

Journal of Benefit-Cost Analysis

Volume 3, Issue 2

2012

Article 2

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Recommended Citation:

Krutilla, Kerry and Alexeev, Alexander (2012) "The Normative Implications of Political Decision-Making for Benefit-Cost Analysis," *Journal of Benefit-Cost Analysis*: Vol. 3: Iss. 2, Article 2.

DOI: 10.1515/2152-2812.1112

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The Normative Implications of Political Decision-Making for Benefit-Cost Analysis

Kerry Krutilla and Alexander Alexeev

Abstract

The Potential Pareto criterion, or Kaldor-Hicks standard, presumes that costs are not fully compensated. Yet, uncompensated costs can incentivize costly political activity and create uncertainty about political outcomes. These consequences are not reckoned in the standard benefit-cost analysis. This study models political costs and uncertainty as a function of project parameters and political-institutional characteristics. The economic consequences of political behavior are then incorporated into an adjusted project evaluation standard. This standard assures that the project's conventionally measured net benefits are sufficient to cover political costs and uncertainty about the decision-making outcome.

KEYWORDS: benefit cost analysis, political costs, transaction costs, political economy

Author Notes: This article extends a model developed in a previous collaboration among Kerry Krutilla, Chulho Jung, and W. Kip Viscusi. Robert Hahn, Oliwia Kuryka, and David Zetland offered thoughtful comments, and two anonymous referees provided perceptive reviews. While indebted to all of these individuals, the usual disclaimer applies: the authors are responsible for the study's conclusions and any errors or omissions. Kerry Krutilla: School of Public and Environmental Affairs, Indiana University, Bloomington. Alexander Alexeev: School of Public and Environmental Affairs, Indiana University, Bloomington.

1. Introduction

This article shows how to modify benefit-cost analysis to reflect political behavior. The rationale is that the usual efficiency standard, the Potential Pareto criterion, presumes that losses are not necessarily compensated, implying that losers will often have an incentive to oppose project proposals. As the possibility of political activity is a corollary of the default assumption justifying the usual efficiency standard, it seems logically inconsistent to ignore the normative consequences for the efficiency evaluation.

The welfare implications of project-related political activity can be distinguished for *ex post* and *ex ante* evaluation.¹ Assuming a project's conventionally measured net present value (NPV) is positive, the relevant question to ask *ex post* is whether the monetized value of the project's political costs are sufficient to tip the accounting into the negative range. If so, society would have been worse off for having gone through the political process of approving a project generally regarded as economically efficient.² The costs of political activity are not typically reckoned in *ex post* benefit-cost studies, such as the retrospective study of the Clean Air Act (US EPA, 1997). That raises a question about the potential size of political decision-making costs relative to conventionally measured resource costs (hereafter "project resource costs" or "project costs"), and the significance of political transaction costs in a more complete appraisal that includes them.

The relevant question to consider *ex ante* is whether the *expected value* of the project's conventionally measured NPV is sufficient to cover the project's political costs. Posing this question recognizes that the outcome of political decision-making is uncertain, and that projects may not pass a political test. If a project proposal turns out not to be politically acceptable, the political cost around the decision-making ends up as unrecovered social waste.³ This possibility should be embodied as a "political risk assessment" within the normative evaluation.

We use a game theoretic model to simulate the economic cost and expected outcome of a political process around project decision-making. The

1. The term "project" is construed broadly enough to encompass what might be labeled as a "program" or "policy," including federal rules, state-level programs, or local policies – for example, congestion pricing on municipal roadways.

2. Of course, the approval of projects with negative NPVs is an even worse outcome, lowering economic welfare through the resource reallocation the project brings about as well as the costs of the decision-making about it. The approval of protectionist trade barriers, agricultural subsidies, and income tax distortions exhibit this type of problem.

3. This was very nearly the outcome of the protracted political struggle over healthcare reform legislation in early 2010. Passage of the legislation was uncertain until the very end, and the final bill narrowly passed the House of Representatives (by a margin of 220 to 207). Legal challenges have continued in the period since, with a Supreme Court ruling expected in June 2012.

reduced-form solution shows that incentives for political mobilization and the probability of the project's acceptance depend on project parameters, such as the project's benefits, resource costs, and property rights structure, as well as on features of the political-institutional environment, including the political power of stakeholders. This functional dependence allows for the solution of benefit-cost ratios that account for political transaction costs and decision-making uncertainty. As in the standard approach, the base for these ratios is a project's resource costs, but the benefits are increased to add a margin that covers decision-making costs. For *ex post* evaluation, these adjusted benefit-cost ratios turn out to vary from 1 to 1.67 – not insignificant, but a standard that many public projects can meet. However, the *ex ante* thresholds are significantly higher, ranging upwards to 32. The higher thresholds occur when the project's opponents are politically powerful and their losses are not significantly compensated, a combination that motivates political actions reducing the probability of the project's acceptance. The expected value of promoting a project facing a low chance of political survival is not likely to be positive, unless the benefit of the project is high enough to provide a margin to cover for the uncertainty of the decision-making outcome.

The next section begins with a discussion of the academic literature on the implications of political activity for project evaluation. Section 3 continues with a definition of a model of political activity over project decision-making. Section 4 describes the model's reduced-form solution, and how parametric variation affects it. Section 5 shows how to incorporate political costs formally into the normative decision criteria for *ex post* and *ex ante* evaluation. Section 6 offers qualifications about the modeling methodology. Section 7 concludes with a discussion of the methodology implications, and suggests practical ways that the welfare effects of political activity can be better incorporated into benefit-cost analyses.

2. Literature Review

A major branch of the public choice field is devoted to the costs of public decision-making, focusing on the implications for optimal government size, and the types of policies that minimize political costs (e.g., Tullock, 1988; Krueger, 1990). By contrast, the literature on the implications of political activity for project evaluation is relatively limited and lacks the coherence of a well-developed research field.

One strand of the literature addresses ways to design projects to make them politically acceptable. An interesting suggestion is to adapt the “preference mapping approach” used by businesses in marketing studies – a method to align product attributes with consumer tastes to maximize product sales. Applied in the project decision-making context, the objective is to find the best match between

project attributes and stakeholder preferences to facilitate the selection of politically feasible project portfolios (Kelvin, 2000).

Stakeholder impact analysis is another way to address the political implications of project proposals and to provide information about project design options for successful implementation (Jenkins, 1999). A disaggregated display of the project's distributional impacts can be used to design compensation schemes (Krutilla, 2005). Stakeholder impact analysis can also be used proactively to help stakeholders achieve consensus about project design and implementation (Lindhall and Soderqvist, 2004). Stakeholder negotiation reduces the resource cost of political activity, but adds the cost of the negotiation itself.

In the context of environmental policy-making, minimizing changes to the *status quo* distribution of environmental use rights is a commonly suggested strategy to reduce political costs.⁴ Grandfathering tradable pollution permits is the classic approach. However, both emissions charges and regulations can be designed to grant firms any degree of environmental entitlement. That flexibility enables policy design modifications to reduce political resistance (see Farrow, 1995, 1999; Pezzey, 2003; Sterner and Isaksson, 2006).

Rent-seeking around project planning can be a problem in developing countries, due to weak institutions and lack of transparency (e.g., Krueger, 1990; Fleming, 1998). To the extent that rent-seeking is endogenous to some aspect of the project's attributes or management, changes can be made during the design and implementation phases to minimize rent-seeking costs. Using competitive bids to solicit input supplies is one example of a project management approach that can be used to reduce rent-seeking activity (Fleming, 1998).

The literature discussed does not consider the possibility of monetizing the cost of political activity as part of a project evaluation, although Fleming (1998: 278) suggests that political costs, in principle, should be included in the analysis. However, a study by Thompson (1999) does take the step of monetizing political costs. This study makes an *ex post* comparison of water pollution control policy in the United States, implemented through technology-based mandates under the Clean Water Act (CWA) and the costs of an effluent charge scheme employed in the Federal Republic of Germany. Two of the costs in the assessment are relevant here; the lobbying costs of industry and environmental groups during the legislative deliberation and enactment, and the administrative costs of developing and implementing the regulations pursuant to the legislation, including the costs of *ex post* litigation. On net, the political costs of enactment and implementation

4. Legally, agents do not have "use rights" to the environment before policy defines them (see Cole and Grossman, 2002), but the terminology is used here in the loose sense traditionally employed by economists (see Hartwick and Olewiler, 1986).

raised the costs of the CWA significantly compared to the system of effluent fees adopted in Germany.⁵

To summarize, some project evaluation literature recognizes political effects as design issues or constraints, but rarely monetizes them as costs. In general, the insights of the public choice literature do not appear to have significantly influenced benefit-cost analysis, either in theory or in practice. The purpose of this article is to attempt to bridge this gap, by integrating a model of political activity within the project evaluation framework. By adding the welfare costs of political activity to benefit-cost analysis, a better assessment can be made of a project's overall economic effect.

