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## On National or Supranational Objectives: Improving the Effectiveness of Targeted Expenditure Programs

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**Abstract**

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Central governments or the international community at large are concerned about subnational service delivery. The design of targeted expenditure programs features frequently in central efforts to redistribute infrastructure and social spending or assure minimum standards. These programs are typically financed by the center, often with external assistance, but are implemented at the subnational level, which may not have incentives to spend the resources as intended by the center or donors. We discuss mechanisms for improving the effectiveness of targeted public expenditure programs, modeling the interaction between different levels of government as a dynamic game. An incentive structure could be designed that compelled local governments to truthfully reveal their ability to implement national programs in a cost-effective manner and to exert the effort required to maximize the expected benefits. The models have direct policy relevance in the Heavily Indebted Poor Countries (HIPC)s, where donor-financed resources are used for poverty-reduction at the local level, or in large countries such as China, where there is an effort to redirect social and infrastructure spending to particular regions.

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## I. INTRODUCTION

### A. Overview

A common problem in developing countries concerns the design of social and infrastructure programs designed to meet certain objectives, such as educational attainment or the quality of health care, financed by the central government, but implemented at the subnational level. The center lacks effective monitoring capabilities, and the subnational governments have an incentive to divert resources to meet their own objectives, which could be characterized euphemistically as “building statues of the mayor,” which may be of local political or personal value but which would not serve the objectives of the center. Problems of this kind occur in large countries, such as China or India, where social development or infrastructure funds are provided to particular regions.<sup>2</sup> A similar genre of issues arises in the context of debt relief provided to enhance social and poverty reducing expenditures at the local level in the HIPCs.

This paper discusses mechanisms for improving the effectiveness of targeted public expenditure programs to attain the desired objectives even though implementation is effected by subnational agents whose actions cannot be directly observed by the center. More precisely, it discusses how to structure mechanisms for selection of programs and remuneration of program deliverables. The interaction between different levels of government and/or different institutions is modeled as a dynamic game. We use simulations to identify illustrative subgame perfect equilibria in this game.

The illustrative model and the simulations outlined in the paper describe a game involving governments at three levels: the center, provinces, and local governments. The central government designs a selection scheme and a contract structure, and enters into contracts with the provincial and local governments. The simulations demonstrate that under certain reasonable conditions, the central government can design an incentive structure that compels local governments to disclose their ability to implement the programs in a cost-effective manner and to maximize the efforts they put into realizing the expected benefits of the programs.

Compared with previous work, this paper adds the following dimensions to the analysis of intergovernmental financial relations:

- The analysis covers three different levels of government, providing a richer and more realistic setting than models with two levels of government.
- The paper focuses on a specific type of financial interaction between government levels of direct policy relevance.

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<sup>2</sup> See Ahmad, Li, and Richardson (2002), and Rao (2002).

The analysis includes explicit modeling of the financial interaction, resulting in a set of concrete decision rules that can be applied in different situations.

## **B. Outline of the Paper**

We focus on issues of asymmetric information and the design of incentive schemes faced by the central government. While audited information on local expenditures may not be available to higher levels of governments, we assume that there is information on “outcomes” that can be observed. We concentrate on a specific type of financial interaction between governments—the allocation of special-purpose transfers for particular programs. The problem then becomes one in which the center selects the most appropriate local agent to perform the program (there may be a number of local governments competing for the program), and the critical issue is how the center motivates the selected subnational government to exert proper effort.

Section II of this paper describes the structure of the model used for the analysis. Three levels of government are defined, and their interaction is modeled as a set of sequential, strategic decisions. The central government is the first mover and decides the agenda of selection and implementation of the program. The provincial government then decides on the selection of the local agent. Given the rules set forth, local government makes decisions on whether or not to reveal true information to upper-level governments and whether or not to exert effort if granted the financing for the program.

