\ell \in [\tau_m, \overline{\tau}]$, (3) implies that

$$V(\ell) = \int_{\frac{\ell}{1+b}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} [\ell - (1-b)\tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau.$$

This means that

$$V'(\ell) = -\int_{\frac{\ell}{1+b}}^{\ell} h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} h(\tau)d\tau = 1 + H\left(\frac{\ell}{1+b}\right) - 2H(\ell).$$

It follows that at the optimal limit

$$1 + H\left(\frac{\ell}{1+b}\right) = 2H(\ell),$$

which is (6). To see that this equation has a solution, note that

$$1 + H(\frac{\tau_m}{1+b}) > 1 = 2H(\tau_m),$$

and that

$$1 + H\left(\frac{\overline{\tau}}{1+b}\right) < 2H(\overline{\tau}) = 2.$$

Thus, by the *Intermediate Value Theorem*, there exists a solution to equation (6). ■

8.4 Proof of Proposition 3

For limits $\ell \in [\tau_m, \overline{\tau}]$, we have that $\ell/(1+b)$ is greater than or equal to $\tau_m/(1+b)$ which, since b is less than $(\overline{\tau}-\tau_m)/\overline{\tau}$, exceeds $\underline{\tau}$. Moreover, since $\tau_m/(1-b)$ is less than $\overline{\tau}$ which is less than $\overline{\tau}/(1-b)$, we have that

$$\frac{\ell}{1-b} \gtrless \overline{\tau} \text{ as } l \gtrless (1-b)\,\overline{\tau}.$$

It follows from (3) that the citizen's welfare with limit $\ell \in [\tau_m, \overline{\tau}]$ is

$$V(\ell) = \begin{cases} \int_{\frac{\ell}{1+b}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau + \int_{\ell}^{\frac{\ell}{1-b}} [\ell - (1-b)\tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau & \text{if } \ell < (1-b)\,\overline{\tau} \\ \int_{\frac{\ell}{1+b}}^{\ell} [(1+b)\tau - \ell]\, h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} [\ell - (1-b)\tau]\, h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau & \text{if } \ell \geq (1-b)\,\overline{\tau} \end{cases}.$$

Thus, the impact on welfare of a small increase in the limit is

$$V'(\ell) = \begin{cases} H(\frac{\ell}{1-b}) + H(\frac{\ell}{1+b}) - 2H(\ell) & \text{if } \ell < (1-b)\overline{\tau} \\ 1 + H(\frac{\ell}{1+b}) - 2H(\ell) & \text{if } \ell \geq (1-b)\overline{\tau} \end{cases}.$$

It follows that the optimal limit is either such that $\ell \in [\tau_m, (1-b)\overline{\tau})$ and solves

$$H(\frac{\ell}{1-b}) + H(\frac{\ell}{1+b}) = 2H(\ell),$$

or is such that $\ell \in [(1-b)\overline{\tau}, \overline{\tau}]$ and solves

$$1 + H(\frac{\ell}{1+b}) = 2H(\ell).$$

It is straightforward to show that at least one of these equations must have a solution in the relevant range. The assumption that b is less than $(\overline{\tau}-\tau_m)/\overline{\tau}$ implies that b is less than $(\tau_m - \underline{\tau})/\underline{\tau}$ which means that $\tau_m/(1+b)$ exceeds $\underline{\tau}$. Thus,

$$1 + H(\frac{\tau_m}{1+b}) > 1 = 2H(\tau_m).$$

Since

$$1 + H(\frac{\overline{\tau}}{1+b}) < 2 = 2H(\overline{\tau}),$$

there exists $\ell \in (\tau_m, \overline{\tau})$ such that

$$1 + H(\frac{\ell}{1+b}) = 2H(\ell).$$

Suppose that for all such ℓ it is the case that $\ell < (1-b)\overline{\tau}$, then it must be the case that

$$1 + H(\frac{(1-b)\overline{\tau}}{1+b}) < 2H((1-b)\overline{\tau}) \Leftrightarrow H(\frac{(1-b)\overline{\tau}}{1+b}) + H(\frac{(1-b)\overline{\tau}}{1-b}) < 2H((1-b)\overline{\tau}).$$

If

$$H(\frac{\tau_m}{1-b}) + H(\frac{\tau_m}{1+b}) > 1 = 2H(\tau_m), \tag{22}$$

this implies that there exists $\ell \in [\tau_m, (1-b)\overline{\tau}]$ such that

$$H(\frac{\ell}{1-b}) + H(\frac{\ell}{1+b}) = 2H(\ell).$$

It suffices, therefore, to prove that (22) holds. Note that symmetry implies that

$$H(\frac{\tau_m}{1+b}) = 1 - H(\tau_m + \frac{b\tau_m}{1+b}).$$

Moreover, we have that

$$\frac{\tau_m}{1-b} = \tau_m + \frac{b\tau_m}{1-b} > \tau_m + \frac{b\tau_m}{1+b}.$$

This means that

$$H(\frac{\tau_m}{1+b}) + H(\frac{\tau_m}{1-b}) > H(\frac{\tau_m}{1+b}) + H(\tau_m + \frac{b\tau_m}{1+b}) = 1.$$

■

8.5 Proof of Proposition 4

Given Proposition 3, it suffices to show that, under the condition of the Proposition, equation (6) has no solution bigger than $(1-b)\overline{\tau}$. Suppose then that ℓ solves equation (6).