3. The Model

This section develops a model of political costs associated with project decision-making. The start point is a politically mediated deliberation about a project proposal. The project's adoption will impact two risk-neutral and perfectly informed groups: a homogeneous beneficiary group, that will consume the project's output, and a mutually exclusive homogenous losing group, that will bear the project's resource costs. In the discussion that follows, "the beneficiary group" and "the losing group" will sometimes be referred to as "the beneficiary" and "the loser," respectively. The assumption that there are only two engaged homogeneous groups represents a boundary point case, in the sense that all of the beneficiaries and losers are aggregated together, and there are no organizing costs to mobilizing the aggregates to lobby.⁶

The model falls within the class of influence models pioneered by Becker (1983) and extended many times since; see, for example, Nitzan (1994) and Maxwell et al. (2000). It is consistent with a representative democratic system in which "decision-makers," undifferentiated with respect to their different roles as legislators, bureaucrats, or executives, respond to constituent pressure. Both the project's beneficiary and loser can lobby to influence the project decision, with the goal to optimize the resources devoted to lobbying *vis-a-vis* the expected benefits of lobbying. The interaction of the beneficiary and loser is modeled as a non-cooperative game in the level of effort devoted to pressuring the political process. The formalization is as follows:

$$\text{Max}_{C_1} P_1 = K(B - T)\pi(C_1, C_2) - C_1, \quad B - T > 0 \quad (1)$$

5. This conclusion is consistent with the assessment of other analysts, e.g., Harrington (2003).

6. The implications of this assumption, and several others in this section, are considered in Section 6.

$$\text{Min}_{C_2} P_2 = K(T - C)\pi(C_1, C_2) - C_2, \quad T - C < 0 \tag{2}$$

The endogenous variables are C_1 and C_2 and P_1 and P_2 . As is standard in the rent-seeking literature, C_1 and C_2 are taken to represent the opportunity costs of devoting resources to influencing the expected pay-offs from the political decision-making. C_1 represents the costs incurred by the beneficiary; C_2 the costs incurred by the loser. P_1 and P_2 are the expected net pay-offs to the beneficiary and loser, in present value terms, when resources are committed to political pressure.

Turning to the exogenous variables, K is a project scale parameter indicating units of project output, whereas B is the average present value to the beneficiary of a unit of project output, and C is the average present value cost to the loser per unit of project output. It is not essential to represent the project's total benefits and costs with separate parameters for scale and averages, but this approach enables an independent assessment of the effects of project scale, the B/C ratio, and the other parameters. It is also assumed that $B/C > 1$, so that the analysis is restricted to projects conventionally regarded as economically efficient.

The parameter “ T ” is the present value of a transfer payment from the beneficiary per unit of project output to the parties who bear the resource cost. It can be thought of as compensation – to help defray a polluter's pollution control costs, for example – or as a user charge that helps to cover the project's resource costs. It is important to note that the beneficiaries who pay T and the losers who receive it regard T as exogenous.

It is assumed that $T \in [0, C)$. The lower bound allows for an assessment of the consequences of the default assumption underlying the Potential Pareto criterion. The upper bound assures that losses are never completely compensated which, under the assumptions of the model, would eliminate the incentive for losers to attempt to influence the project decision.

The expression $\pi(C_1, C_2)$ in Equations (1) and (2) denotes a political influence function, giving the probability of the project's acceptance, π , as a function of the resources the beneficiary and losing groups devote to influencing the project decision. The functional form is assumed to be:

$$\pi(C_1, C_2) = \frac{C_1}{C_1 + \alpha C_2} = \frac{1}{1 + \alpha \frac{C_2}{C_1}} \tag{3}$$

C_1 and C_2 are as defined above, and α is a parameter that shows the relative political power between agents. Equation (3) is a common functional form for a “contest success function” used in the study of power and conflict (e.g., Hirschleifer, 1995) and in the rent-seeking literature (e.g., Nitzan, 1994; Amegashie, 2006). Note that $\pi = 0$ when $C_1 = 0$, and $\pi \rightarrow 1$ as $C_1 \rightarrow \infty$, while $\pi = 1$ when $C_2 = 0$ and $\pi \rightarrow 0$ as $C_2 \rightarrow \infty$. Also, note that when $\alpha = 1$ and $C_1 = C_2$, $\pi = 0.5$.

The α parameter is taken to reflect attributes of the political landscape that exogenously affect the agents’ relative capacity to influence the project’s adoption. If the decision-making process is biased against the beneficiaries $\alpha > 1$. If $\alpha < 1$, the political process is biased against the loser. It is evident that $\pi = 1$ when $\alpha = 0$, i.e., the loser has no influence on the project’s adoption. From this limiting extreme, $\pi \rightarrow 0$ as $\alpha \rightarrow \infty$ – the other limiting extreme where the beneficiary has no political power.

4. Model Solution

Given the functional form of the political influence function, the expected pay-off functions in Equations (1) and (2) are quasi-concave in own effort, and a Nash equilibrium in pure strategies exists for simultaneous moves (Hamilton and Slutsky, 1990). As the pay-off functions are concave/convex for the beneficiary/loser, the equilibrium is unique.

Solving for Equations (1) and (2) gives the first order conditions:

$$\frac{\partial P_1}{\partial C_1} = K(B - T) \left[\frac{\alpha C_2}{(C_1 + \alpha C_2)^2} \right] - 1 = 0 \quad (4)$$

$$\frac{\partial P_2}{\partial C_2} = K(C - T) \left[\frac{\alpha C_1}{(C_1 + \alpha C_2)^2} \right] - 1 = 0 \quad (5)$$

Algebraic simplification yields the solutions:

$$C_1^* = \frac{\alpha K(C - T)(B - T)^2}{[(B - T) + \alpha(C - T)]^2} \quad (6)$$

$$C_2^* = \frac{\alpha K(B-T)(C-T)^2}{[(B-T) + \alpha(C-T)]^2} \tag{7}$$

Of most interest is the sum of the resource costs that both agents devote to lobbying $(C_1^* + C_2^*)$ – the total political transactions costs associated with project decision-making. This sum is expressed as a ratio to the project’s resource costs, CK . Adding Equations (6) and (7) and dividing by CK gives:

$$\frac{C_1^* + C_2^*}{CK} = \frac{\alpha(C-T)(B-T)[(B-T) + (C-T)]}{C[(B-T) + \alpha(C-T)]^2} \tag{8}$$

Note that the scale parameter K drops out on the right-hand side.

The C parameter can be eliminated from Equation (8) by dividing the numerator and denominator of the right-hand side by C^2 giving:

$$\theta = \frac{\alpha(1-\tau)(\beta-\tau)(\beta-2\tau+1)}{(\alpha(1-\tau) + (\beta-\tau))^2} \tag{9}$$

with $\theta \equiv (C_1^* + C_2^*) / CK$; $\beta \equiv B / C$, and $\tau \equiv T / C$ ($0 \leq \tau < 1$). With $1 - \tau > 0$ and $\beta - \tau > 0$, θ is always positive for $\alpha \in (0, \infty)$.⁷

It is also useful to show the reduced form probability that results when C_1^* and C_2^* in Equations (6) and (7) are substituted into Equation (3), and the C parameter is eliminated:

$$\pi^* = \frac{1}{1 + \alpha \frac{(1-\tau)}{(\beta-\tau)}} \tag{10}$$

It is evident in Equation (10) that the probability of the project’s passage decreases in α and increases in β , and the partial derivative $\frac{\partial \pi^*}{\partial \tau}$ shows that the probability also increases in the level of compensation:

$$\frac{\partial \pi^*}{\partial \tau} = \frac{\alpha(\beta-1)}{[\alpha(1-\tau) + (\beta-\tau)]^2} > 0, \text{ with } \beta > 1 \tag{11}$$

7. From Equations (1) and (2), $B - T > 0$ and $T - C < 0$. Dividing through by C implies $\beta - \tau > 0$ and $1 - \tau > 0$.

By contrast, the directional effect of the parameters on θ in Equation (9) is not intuitively obvious. To provide some insight, the effects of parameter variation are simulated and graphically displayed. The partial derivatives that correspond to the simulated cases are shown in the mathematical appendix (Appendix A).

4.1 Ratio of Lobbying Costs to Project Costs (θ) as a Function of the B/C Ratio (β)

The relationship between θ and β is first considered for a benchmark case where the political power of beneficiaries and losers is symmetric ($\alpha = 1$). Cost compensation ratios (τ s) are parametrically varied (see Figure 1). Looking first at the default case where losses are uncompensated ($\tau = 0$), the top line in Figure 1 shows that θ begins at 0.5 and rises monotonically at a declining rate, with θ going to 1 as $\beta \rightarrow \infty$. Under these commonly assumed conditions – evenly distributed political power, no compensation for losers – political transaction costs will always be greater than 50% of the project’s resource costs. However, compensation significantly reduces transaction costs for this parameterization. When $\tau = 0.75$ for example, θ ranges from approximately 0.2 to 0.25 as β increases beyond 2 (again see Figure 1).

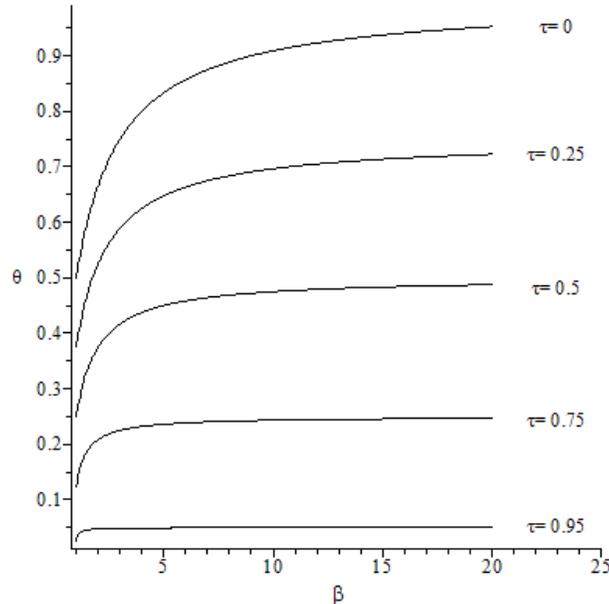


Figure 1. Ratio of Lobbying Costs to Project Costs (θ) as a Function of B/C Ratios (β) for Different Cost Compensation Ratios (τ) and Symmetric Political Power ($\alpha = 1$).