The benevolent central government would like to select the most cost-effective local agent to carry out a certain social program. However, it has limited access to information on the local value of the program. Leviathan-type local agents who want to obtain as large a budget as possible have no incentive to provide such information to the center. Thus, a special selection scheme must be designed to be compatible with local incentives and central objectives.

In the first-best scenario, the central government would have information on local characteristics and be able to observe the spending patterns and effort level of local governments. The local government would exert the necessary effort to achieve the objectives of the expenditure program, and both provincial and local governments would truthfully reveal the costs of reaching the objective of the program. However, in the typical developing country case, the central government has to overcome its inherent information disadvantage. We examine a selection scheme that helps the central government approach the first-best solution.

Section III describes the results of the model simulations. We establish a numerical example of a specific scheme to finance a national program—for example, schools for disabled children. We determine a set of values for the different parameters in the model, and go through the strategic choices facing each of the players. The example demonstrates that it is possible to find a separating equilibrium of which local governments will truthfully reveal whether they would incur high or low costs in meeting the national objectives and where the

local government that is awarded the program will put in sufficient effort to meet its objectives.

Section IV discusses the conclusions and implications of the analysis. Some main conclusions are the following:

- It is generally not possible to obtain an efficient solution in a one-period game.
- In order to mitigate adverse selection problems, there must be some element of competition between the different governments at the same level.
- To avoid moral hazard, the transfer scheme must include elements of punishment and rewards from the higher to the lower levels of government, based on the evaluation of the final outcomes.
- In order to create an effective competitive process, the central government must be able to define the expected program deliverables precisely and to monitor the degree of compliance against these specifications.

Section V discusses various applications of the model to related areas. The most direct application is in the area of transfers for infrastructure programs, but we also draw some lessons for the design of special purpose grants. We also explore whether the results are relevant for international transfer or financing mechanisms, such as the HIPC Initiative.

## **II. MODELING CENTRAL AND SUBNATIONAL INCENTIVES**

### **A. Previous Research**

Contract theory has been applied in the literature in the analysis of political organizations. In the contract model, local governments have informational advantages relative to the central government. Theoretically, it is possible for the central government to offer a contract such that the local government will truthfully reveal information on its actions. If the contract bargaining worked perfectly, social programs carried out by the central government could produce the same outcomes if they were implemented locally. However, since real life-contract bargaining is imperfect, in particular due to transaction costs, the extent of decentralization of control does matter. Cramer, Estache, and Seabright (1995) provide an overview of contract models and their implications for political organization.

Seabright (1996) sets up an incomplete contracts model to study the relative merits of centralized and decentralized allocation of functions to motivate governments to act in the interests of their citizens. Decentralization grants local electors the power to decide the composition of local governments at each election—abstracting from “power” or feudal relations that may influence the outcome of local elections. This provides a direct incentive for local governments to satisfy the needs of their electors. The assumption that local

governments are more responsible to the needs of their electorates, leads to the argument that decentralization may lead to efficient social outcomes holding other factors constant.

However, the assumption about better accountability of local government to their electorates does not always hold, especially in many developing countries: electorates cannot exert effective influences on their local government, and local “hierarchy” does not necessarily represent the preferences of local electorates. Humplick and Estache (1995) performed an empirical study on the impact of decentralization on the performance of infrastructure programs in three sectors: roads, electricity, and water. They find no clear-cut effect of decentralization on the indicators of infrastructure program performance. In many developing countries inefficient internal functioning of the local government hinders the potential effects of decentralization, and there are ample opportunities for corruption and misdirection of funds (see Tanzi, 2002). Contract models cannot easily be applied in such cases.

An alternative approach is to assume that the local government is a budget-maximizing Leviathan. It maximizes available budgets and extracts perquisites out of programs performed, while the central government acts as a benevolent planner. In this setting, the central government can adopt various schemes to motivate local governments to act in the interests of their citizens. The analytical framework of the principal agent problem can be applied to address the issue of designing mechanisms to improve local accountability.<sup>3</sup> Given the informational advantage of local governments, the key elements affecting local accountability include the accuracy of information available to the central government, the divergence of objectives between the central and the local government, and the local value of the program.