We first observe that ℓ must be less than or equal to $(1+b)\overline{\tau}/(1+2b)$. To see this, note first that, since h is decreasing over the interval $(\tau_m, \overline{\tau}]$ by assumption, we have that

$$1 - H(\ell) = H(\overline{\tau}) - H(\ell) \leq h(\ell)(\overline{\tau} - \ell)$$

and that

$$H(\ell) - H\left(\frac{\ell}{1+b}\right) \geq h(\ell)\left[\ell - \frac{\ell}{1+b}\right] = h(\ell)\frac{\ell b}{(1+b)}.$$

As a result, we have that

$$\begin{aligned}
1 - H(\ell) &\leq h(\ell)(\overline{\tau} - \ell) \\
&\leq \left(\frac{H(\ell) - H\left(\frac{\ell}{1+b}\right)}{\frac{\ell b}{(1+b)}}\right)(\overline{\tau} - \ell) \\
&= \left(H(\ell) - H\left(\frac{\ell}{1+b}\right)\right)\frac{(\overline{\tau} - \ell)(1+b)}{\ell b}.
\end{aligned}$$

Given that ℓ solves (6), it must be the case that $H(\ell) - H(\ell/(1+b)) = 1 - H(\ell)$. The above inequality then requires that

$$\frac{(\overline{\tau} - \ell)(1+b)}{\ell b} \geq 1,$$

which in turn implies that

$$\ell \leq \overline{\tau}\frac{1+b}{1+2b}.$$

We now show that ℓ must be less than $(1-b)\overline{\tau}$. Suppose not. Then, it must be the case that $\ell \in [(1-b)\overline{\tau}, (1+b)\overline{\tau}/(1+2b)]$. Since H is increasing and $\ell \geq (1-b)\overline{\tau}$, we have that

$$1 - H((1-b)\overline{\tau}) \geq 1 - H(\ell).$$

Moreover, since $\ell \leq (1+b)\overline{\tau}/(1+2b)$, we have that

$$H(\ell) - H\left(\frac{\ell}{1+b}\right) \geq H((1-b)\overline{\tau}) - H\left(\frac{\overline{\tau}}{1+2b}\right).$$

The condition of the Proposition tells us that

$$H\left((1-b)\overline{\tau}\right) - H\left(\frac{\overline{\tau}}{1+2b}\right) > 1 - H\left((1-b)\overline{\tau}\right).$$

Combining these three inequalities reveals that

$$H(\ell) - H\left(\frac{\ell}{1+b}\right) > 1 - H\left((1-b)\overline{\tau}\right) \geq 1 - H\left(\ell\right),$$

which contradicts the fact that ℓ solves equation (6). ■

8.6 Proof of Proposition 6

As argued in the text, the result for the case in which the politician's bias exceeds $(\overline{\tau} - \tau_m)/\underline{\tau}$ follows from Propositions 1, 2, and 5. Thus, we just need to deal with the case in which the politician's bias is less than $(\overline{\tau} - \tau_m)/\underline{\tau}$.

We begin by showing that the optimal limit is always at least as big as τ_m. We establish this by demonstrating that with any limit $\ell \in [\underline{\tau}, \tau_m)$, marginally increasing ℓ will increase the citizen's expected welfare. Suppose first that $\ell \geq (1+b)\underline{\tau}$, then, from (10), we have that the citizen's welfare is

$$V_N(\ell) = \int_{\frac{\ell}{1+b}}^{\ell} \left[(1+b)\tau - \ell\right] h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} \left[\ell - (1-b)\tau\right] h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau.$$

Note that this is equal to $V(\ell)$ when $\ell \geq (1-b)\overline{\tau}$ and $\ell \geq (1+b)\overline{\tau}$. By the argument in the proof to Lemma 1, raising the limit slightly will increase the citizen's welfare. If $\ell < (1+b)\underline{\tau}$ then, from (10), we have that

$$V_N(\ell) = \int_{\underline{\tau}}^{\ell} \left[(1+b)\tau - \ell\right] h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} \left[\ell - (1-b)\tau\right] h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau.$$

Note that this is equal to $V(\ell)$ when $\ell \geq (1-b)\overline{\tau}$ and $\ell < (1+b)\overline{\tau}$. Again, by the argument in the proof to Lemma 1, this implies that raising ℓ will benefit the citizen.

Now for limits $\ell \in [\tau_m, \overline{\tau}]$, we have that $\ell/(1+b)$ is greater than or equal to $\tau_m/(1+b)$ which, since b is less than $(\tau_m - \underline{\tau})/\underline{\tau}$, exceeds $\underline{\tau}$. As a result, from (10), we have that the citizen's welfare is

$$V_N(\ell) = \int_{\frac{\ell}{1+b}}^{\ell} [(1+b)\tau - \ell]h(\tau)d\tau + \int_{\ell}^{\overline{\tau}} [\ell - (1-b)\tau]h(\tau)d\tau - \int_{\underline{\tau}}^{\overline{\tau}} b\tau h(\tau)d\tau.$$

Thus, the impact on welfare of a small increase in the limit is

$$V_N'(\ell) = 1 - 2H(\ell) + H(\frac{\ell}{1+b}).$$

It follows that the optimal limit will satisfy

$$1 + H\left(\frac{\ell}{1+b}\right) = 2H(\ell),$$

which is equation (6). By the argument in the proof of Proposition 2, this equation has a solution.

■