Figure 2 shows how θ responds to β when winners and losers do not have symmetric political power ($\alpha \neq 1$). In these simulations $\tau = 0$. It turns out that the form of the functional relationship between θ and β differs in each of three ranges for α : $\alpha \leq 0.33$; $0.33 < \alpha < 0.5$; and $\alpha \geq 0.5$. The form of the relationship shown in Figure 1 holds only for $\alpha \geq 0.5$ (see top line in Figure 2). For the $0.33 < \alpha < 0.5$ range, the relationship is not monotonic. For example, for the $\alpha = 0.4$ parameterization indicated in Figure 2, θ is increasing in β up to $\beta = 2$, and declining thereafter. When $\alpha \leq 0.33$, θ is monotonically declining in β (whenever $\beta > 1$). That pattern is demonstrated by the bottom line in Figure 2.

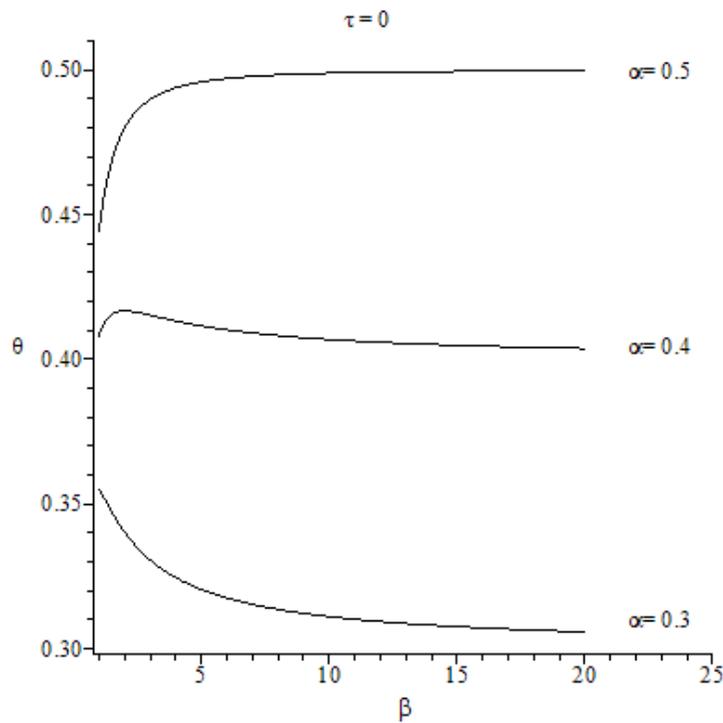


Figure 2. Ratio of Lobbying Costs to Project Costs (θ) as a Function of B/C ratios (β) for Three Distributions of Relative Political Power (α) and Uncompensated Losses ($\tau = 0$).

The relationship between θ and β reflects the sum of the actions of the beneficiaries and losers. As might be expected, the resource commitments of beneficiaries are always increasing in β , while the resource commitments of the losers can increase or decrease, depending on the relationship among α , β , and τ (see Appendix A). For the parameterizations shown in Figure 2, the resource costs

of the loser are declining in β . The increase in the resource commitments of the beneficiaries dominates the sum unless their relative political power is high enough ($\alpha \leq 0.33$). In that case, the resource commitments of the loser decline rapidly enough to dominate the sum. The range where α lies between 0.33 and 0.5 is a transitional zone in which the sum can increase or decrease, as shown by the middle line in Figure 2.

4.2 Ratio of Lobbying Costs to Project Costs (θ) as a Function of Relative Political Power (α)

At the limiting extremes of asymmetric political power, where $\alpha = 0$ or $\alpha = \infty$, the probability of the policy outcome will either be 1 or 0, as noted before. In either of these cases, θ will be zero.⁸ It is not economically rational for agents to contest project decision-making when one of the sides has the political power to impose the outcome. However, between these extremes θ is positive under our assumptions. This implies that starting at $\alpha = 0$ – the point at which the beneficiary has all of the political power – θ must be initially increasing as the value of α rises. But since θ ultimately declines to zero, there must be a maximum point at which the initial increase is reversed and θ begins to fall as α rises further. This maximum turns out to occur when $\alpha^* = \frac{\beta - \tau}{1 - \tau}$. Note that

substituting α^* for α in Equation (10) gives $\pi^* = 0.5$. In short, the resource costs of efforts to influence the project decision-making are maximized when the combination of the relative political power and the net benefit ratio, $(\beta - \tau) / (1 - \tau)$, incentivizes resource commitments that give an equal probability of the project politically passing or failing. As the relative political power is skewed from this point towards either the beneficiary or the loser, the resource costs of lobbying decline. Figure 3 illustrates for various values of β with τ fixed

at zero (the maximum value $\alpha^* = \frac{\beta - \tau}{1 - \tau} \rightarrow \beta$ with $\tau = 0$). Note that political costs at the maximums will exceed the project's resource costs ($\theta > 1$) whenever $\beta > 3$. For example, at $\beta = 4$ and $\alpha = 4$, $\theta = 1.25$. At $\beta = 5$ and $\alpha = 5$, $\theta = 1.5$. In fact, there is a wide range of α values which will yield values for $\theta > 1$ when $\beta = 4$ and $\beta = 5$. When $\beta = 4$, $\theta > 1$ for $\alpha \in [1.53, 10.47]$. For $\beta = 5$, $\theta > 1$ for $\alpha \in [1.34, 18.67]$.

8. This is evident by substituting $\alpha = 0$ and $\alpha = \infty$ into Equation (9).

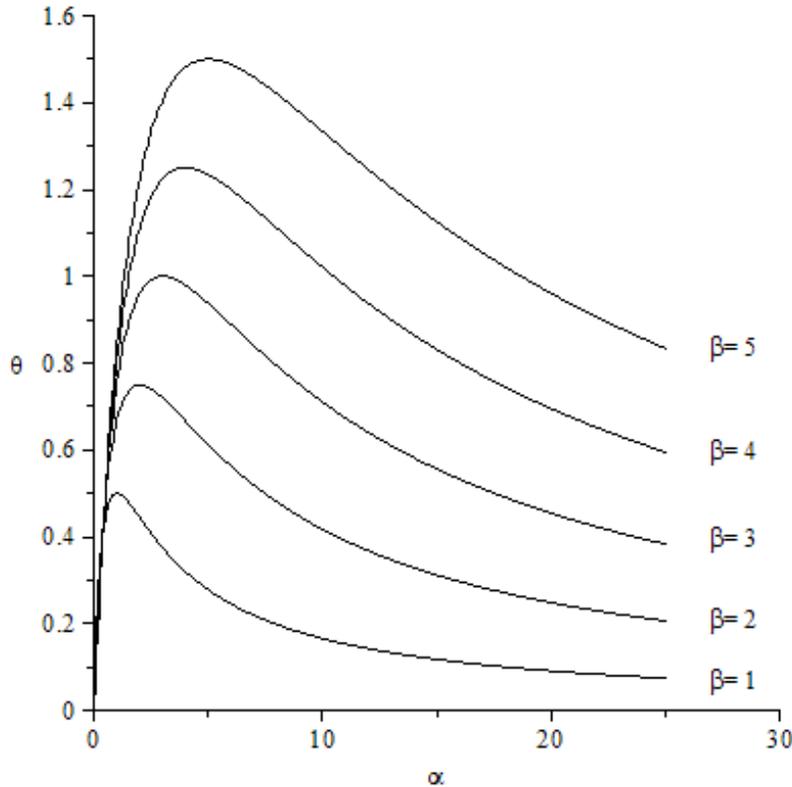


Figure 3. Ratio of Lobbying Costs to Project Costs (θ) as a Function of Relative Political Power (α) for Different B/C ratios (β) and Uncompensated Losses ($\tau = 0$).

The simulations shown in Figure 3 do not give θ values close to the theoretical limit. Maintaining the assumption that $\tau = 0$, for example, θ rises to 5.25 when β increases to 20 for $\alpha = 20$. When high β values incentivize project beneficiaries to contest against politically powerful, uncompensated opposition, the political transaction costs can significantly exceed the project's resource costs.

Figure 4 uses the $\beta = 3$ curve to illustrate the effect of compensation on the form of the relationship displayed in Figure 3. With $\beta = 3$, the maximums will occur when $\alpha^* = \frac{3-\tau}{1-\tau}$. Compensation has the effect of increasing the α value at which the maximums occur, e.g., increasing τ from 0 to 0.75 increases the α value for the maximum from 3 to 9. Compensation also lowers the value of the maximums, as can be seen in Figure 4.