Some research has been done on how to improve the quality and accuracy of the information that is collected for tracking of actual expenditures. Kofman and Lawaree (1993) analyze the role of auditing within an organization, and specify the conditions for employment of internal and external audit. Diamond (2001) points out that internal and external auditing are key instruments to improve the technical quality of the information available to the center and the local electorates—but these structures are often inadequate or non-existent in many developing countries.

## **B. The Policy Framework**

Our model is based on a hierarchical structure of government: the central government is at the top level of the hierarchy, several provincial governments in the middle layer, and a few local or county-level governments within the administrative area of each of the provinces. All the governments are assumed to be risk neutral.<sup>4</sup> The central government is assumed to be

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<sup>3</sup> De Groot (1988) modeled the bureaucratic choice of allocation of control power as a principal-agent problem.

<sup>4</sup> This assumption serves to simplify the identification of solutions to the simulation model, and its implications will be discussed in Section V.

benevolent, maximizing a social welfare function with a limited budget. The central government wants to achieve certain social outcomes with the smallest expenditure. However, provincial and county governments are assumed to be run by bureaucrats, maximizing perquisites and their overall budgets.<sup>5</sup>

The central government sets aside a certain amount of financing for specific programs to be carried out by the counties. The numerical example and simulations presented in section III refer to a specific type of capital expenditure programs, but the results can be generalized to other areas. We assume that the central government cannot contract directly with the local counties, due to high-transaction costs or political reasons. The central government selects a province to grant the funds for the program, and the chosen province will select counties to implement the program. In this simplified model, the central government does not have any preferences regarding the location of the program. The priority is to have the program performed by the most cost-effective county government. This implies that distributional concerns play no role in the selection process.

The central government establishes the following selection process. It first announces objectives of the program, including services to be provided, and timing, and the quality standards for the deliverables. Second, provinces bid for the programs, submitting proposals for the necessary funds required. Then, the central government selects one province to carry out the program and transfers the necessary funds. The provinces receiving the funds will allocate these to the selected county(ies) within the province.

The interaction between the provincial and local governments is nested in the central selection process. Prior to the submission of its bid, the provincial government arranges a bidding process among its counties. Each county within the province offers a bid proposal. The provincial government selects one and formulates the provincial proposal based on the selected local proposals. If the province wins the program in the central selection, it will receive the amount equal to its budget bid. Then the provincial government decides the proportion of the budget to be allocated to the local county, to carry out the program. The county government then determines the effort level it will exert to implement the program.

Though a program has a direct value for the province and county involved, we assume that the total cost of the program is financed solely through central funding; subnational governments (both provincial and county) only exert effort to carry out the program.<sup>6</sup>

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<sup>5</sup> In order to illustrate the selection scheme, we assume that local/provincial government is run by pure Niskanen-type agents. For a more general modeling of distributive politics and the costs of centralization, see Lockwood (2002).

<sup>6</sup> The analysis of matching grants (i.e., the bids for the funds that are required from the central government to realize the program are less than the total cost) involves budgetary decisions of local governments, which are not discussed here.



Figure 1 presents the decision diagram of the three levels of governments.<sup>7</sup>

### Objectives of the governments

Local governments bid for the program within their province. If the county wins the program, it will incur a cost  $C(e, \theta)$  to carry it out, where  $\theta \in [0, 1]$  reflects the economic and social conditions in the county,  $e$  is the effort that local county exerts in the program.  $\theta$  represents private information about the cost type of the local program, which is not observable to the central and provincial government. We assume the cost function has the following properties:

- i.  $MC(e, \theta)/Me > 0$ , the higher the effort level  $e$  is, the more it costs the agent/county to carry out the program;
- ii.  $MC(e, \theta)/M\theta > 0$ , the more favorable the local conditions  $\theta$  (the smaller  $\theta$  is), the lower are the costs for the county.