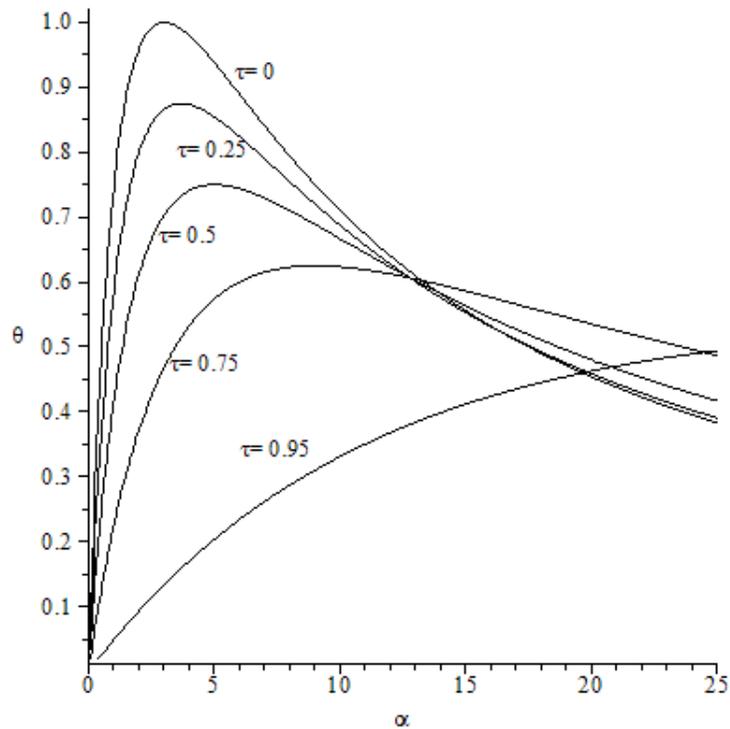


Figure 4. Ratio of Lobbying Costs to Project Costs (θ) as a Function of Relative Political Power (α) for Different Cost Compensation Ratios (τ) and Benefit-Cost ratio $\beta = 3$.

4.3 Ratio of Lobbying Costs to Project Costs (θ) as a Function of Cost Compensation Ratios (τ)

For the parameterizations discussed, political transaction costs have been inversely related to the level of compensation – an intuitive result. However, given the way τ enters the θ function in Equation (9), it is not surprising that the relationship between θ and τ is not monotonic. Figure 5 illustrates with $\beta=3$ and various values for α . For $\alpha \leq 10$, θ is declining as τ increases. But note that for the $\alpha = 20$ and $\alpha = 50$ lines, θ is initially increasing in τ . Some insight can be obtained by recalling that the partial relationship between θ and α will have a maximum at $\alpha^* = \frac{\beta - \tau}{1 - \tau}$. Substituting $\alpha = 20$ and $\beta=3$ in this equation gives a τ solution of 0.86. For $\alpha = 50$, the τ solution is 0.96. These are the τ values, respectively, for the θ maximums shown in Figure 5 for the $\alpha = 20$ and $\alpha = 50$ lines. These maximums reflect the way increasing compensation changes

the relative incentives of stakeholders. Starting at $\tau = 0$ when $\alpha = 20$ and $\beta = 3$, a combination of resource commitments is incentivized that gives $\pi^* = 0.13$. As compensation to the loser increases from zero, the relative pay-off from influencing the activity, $(\beta - \tau)/(1 - \tau)$, increases (assuming $\beta > 1$), increasing the incentive for influence activity on the part of the beneficiary relative to the loser, and the probability of the policy's passage. As τ increases to 0.86, $\pi \rightarrow .5$. As τ increases beyond 0.86, the relative pay-off becomes more skewed and resource commitments begin to decline, going to zero in the limiting extreme as $\tau \rightarrow 1$ and $\pi \rightarrow 1$. The same pattern occurs when $\alpha = 50$. In this case, $\pi^* = 0.06$ when $\tau = 0$, and increases to 0.5 as $\tau \rightarrow 0.96$. In short, increasing compensation to a politically powerful loser can incentivize more political competition, rather than less. That happens by altering the net pay-off structure in a way that reduces the politically powerful opposition and brings the less powerful beneficiary into the political contest.

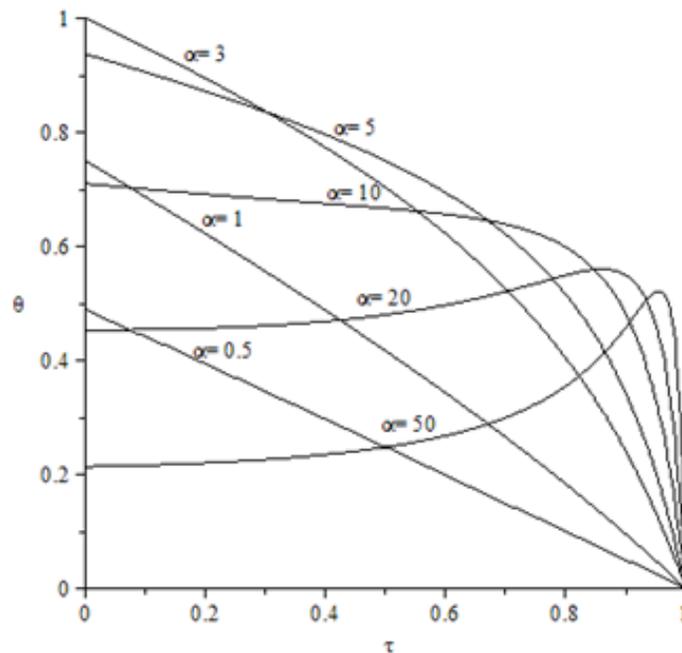


Figure 5. Ratio of Lobbying Costs to Project Costs (θ) as a Function of Cost Compensation Ratios (τ) for Different Distributions of Relative Political Power (α) and Benefit-Cost ratio $\beta = 3$.

5. Implications for Project Evaluation

The previous section has shown that political transaction costs can amount to a significant fraction of the resource costs of a project conventionally regarded as economically efficient – indeed, can exceed the project’s resource costs – depending on the benefit-cost ratio, the level of compensation, and the relative political power of stakeholders. The crucial question is whether the benefits of such a project are large enough to cover these transaction costs. The implications of probabilistic decision-making must also be considered. This section develops modified project evaluation standards that address these issues.

5.1 *Ex Post* Normative Standard

Ex post, conventionally measured net benefits should be large enough to cover political costs, that is, to equal or exceed the break-even threshold:

$$(B - C)K = C_1^* + C_2^* \quad (12)$$

Equation (12) can be rewritten as:

$$BK - C_1^* = CK + C_2^* \quad (13)$$

Equation (13) expresses Equation (12) as an adjusted Potential Pareto criterion. This modified standard requires that the benefits to the winner less the political costs to obtain them ($BK - C_1^*$) should be large enough to cover the total costs of the project, which include both the project’s resource costs and the costs of political opposition ($CK + C_2^*$).

Dividing Equation (13) by CK and rearranging implies the break-even threshold:

$$\beta = 1 + \theta \quad (14)$$

As θ endogenously depends on the project’s benefit-cost ratio, β in Equation (14) can be solved to give an *ex post* β threshold that covers both the resource costs of the project and its political costs. This β threshold will vary parametrically with τ and α . Using the $\alpha = 1$ parameterization to illustrate, the concept is graphically demonstrated in Figure 6. It shows a plot of $1 + \theta$ as a function of β against a 45° line where $\beta = \beta$. The $1 + \theta$ lines vary parametrically in τ , and are the same as the lines shown in Figure 1 over the β

range from 1 to 1.7, increased everywhere by 1. The intersection points in Figure 6 at $\beta = 1 + \theta(\beta)$ give the break-even β thresholds (β^*). For example, at $\tau = 0$, a β at 1.62 or above will always equal or exceed $1 + \theta$, whereas at $\tau = 0.95$, a β at 1.03 will always equal or exceed $1 + \theta$.

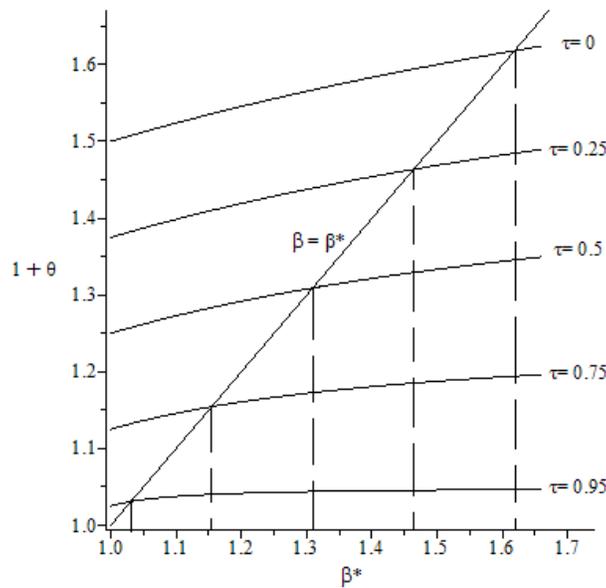


Figure 6. *Ex Post* Break-Even Ratios (β^*) for Different Cost-Compensation Ratios (τ) and Symmetric Political Power ($\alpha = 1$).

The analytical solution for $\beta = 1 + \theta(\beta)$ is described in Appendix A. It turns out to be linear in τ , as shown in Figure 7 for a number of different α values. Interestingly, 1.67 is the maximum β^* value obtained; it occurs in the left-hand panel at $\tau = 0$ and $\alpha = 1.67$. Whatever the β^* values at $\tau = 0$, they decline linearly as τ increases, reaching $\beta = 1$ as $\tau \rightarrow 1$.

The relationship between β^* and α is quadratic; plots are shown in Figure 8. Interestingly, maximum values occur at $\alpha = 1.67$ independently of parametric variation in τ . Again, the largest β^* value is 1.67.