County  $L$  thus chooses a budget proposal  $T_L$ , and effort level  $e$ , to maximize the following function:

$$\text{Max } E[U(e, T_L) + T_L - C(e, \theta)] \quad (1)$$

where  $U(e, T_L)$  denotes a utility function for the local government. As a Leviathan-type agent, local government obtains more fringe benefits the larger the budget  $T_L$  is allocated, i.e.,  $MU(e, T_L)/MT_L > 0$ . On the other hand, the more involved in the program, the more rent local government is able to extract, i.e.,  $MU(e, T_L)/Me > 0$ . Local government has a tendency to complicate the program. It should be noted here that the utility function  $U(e, T_L)$  is in term of money units given our assumption of risk-neutral agent. However, it captures both political and monetary benefits extracted by local agents.

Counties can always choose not to bid for the program. We assume zero reservation value for local governments staying out of the selection. The following individual rationality constraint should be satisfied for those participating in the game:

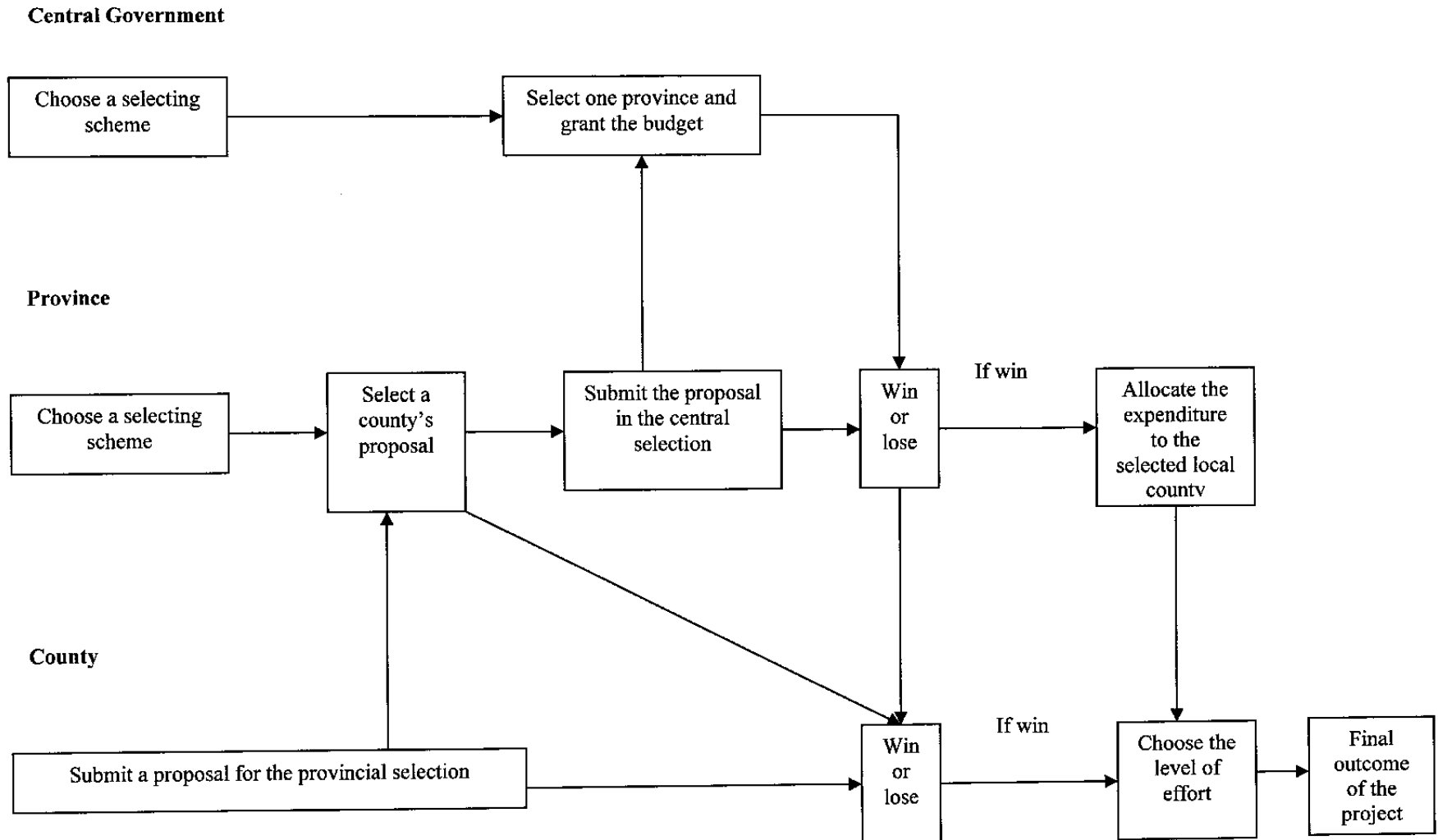
$$E[U(e, T_L) + T_L - C(e, \theta)] \geq 0 \quad (2)$$

That is, the expected gains from implementation of the program are greater than the reservation value.

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<sup>7</sup> For simplicity we assume that the central government only selects one program, involving one province and one county. The implication of relaxing this assumption is discussed in Section V.

Figure 1. Decision Diagram of the Three Tiers of Governments



If the individual rationality constraint does not hold for some counties, we would expect that high-cost counties would withdraw from the selection, while the rest participate. Under certain conditions, a separating equilibrium can be reached in a one-period game.

Assume that there are only two types of agents, high-cost agent with  $\theta^H$  and low-cost agent with  $\theta^L$  where  $\theta^H > \theta^L$ . In a one-period game, it is optimal for the local government to exert the lowest level of effort (assume  $e^*=0$ )<sup>8</sup> if the program is awarded.

Thus, if a local county wins the program, it has payoff

$$U(0, T^*) + T^* - C(0, \theta)$$

where  $T^*$  is its winning bid.

For high-cost counties, the lowest possible bid  $T^H_L$  satisfies

$$U(0, T^H_L) + T^H_L - C(0, \theta_H) = 0.$$

Similarly, the lowest possible bid for low-cost counties  $T^L_L$  satisfies

$$U(0, T^L_L) + T^L_L - C(0, \theta_L) = 0.$$

Assume that the utility from the program are the same for both types. Given  $\theta_H > \theta_L$ ,  $MC(e, \theta)/M\theta > 0$ , we know that  $T^H_L > T^L_L$ . Therefore, in equilibrium, all low-cost counties will bid  $T^L_L$  and high-cost counties will simply withdraw. Under such circumstance, there is a separating equilibrium in a one-period game, but central government objectives of providing the public services or programs in higher-cost regions (which may be among the poorest) would not be addressed.

With more than two cost types where  $\theta \in [0, 1]$ , there exists a critical value  $\theta^*$  such that only local counties with  $\theta$  below  $\theta^*$  bid for the program. In such a scenario, we expect a partial separating equilibrium in a one-period game.

To make the analysis of greater policy relevance, we assume that individual rationality constraint holds for all counties in the province in the numerical simulation in Part III. Thus the expected gains from the program for the local government can be expressed as

$$\text{Expected gain} = \text{Pr}_L(\text{Win}) * [U(e, T_L) + T_L - C(e, \theta)], \quad (3)$$

where  $\text{Pr}_L(\text{Win}) = p * q$ .

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<sup>8</sup> The optimal effort level  $e^*$  can be solved out given the specific forms of the utility and cost function. For the purpose of illustration, we normalize  $e$  to zero.

Here, the probability of winning the program for the county,  $Pr_L (Win)$  is a product of two probabilities:  $q$ , the probability for the local county to win the program inside the province; and  $p$ , the probability for the province to win the program in the central auction. Note that  $q$  is a function of biddings from all counties; the functional form is affected by the selection scheme of the provincial government, and the heterogeneous cost types across counties.