In summary, these results show that the *ex post* break-even ratios range from 1 to 1.67 for a wide range of parameter combinations. This seems like relatively “good news” in the sense that many projects have benefit-cost ratios greater than 1.67. Still, adding costs that can amount to 67% of the project’s resource costs is not insignificant, and many projects conventionally viewed as economically efficient might not meet this standard.

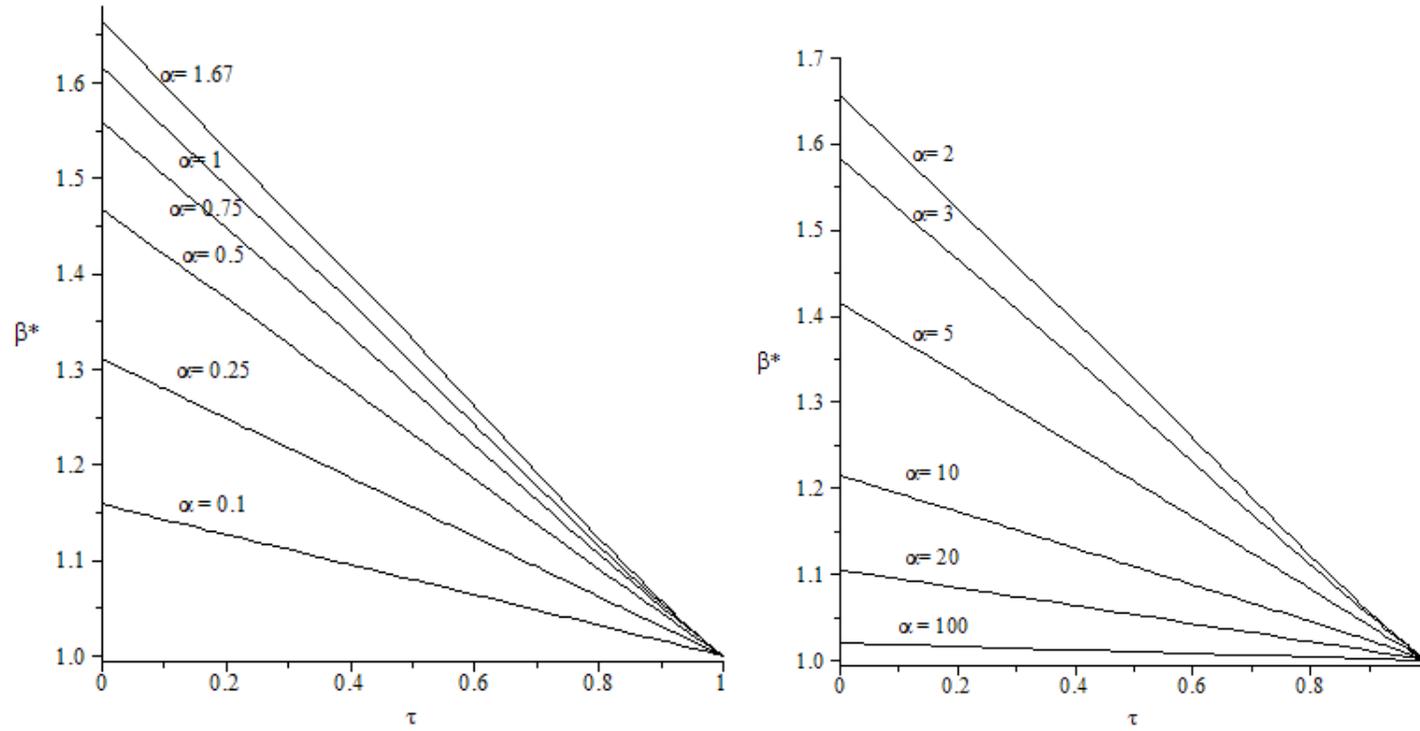


Figure 7. *Ex Post* Break-Even Ratios (β^*) as a Function of Cost-Compensation Ratios (τ) for Different Distributions of Relative Political Power (α).

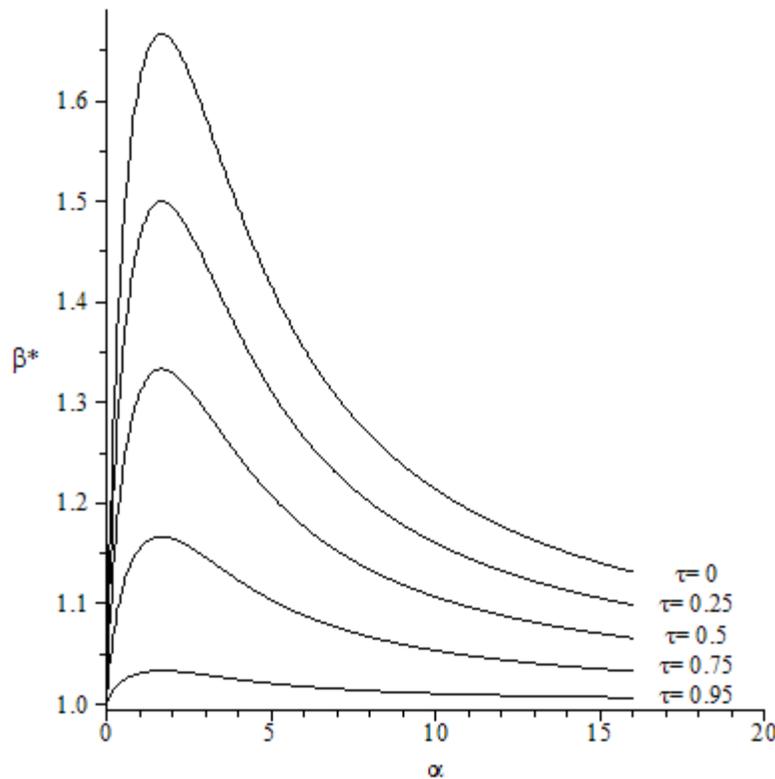


Figure 8. *Ex Post* Break-Even Ratios (β^*) as a Function of Relative Political Power (α) for Different Cost-Compensation Ratios (τ).

5.2 *Ex Ante* Normative Standard

Conventionally-measured net benefits and a project's political costs exhibit an important asymmetry. The net benefits will only accrue if the project passes the political test, whereas the political costs will accrue regardless of the political outcome. On the assumption that the goal of public policy should be to increase expected social welfare, the break-even standard *ex ante* should be:

$$\pi(B - C)K = C_1^* + C_2^* \tag{15}$$

Equation (15) can also be written as:

$$\pi BK - C_1^* = \pi CK + C_2^* \tag{16}$$

The formulation in Equation (16) expresses Equation (15) as an adjusted Potential Pareto criterion in which the expected net gains from the policy, $\pi\beta K - C_1^*$, are sufficient to cover the expected costs, $\pi CK + C_2^*$. Dividing Equation (16) by CK and rearranging gives:

$$\beta = 1 + \frac{\theta}{\pi} \tag{17}$$

This *ex ante* standard is just the *ex post* standard weighted by a probability term that reflects political uncertainty. As $\pi < 1$ except for boundary-case parameter configurations, the *ex ante* standard will generally be greater than the *ex post* standard. For example, if $\alpha = 1$ and $\tau = 0$, Equations (9) and (10) show that $\theta = \pi$ which implies from Equation (17) that $\beta^* = 2$. Recall that the corresponding β^* for *ex post* evaluation is 1.62.

The panels in Figure 9 show the expected break-even ratios as a function of τ for parametric variation of α values ranging from 0.1 to 500. The relationship between expected break-even ratios and τ is linear. Expected break-even ratios will be high when the probability of the policy's passage is low and *visa versa*. For $\tau = 0$, π^* will vary between 0.995 to 0.038 as α varies from 0.1 to 500. With α at 0.1 for the $\tau = 0$ case, the *ex ante* break-even ratio is very close to the *ex post* break-even ratio for the same parameterization (1.17 and 1.16, respectively). However, if $\alpha = 500$ at $\tau = 0$, the expected break-even ratio is approximately 32, whereas the *ex post* ratio is approximately 1.

Figure 10 provides a plot of the expected break-even ratios as a function of α for different τ values. The probability of the policy's passage will be declining as α is increasing, and expected break-even ratios will be rising. The upshot is that the expected social welfare of promoting projects facing politically powerful opposition and, consequently, the low likelihood of political acceptance, is not likely to be positive, unless conventionally measured benefit-cost ratios are very high.