The provincial government makes two decisions. First, it selects one local proposal  $T_L$  among all offered by local counties; second, it decides the optimal bid in the central selection  $T_P$ . As Niskanen-type bureaucrats, the provincial government obtains utility from maximized net-transfer gains (the difference between the amount obtained from the central  $T_P$  and the amount allocated to the local county  $T_L$ ), and from perquisites related to the performance of the program.  $V(T_L)$  are assumed to be a function of the budget allocated the local government  $T_L$ , where  $V'(T_L) > 0$ .

The maximization problem facing provincial government is:

$$\text{Max } E [V(T_L) + (T_P - T_L)]. \quad (4)$$

Note that the province competes with the other  $n-1$  provinces for the program. Let  $p$  denote the probability that a province wins the program. Thus the expected gains for the province from the program can be expressed in equation (3):

$$\text{Expected gains} = p * [V(T_L) + (T_P - T_L)]. \quad (5)$$

It should be noted that  $p$ , the probability to win the program in the central selection, is a function of biddings  $T_P$  from all provinces, the functional form is determined by the selection scheme adopted by the central government (discussed later in the paper).

As mentioned in the previous section, the central government acts as a benevolent planner. The objective function of central government is a lexicographic one: first it sets forth explicit objectives of the program  $X^O$ , then the central government selects the most cost-efficient proposal  $T^*$  among all the provincial proposals given that the expected final outcome  $EX$  in the chosen province meets the objective  $X^O$ .

$X$ , the final outcomes of the program, is a function of effort  $e$  exerted by the local county, and a function of the budget  $T_L$  allocated to the county. There are uncertainties involved with the realization of  $X$ . Given the amount of funds  $T_L$  and the effort level  $e$ , the outcome  $X$  follows a probability density function  $f(X|e, T_L)$  over  $(X^L, X^H)$ , where  $X^L$  represents the worst outcome, while  $X^H$  the best outcome. We assume that:

- holding the funding  $T_L$  constant, the distribution of the outcomes under the high effort  $f(X|e^H, T_L)$  first-order stochastically dominates the distribution under the low-effort level  $f(X|e^L, T_L)$ , i.e., the higher the effort exerted by the local county, the greater is the chance that a better outcome  $X$  is achieved; and

- holding the effort level  $e$  constant, the distribution of the outcome  $X$  with a high-funding level  $f(X|e, T_L^H)$  first-order stochastically dominates the distribution of the outcome  $X$  with a low funding level  $f(X|e, T_L^L)$ , i.e., the higher the budget spent on the program, the greater is the chance that a better outcome  $X$  is achieved.

The contract design problem for the central government is to set up a selection scheme such that:

$$\text{Min } T_P, \text{ s.t. } EX = X^O, \quad p \in \{1, \dots, n\} \quad (6)$$

where

$$EX = \int X(e, T_L) f(X|e, T_L) dx,$$

given that  $T_P$  and  $T_L$  satisfy conditions (1), (2), and (4).

### Conditions for the first-best solution

Suppose that the central and the provincial governments had full access to the information of local economic and social conditions  $\theta$ . Then the cost to carry out the program in each county could easily be calculated for different levels of local effort. Furthermore, if the effort level  $e$  of the county were observable, the central government could reach a contract with the counties through the intermediation of provincial governments, in which the budget of the program is a function of the requisite local-effort level. In such a setting, it is optimal for local agents to exert the level of effort required to achieve the program objectives. The central government thus successfully assigns the program to the most cost-effective agent. However, such social and optimal solution is unlikely to hold in reality. Counties with private information about local economic and social conditions do not reveal it to upper governments in their program proposals.