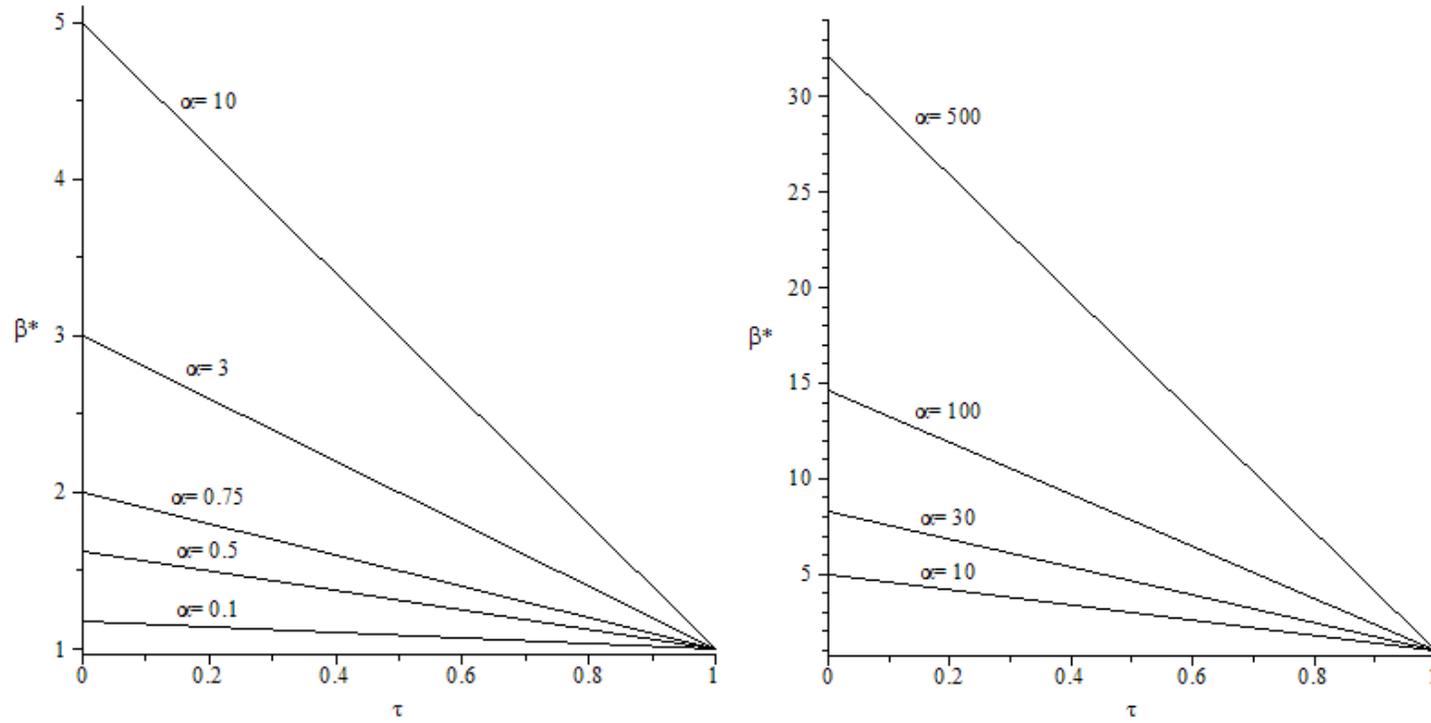


Figure 9. *Ex Ante* Break-Even Ratios (β^*) as a Function of Cost-Compensation Ratios (τ) for Different Distributions of Relative Political Power (α).

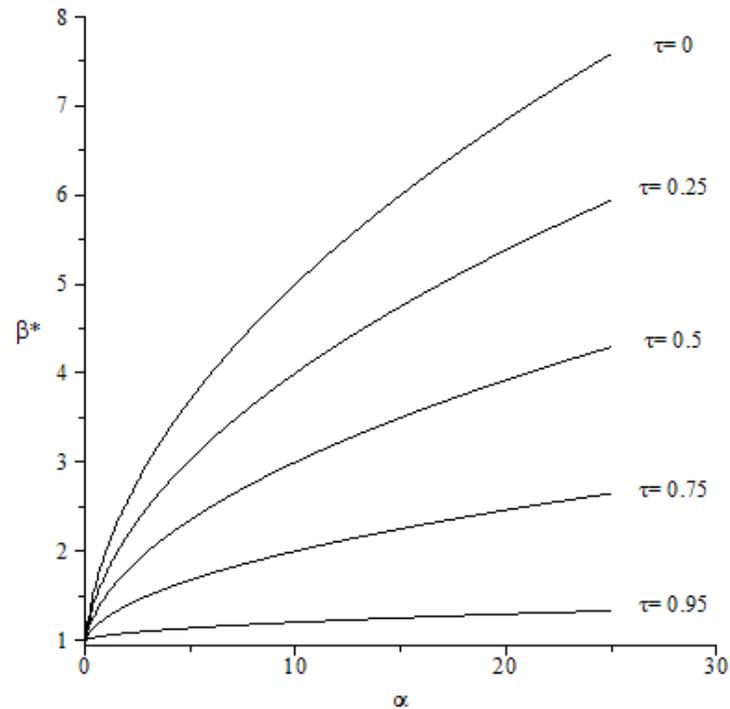


Figure 10. *Ex Ante* Break-Even Ratios (β^*) as a Function of Relative Political Power (α) for Different Cost-Compensation Ratios (τ).

6. Modeling Qualifications

Some of the modeling assumptions are likely to bias predicted political activity high, whereas others are likely to bias predictions low. Both types of bias are considered here, before turning to some methodology implications and conclusions.

6.1 Modeling Assumptions That Bias the Break-Even Ratios High

The stakeholders in this model are well informed about their expected gains and losses, and the two-agent homogeneous group formulation obviously abstracts from the possibility of free riding or the transaction costs of organizing political activity. Thus, the assumptions of the model are most likely to be empirically relevant for political contexts featuring well-informed and mobilized stakeholders on both sides of the decision issue. Regulatory policy-making offers a case in point, given the lobbying effort it elicits from business interests, environmentalist, labor unions, and health and consumer advocates. The policy-making is also

frequently followed by contested rule-making during the implementation period (see Harrington et al. 2003).

Stakeholders at the state and local levels are often well informed about the consequences of projects that directly affect them, encouraging political action. Almost any issue involving land use, such as the proposed reservation of a parkland or a wetland, or the opposite, a development proposal, elicits a significant political response (see Horan and Jonas, 1998; Bourne, 2000). Concerns about the environmental impact of urban growth, in conjunction with federal environmental regulations, have increased the political difficulty of infrastructure investments in crowded urban areas (Giuliano, 1992; Purcell, 2000). Demand-side policies can also generate political opposition, e.g., user resistance to proposals for toll collection or congestion pricing (Giuliano, 1992; Nash, 2007). Political activity around water projects, particularly in the west, can be significant, owing to environmental concerns, as well as the court enforcement of Native American water claims (Colby, 1990, 2000). Of course, projects exhibiting not-in-my-backyard (NIMBY) characteristics will feature highly mobilized stakeholders, e.g., prison construction (see Blakenship and Yanarella, 2004) or hazardous waste disposal (see Fredriksson, 2000). Land use issues can exhibit NIMBY levels of resistance from landowners facing evictions under eminent domain. Given the extensive responsibility for investment falling on states and localities (Gramlich, 1994), the high degree of stakeholder mobilization, and the complex decision-making environment – impacted by multiple jurisdictional rules and requirements – political activity over state and local governmental decision-making often imposes substantial resource costs (see Giuliano, 1992; Purcell, 2000; Bulkeley and Betsill, 2005).

Although the scope for policy conflict is significant, the model's stylization ignores information asymmetries and organizing transaction costs that would reduce political costs. Adding these features to the model would lower the break-even ratios, *ceteris paribus*.

Another issue is that some forms of influence activities, such as bribes to influence decision-making, take the form of pure financial transfers. To the extent that financial transfers are used to pressure the political process, the computed break-even ratios are overestimated. Note that campaign contributions, while financial transfers at the proximate level, have efficiency implications, as they are often used to cover the resource costs of political mobilization. Some rents might be associated with campaign contributions, in which case, a shadow price would have to be developed for mobilization costs.

The modeling framework does not allow for the possibility that well-informed beneficiaries and losers, perhaps with the help of a mediator, could negotiate compensation *ex ante*, achieving a consensual policy design that would attenuate the political struggle – and its consequent resource costs. In this case,

the “T” parameter would be endogenous. However, stakeholders will not always have an incentive to achieve consensus; that depends on whether the expected net pay-offs of negotiating a consensual policy *ex ante* are greater or less than the expected net pay-offs of a political contest. Formally, this comparison could be modeled as a two-stage game in which agents first attempt to achieve consensus, and failing that, engage in the second stage political dispute.⁹ Assuming that the resource costs of consensus are low enough to allow it, and are less than the resource costs of an avoided political contest, the computed break-even ratios would be overestimated. Thus, the ratios must be assumed to hold for the class of projects lacking the necessary incentives for low-cost political consensus.

The model is based on the assumption that the beneficiary and loser are risk-neutral. Risk-averse stakeholders would commit fewer resources to influencing the project decision, lowering the break-even ratios.

6.2 Modeling Assumptions That Bias the Break-Even Ratios Low

Several assumptions are likely to bias the break-even ratios low. For starters, the model does not fully reflect the range of possible property rights structures associated with regulatory policy-making. Taking environmental regulation as an example, the Kaldor-Hicks default that losses are not compensated gives the same environmental entitlement as that of a pollution control regulation requiring emissions reductions. This type of policy forces firms to fully cover their pollution abatement costs ($\tau = 0$). The cost compensation range $0 < \tau < 1$ in the environmental policy context corresponds to some degree of pollution control subsidy (with a limiting extreme at $\tau = 1$ giving the equivalent of a Coasean property rights assignment to the polluter). But often firms are required to fully cover their abatement costs and pay an environmental fee. For example, firms may have to buy pollution permits or pay environmental taxes. Firms facing a policy with the property rights structure of auctioned tradable permits or emissions taxes – or any environmental entitlement less than that of a standard pollution control regulation – will have a greater incentive to oppose the policy than for the standard zero-compensation benchmark (see Farrow, 1995, 1999; Pezzey, 2003). Break-even benefit-cost ratios will be higher for this type of policy than for those computed in this article.¹⁰

9. This is the type of game played in legal contests. The plaintiff and defendant can settle out of court, or pursue legal action to trial (see Cooter and Rubinfeld, 1989).

10. If environmental policies are large enough to cause price changes or secondary market adjustments, the normative analysis has to be broadened to consider the possible value of environmental revenue in public finance. Taking climate policy as an example, computable general equilibrium (CGE) modeling shows that the revenue raised from selling carbon allowances can be used to reduce labor taxes, attenuating negative efficiency effects the regulation itself causes (Parry and Williams, 1999; Bovenberg and Goulder, 2001). And since CO₂ regulation

The model does not reflect behavioral factors, such as loss aversion, or feelings of entitlement, that can motivate political activity. Political opposition to congestion fees in the United States offers a possible example (Giuliano, 1992; Nash, 2007). Although drivers have an economic incentive to oppose congestion fees, congestion pricing also "...conflicts with a fundamental and highly valued belief held by many Americans, namely, that mobility is a right" (Giuliano, 1992). That sense of entitlement is likely to increase political opposition, and to raise the break-even ratios.

Governmental actors are obviously important players in public decision-making, and they incur substantial resource costs – the time of legislators and their staff in drafting legislation, and the resource costs of agency input into legislative decision-making. Public resource costs are also incurred during the implementation period – to develop regulations, or to respond to legal claims – and afterwards for monitoring and enforcement actions (Krutilla and Krause, 2011). These costs are assumed away in the class of influence models upon which our model is based; that is, the class of models in which the policy emerges without friction in response to stakeholder pressure. Adding the resource costs incurred by the governmental sector would obviously raise the break-even ratios.

The representation of total benefits and costs as proportionally related to the level of output drops the scale parameter (K) from θ , and therefore from the break-even thresholds. Relaxing this implicit production function assumption would give break-even ratios that vary with project size. The direction and magnitude of this variation would depend on the particular production function.

The model is based on a single contest rather than a repeated game. Stakes are raised in a strategic context featuring regular competition. Repeated contestation has been found to increase the resources that legal disputants expend to influence trial outcomes (see Cooter and Rubinfeld, 1989). Similar behavior in the political context would increase the break-even ratios.

Project financing, whether through taxation or the displacement of alternative investments having positive NPVs, is likely to impose welfare costs beyond the project's resource costs (Dahlby, 2008). Including a positive marginal cost of public funds would raise the break-even ratios.

creates scarcity rents, firms need a relatively small share of allowances to cover abatement costs (Burtraw and Palmer, 2008).

These research findings and their policy implications rest on some particular assumptions, however. The efficiency effects of raising revenue depend on the size of government, and the uses of public revenue (see Farrow, 1999). Firms may rent-seek over supernormal returns, as is assumed in the rent-seeking literature; hence, may resist policies that reduce rents, such as permit auctions. And CGE models assume away transaction costs, including political costs (see Krutilla and Krause, 2011). Still, market ramifications are obviously relevant in the normative assessment of large-scale policies, and have been assumed away in this study.

The functional form of the political influence function also affects the results. It implicitly captures features of the institutional context affecting the decision-making. The responsiveness of the political process to lobbying effort is one feature that is likely to influence lobbying activity, political costs, and the probability of political outcomes. It is not clear how results would be affected by using variants of the functional form employed in this article, or using possible alternatives, e.g., the logit functional form sometimes used to model contests (see Skaperdas, 1996).

Overall, the net effect of the assumptions and modeling features discussed are not certain. Future research should be used to assess the sensitivity of the break-even ratios to alternative modeling approaches.

7. Methodology Implications and Conclusions

Although the numerical values for adjusted break-even ratios are not certain, two points seem obvious. First, there will always be some political costs, and other types of transaction costs, associated with project decision-making. Secondly, with the exception of some categories of administrative costs, the standard practice in benefit-cost analysis is to ignore these costs.¹¹ This approach would have a degree of justification if the rationale was based on the assumption that stakeholders are compensated. However, as the standard welfare metric is evoked on the opposite assumption, it is logically inconsistent to ignore the resource implications of the political consequences. Adjusting benefit-cost ratios to include them is a way to resolve this inconsistency.

To better estimate adjusted benefit-cost ratios, an improved theoretical model could be developed to conduct the types of simulations shown in this article, with uncertain parameters varied in sensitivity analysis or Monte Carlo simulation. Econometric methods could be used to estimate the parameter values for such models, or to otherwise estimate project-related political costs and uncertainty. This type of analysis is not more difficult than the complex empirical assessments routinely conducted in regulatory impact assessments, and in the benefit-cost analyses of large infrastructure projects.

Subjective professional judgment could be used to ballpark the adjusted benefit-cost ratios. For example, analysts might conclude that the ratio of political costs to project costs (θ) is likely to vary between 0.2 and 0.4 if a project is financed out of general revenue, and the associated probability of the project's passage (π) is likely to be approximately 0.8. However, if the project is financed out of user charges, θ is likely to rise to between 0.4 and 0.6, and π to decline to

11. The Unfunded Mandate Reform Act of 1995 (42 USC §4332 1995) requires regulatory impact assessments to record administrative costs imposed on state and local governments.

0.6. Substituting these values into the *ex ante* evaluation standard $\beta = 1 + \frac{\theta}{\pi}$ gives benefit-cost ratios between 1.25 and 1.5 if the project is financed from general revenue, and 1.67 and 2 if the project is user-fee financed. This type of information should be useful for the decision-making. And the particular example raises the point that the political cost of financing – not just the conventionally measured cost of public funds – could be relevant for project evaluation.

It seems plausible that political costs are comparable to resource costs ($\theta = 1$) when project decision-making is politically controversial, particularly if public-sector transaction costs are added into the accounting. It also seems likely that the chance of political acceptance in this situation is often around 50% ($\pi = 0.5$). Substituting $\theta = 1$ and $\pi = 0.5$ into $\beta = 1 + \frac{\theta}{\pi}$ gives 3. This standard might be taken as a conservative rule-of-thumb that presumptively justifies controversial projects *ex ante*. For projects having benefit-cost ratios of less than 3, an explicit evaluation of political transactions costs and uncertainty would add useful information.

Similar considerations apply for the *ex post* analysis. The *ex post* evaluation standard was shown to be 1.67 or less under a wide range of parameter variation. Yet, Section 6 describes a variety of outside-the-model assumptions that could move adjusted ratios in one direction or the other. In fact, the rule-of-thumb assumption that $\theta = 1$ for politically controversial projects implies an *ex post* benefit-cost ratio of 2, using the formula $\beta = 1 + \theta$. This standard might be taken as a conservative benchmark, in the sense that controversial projects with benefit-cost ratios greater than 2 can be assumed *ex post* to have probably covered their political transaction costs. Empirical estimates would be needed for more precise estimates for projects having benefit-cost ratios less than 2.

There are two overarching conclusions from this article. First, the welfare effects of project-related political activity should be regarded as normatively relevant. The evaluation of efficiency and equity cannot be dichotomized; the benefits and costs of a project and the degree of stakeholder compensation influence the level of political contestation, and a project's overall efficiency effect. The second point is that the modeling methods and statistical tools commonly used in benefit-cost analysis should be used to estimate the welfare effects of a project's political consequences. Just as the literature on the marginal cost of public funds gives estimates for the costs of project finance (see Dahlby, 2008), additional research should provide estimates of the welfare effects associated with politicized project decision-making. These analytically derived estimates could inform or complement professional judgments. However derived,

incorporating this information into benefit-cost analysis would make for more accurate economic assessments.

Appendix A. Mathematical Appendix

1. The Effect of Parameter Variation on the Ratio of Lobbying Costs to Resource Costs (θ)

The expression for θ is:

$$\theta = \frac{\alpha(1-\tau)(\beta-\tau)(\beta-2\tau+1)}{(\alpha(1-\tau)+(\beta-\tau))^2} \quad (\text{A1})$$

$\theta \equiv (C_1^* + C_2^*) / CK$; $\beta \equiv B / C$, $\tau \equiv T / C$ ($0 < \tau < 1$); α is relative political power.

1.1 Ratio of Lobbying Costs to Project Costs (θ) as a Function of the B/C Ratio (β)

For $\alpha = 1$.

With $\alpha = 1$, Equation (A1) reduces to:

$$\theta = (1-\tau) \left(1 + \frac{1-\tau}{\beta-\tau} \right)^{-1} \quad (\text{A2})$$

Taking partial derivatives gives:

$$\left. \frac{\partial \theta}{\partial \beta} \right|_{\alpha=1} = \frac{(1-\tau)^2}{((1-\tau)+(\beta-\tau))^2} > 0, \quad \text{and} \quad \left. \frac{\partial^2 \theta}{\partial \beta^2} \right|_{\alpha=1} = \frac{-2(1-\tau)^2}{((1-\tau)+(\beta-\tau))^3} < 0 \quad (\text{A3})$$

$$\left. \frac{\partial \theta}{\partial \tau} \right|_{\alpha=1} = \frac{-((1-\tau)^2 + (\beta-\tau)^2)}{((1-\tau)+(\beta-\tau))^2} < 0, \quad \text{and} \quad \left. \frac{\partial^2 \theta}{\partial \tau^2} \right|_{\alpha=1} = \frac{-2(\beta-1)^2}{((1-\tau)+(\beta-\tau))^3} < 0 \quad (\text{A4})$$

The signs of these derivatives are consistent with the shape of the curves illustrated in Figure 1.

For $\alpha \neq 1$.