The local governments have incentives either to overstate or understate their information. For instance, they might understate their true costs in order to increase their possibility to obtain financing for the program, given the fact that the central government intends to minimize budget outlays. Alternatively, they may exaggerate costs in order to obtain a higher transfer, if their chance of winning the bid is independent of the amounts bid.

Furthermore, since the local effort is not observable by higher-level governments, the county selected does not have an incentive to exert the proper effort required to achieve the first best outcome once the program is granted.

### Agenda design by upper levels of government

Though the central government has a disadvantage in its access to local information, **it can control the agenda of the program selection and implementation**, because it is the first mover in the game.

The agenda involves two parts: (1) a program auction among all the local agents; and (2) program evaluation afterwards. The connection between the two parts of the agenda is a reward/punishment scheme—a scoring system. Given the assumption that both provincial and county governments are Niskanen type of agents, the rule of auction is set such that the **proposal with the lowest scaled budget to achieve specified standards will be selected**. Such an auction rule will suppress local incentives to expand the budget.

However, some local government may be tempted to understate their budget in order to win the program and then exert almost zero effort to implement it. To avoid such a moral hazard, we introduce a scoring system as a reward/punishment scheme. After the program is implemented locally, an evaluation is performed through specified reporting on outcomes, eventually subject to internal and external audits. Compared with standards set beforehand, an accountability score  $S_t$  is assigned according to the performance. The accountability score  $S_t$  is set to be a strictly increasing function of the project outcome  $X_t$ :

$$S_t = g(X_t - X_t^0) \quad \text{where } d S_t / d X_t > 0.$$

The better the outcome is, the higher score local agent receives.

The score serves as an index of local accountability. The higher the score is, the more accountable local agent. Over time, local agents build up their reputation through an accumulation of accountability scores. These scores are transformed into a scale factor that can be used in the central auction to select local agent for future programs. The scale factor  $\pi$  is calculated as the inverse of a weighted average of previous accountability scores:

$$\pi = 1 / (3w_t * S_t),$$

where  $w_t$  is the weight assigned to the score of period  $t$ .

The more recent the scale factor is the higher the weight it receives. Thus, better performance in a more recent past program results in a lower-scale factor.

Scaled budgets are calculated for each local agent in the auction as follows:

$$\text{scaled budget} = \pi * \text{proposed budget}$$

Local agents exerting proper effort in the current program are rewarded through a low-scale budget in the next auction by increasing its chance to win the next program.

Let us look at a numerical illustration of the scoring system. Suppose all counties start with an accountability score of 1. In the first period, county A gets the program. At the end of the first period, if county A successfully achieves the program objectives, it will obtain a score

greater than 1, say, the accountability score of the current program is 1.1. The scale factor of county A in the second period then becomes  $\pi = 1/1.1 \cong 0.89$ . If county A bids \$1 million for the next program, its scaled budget becomes  $0.89*1 = 0.89$  million. Given the auction rule of choosing the lowest scaled budget proposal, the chance that county A will win the program in the second period is enhanced.

If county A failed to achieve the objectives at the end of the first period, it will score lower than 1, say, its accountability score of this program is 0.67. Its scale factor in the second period becomes  $\pi = 1/0.67 = 1.5$ . So if county A bids \$1 million for another transfer in the second period, its scaled budget =  $1.5*1 = 1.5$  million. Its chances of winning the next program are reduced.

### III. NUMERICAL ILLUSTRATION OF THE MODEL

#### A. The Program

Suppose that the central government has decided to build a national education center for disabled children. There are a number of possible locations for such a center, and the central government has no geographical preferences. In order to ensure that the program is implemented as efficiently as possible, the central government decides to award the program to the province that is able to meet the timeline and quality standards for the center at the lowest possible cost. The provinces will submit bids for the program, based on inputs from counties within their jurisdiction. The range of financial contributions from the central government for the program is US\$1–5 million, and all bids must be kept within this range.