The partial derivative in this case is:

$$\frac{\partial \theta}{\partial \beta} = \frac{\alpha(1-\tau)^2((\alpha + \tau - \beta) + \alpha(2\beta - 3\tau))}{(\alpha(1-\tau) + (\beta - \tau))^3} \tag{A5}$$

To check to see if there is a critical value, Equation (A5) is set equal to zero to give:

$$\frac{\partial \theta}{\partial \beta} = 0 \text{ if } \beta^* = \frac{(3\tau - 1)\alpha - \tau}{2\alpha - 1} \tag{A6}$$

Not that the assumption that $\beta > 1$ requires $\beta^* = \frac{(3\tau - 1)\alpha - \tau}{2\alpha - 1} > 1$. Solving this inequality with respect to α (while allowing for the discontinuity at $\alpha = 0.5$) gives $\alpha \in (0.33, 0.5)$ as the range on which $\partial \theta / \partial \beta = 0$ and $\beta > 1$ for $\tau \in [0, 1)$.

The second derivative is:

$$\left. \frac{\partial^2 \theta}{\partial \beta^2} \right|_{\beta=\beta^*} = \frac{2(\alpha - 1/2)^4}{\alpha^2(1-\tau)(\alpha - 1)^3} \tag{A7}$$

On interval $\alpha \in (0.33, 0.5)$ the following holds:

$$\left. \frac{\partial^2 \theta}{\partial \beta^2} \right|_{\beta=\beta^*} \in \left(-\frac{3}{64(1-\tau)}, 0 - \varepsilon \right] < 0 \tag{A8}$$

for $\tau \in [0, 1)$ where ε is an arbitrarily small positive number. This condition is shown by the middle line in Figure 2.

To consider the α range for which $\frac{\partial \theta}{\partial \beta} > 0$, the right-most term in the numerator of Equation (A6) must be greater than zero, implying the inequality: $\alpha > \frac{1}{\frac{1-\tau}{\beta-\tau} + 2}$. As $0 < \tau < 1$ and $\beta > 1$ by assumption, the first term in the

denominator of this inequality must satisfy: $0 < \frac{1-\tau}{\beta-\tau} \leq \frac{1}{\beta} < 1$. Within these bounds, the maximum possible value for $\frac{1}{\frac{1-\tau}{\beta-\tau} + 2}$ is $0.5 - \varepsilon$, where ε is some arbitrarily small amount. This implies $\alpha > 0.5 - \varepsilon$ for $\frac{\partial \theta}{\partial \beta} > 0$, or the sufficient condition: $\alpha \geq 0.5$ for $\frac{\partial \theta}{\partial \beta} > 0$. A case consistent with this condition is shown as the top line in Figure 2.

For the α range for which $\frac{\partial \theta}{\partial \beta} < 0$, the inequality is reversed: $\alpha < \frac{1}{\frac{1-\tau}{\beta-\tau} + 2}$. Given the boundary condition $0 < \frac{1-\tau}{\beta-\tau} \leq \frac{1}{\beta} < 1$, $1/3 + \varepsilon$ is the lowest possible value for this inequality to hold, implying that $\frac{\partial \theta}{\partial \beta} < 0$ for $\alpha < 1/3 + \varepsilon$, or the sufficient condition $\alpha \leq 1/3$ for $\frac{\partial \theta}{\partial \beta} < 0$.

The bottom line in Figure 2 shows a case consistent with this condition. As noted in the text, the indicated relationships reflect the sum of the parameter effects on each individual's incentive to lobby. Defining $\theta_1 \equiv C_1 / C$ and $\theta_2 \equiv C_2 / C$ gives:

$$\theta_1 = \frac{\alpha(1-\tau)(\beta-\tau)^2}{(\beta-\tau + \alpha(1-\tau))^2} \tag{A9}$$

$$\theta_2 = \frac{\alpha(1-\tau)^2(\beta-\tau)}{(\beta-\tau + \alpha(1-\tau))^2} \tag{A10}$$

with partial derivatives:

$$\frac{\partial \theta_1}{\partial \beta} = \frac{2\alpha^2(1-\tau)^2(\beta-\tau)}{(\alpha(1-\tau) + \beta - \tau)^3} > 0 \tag{A11}$$

$$\frac{\partial \theta_2}{\partial \beta} = \frac{\alpha(\alpha(1-\tau) - \beta + \tau)(1-\tau)^2}{(\alpha(1-\tau) + \beta - \tau)^3} > 0 \text{ if } \alpha(1-\tau) > \beta - \tau \quad (\text{A12})$$

1.2 Ratio of Lobbying Costs to Project Costs (θ) as a Function of Relative Political Power (α)

From Equation (A1), $\frac{\partial \theta}{\partial \alpha}$ is:

$$\frac{\partial \theta}{\partial \alpha} = \frac{(1-\tau)(\beta - \tau)(\beta - 2\tau + 1)((\beta - \tau) - \alpha(1-\tau))}{(\alpha(1-\tau) + (\beta - \tau))^3} \quad (\text{A13})$$

The sign of this derivative is determined by the sign of the last term in the numerator, $((\beta - \tau) - \alpha(1-\tau))$, as all other terms are positive under the assumptions of the analysis, implying a critical value at $\frac{\partial \theta}{\partial \alpha} = 0$ when $(\beta - \tau) - \alpha(1-\tau) = 0$ or $\alpha^* = \frac{\beta - \tau}{1 - \tau}$. The second derivative is negative in this neighborhood, so α^* is a maximum:

$$\left. \frac{\partial^2 \theta}{\partial \alpha^2} \right|_{\alpha=\alpha^*} = -\frac{(1-\tau)^2(1-\tau + \beta - \tau)}{8(\beta - \tau)^2} < 0. \quad (\text{A14})$$

Consistent with the condition $\alpha^* = \frac{\beta - \tau}{1 - \tau}$, Figure 3 illustrates the partial relationship between θ and α at various values of β with τ fixed at zero, whereas Figure 4 shows the relationship with β fixed at 3 and τ parametrically varied.

1.3 Ratio of Lobbying Costs to Project Costs(θ) as a Function of Cost Compensation Ratios (τ)

The partial derivative in this case is:

$$\frac{\partial \theta}{\partial \tau} = \frac{\alpha}{(\alpha(1-\tau) + \beta - \tau)^3} \left[\alpha(\beta^2 - 2\beta - 1) - \beta(\beta^2 + 2\beta - 1) + 2(\alpha + 1)\tau^3 - 6(\beta + \alpha)\tau^2 + ((-\beta^2 + 2\beta + 5)\alpha + (5\beta^2 + 2\beta - 1))\tau \right] \quad (\text{A15})$$

The sign of $\frac{\partial \theta}{\partial \tau}$ is indeterminate. Figure 5 shows some special cases.

2. Implications for Project Evaluation

2.1 *Ex Post* Normative Standard

The analytical solution for $\beta = 1 + \theta(\beta)$ is:

$$\beta^* = \frac{1}{3}(2\tau + 1 - \alpha(1 - \tau)) + \frac{1}{6}(1 - \tau) \sqrt[3]{12\sqrt{3}\alpha\sqrt{3\alpha^4 - 14\alpha^3 + 53\alpha^2 - 42\alpha - 5} + 28\alpha^3 - 12\alpha^2 + 84\alpha + 8} - \frac{2(1 - \tau)(2\alpha^2 - 7\alpha - 1)}{3\sqrt[3]{12\sqrt{3}\alpha\sqrt{3\alpha^4 - 14\alpha^3 + 53\alpha^2 - 42\alpha - 5} + 28\alpha^3 - 12\alpha^2 + 84\alpha + 8}} \quad (\text{A16})$$

Equation (A16) shows that β^* is linear in τ . Figure 7 illustrates for a number of different α values.

Partially differentiating β^* in Equation (A16) with respect to α and solving for $\partial \beta^* / \partial \alpha = 0$ gives an exact solution at $\alpha^* = 5/3$. As the equation for $\partial \beta^* / \partial \alpha$ is rather complex, the solution was checked by numerically solving $\partial \beta^* / \partial \alpha = 0$, giving $\alpha^* \approx 1.667$ for $\tau \in [0, 1)$.

Figure 8 plots cases consistent with this result.

2.2 *Ex Ante* Normative Evaluation

Solving $1 + \frac{\theta}{\pi} - \beta = 0$ gives:

$$-2\alpha\tau^2 + (4\alpha - \beta + 1)\tau - 2\alpha - \beta + \beta^2 = 0 \quad (\text{A17})$$

which has one positive real root for $\alpha > 0$ and $0 < \tau < 1$:

$$\beta^* = \frac{1}{2} \left(1 + \tau + (1 - \tau) \sqrt{1 + 8\alpha} \right) \quad (\text{A18})$$

The partial derivatives are:

$$\frac{\partial \beta^*}{\partial \tau} = \frac{1}{2} (1 - \sqrt{1 + 8\alpha}) < 0 \quad (\text{A19})$$

$$\frac{\partial^2 \beta^*}{\partial \tau^2} = 0 \quad (\text{A20})$$

$$\frac{\partial \beta^*}{\partial \alpha} = \frac{2(1 - \tau)}{\sqrt{1 + 8\alpha}} > 0 \quad (\text{A21})$$

$$\frac{\partial^2 \beta^*}{\partial \alpha^2} = -\frac{8(1 - \tau)}{(1 + 8\alpha)^{3/2}} < 0 \quad (\text{A22})$$

Figure 9 shows plots consistent with Equations (A19) and (A20). Figure 10 gives some plots consistent with Equations (A21) and (A22).

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