The optimal decisions for the governments will depend on whether they perceive this as a one period or a repeated game. The next subsections will outline the differences between the two timeframes. Decision trees in Figures 1–4 in the appendix describe the decisions of the provincial and county governments. We assume that provincial government adopts the same selection scheme as the central government.<sup>9</sup>

#### B. One-Period Bidding Game

First, county A decides how much to bid, i.e., how large a transfer it will require in order to build the center. For simplicity, we assume that the county only has two discrete choices: to bid \$1 million, the lower bound of the budget, or \$5 million, the higher bound of the budget. Since the provincial government selects the lowest bid, the probability of winning the

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<sup>9</sup> It is politically reasonable to assume that the central government requires all provinces to follow suits . Extension of the model could allow each provincial government the power to determine its own agenda of selection.

program with \$1 million bid is 0.9, whereas the probability to win the program by bidding \$5 million is only 0.01.<sup>10</sup>

If its budget proposal is accepted, the county must decide how much effort to put into the program. A high level of effort costs the county \$3 million, while low effort costs the county \$1 million. If the county exerts the higher effort, its chances of achieving the objective of the program are obviously higher than if it exerts low effort. We assume that if the county is awarded the \$5 million budget, there is a 70 percent chance that the objective will be achieved if the county exerts high effort, while there is only 30 percent chance of success if the county exerts low effort. A similar probability distribution of outcomes is assigned to the case of low budgets. With a smaller amount of available funds, the chance of success is smaller, even if the county exerts high effort. If the objective of the program is achieved, the benefit of the program to the county is \$5 million. If the objective is missed, the benefit is only \$1 million.

The first column at the right hand of Figure 2 is the end value of the program to county A. It is calculated as the sum of the benefits from the program and the transfer from the provincial government, after allowing for the cost of the effort. The second column is the credibility score of the county from the evaluation. If county A successfully achieves the objectives, it obtains a score of 1.1. If county A fails to achieve the objectives, it scores only 0.25.

The decisions of the county are derived through backward induction. The county will follow the decision leading to the largest expected final value in Figure 2. The number in the square is the optimal decision; 1 denotes the upper branch, 2 denote the lower branch. As we can see, **in a game of only one period, the county will bid the lower bound of the budget in order to try to obtain the transfer, and it will exert low effort if it wins the program.**

Counties are heterogeneous in economic and social conditions. Costs vary across counties to achieve the same objectives. Suppose county B (in Figure 3) incurs a higher cost than county A to achieve the same expected outcomes of the program. If it costs county A \$3 million to exert high effort, it costs county B \$6 million to achieve the same probability distribution for the final outcome. Similarly, if it costs county A \$1 million to exert low effort, it costs county B \$2 million to achieve the same probability distribution. The optimal decision for the high-cost county B is the same as that of the low-cost county A. County B will bid the lower bound of the budget, \$1 million, in order to obtain the transfer, and it will exert low effort, \$2 million, if it wins the program.

**If the game is of only one period, the selection scheme is insufficient to make the counties reveal their true types.** The result is a pooling equilibrium, where all counties make the same bid, regardless of their cost structures or the local benefits of the program.

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<sup>10</sup> These probabilities are selected to demonstrate certain aspects of the selection model. They are not computed from a specific probability distribution.



There is no possibility of punishment or reward to encourage high effort from the counties to overcome the problems of moral hazard.

Figure 4 reflects the decision tree of province I in a one-period game. The province has two decisions to make: to bid a high or low budget in the central selection and to allocate a high or low budget to the county. Two kinds of uncertainty are involved in the decision making of the provincial government: the probability of winning the program and the probability distribution of the final outcome. The probability of winning the program is affected by how many provinces enter into the central selection.

In a one period game, the provincial government understands that local governments will exert low-effort in the program, thus the final outcome follows the distribution of the outcomes given that the selected county is to exert a low effort. Since the distribution of outcomes is assumed to be the same for both high-cost and low-cost agents given the same effort level exerted, we do not consider the distribution of types of counties into the figure. The end value of the program to the provincial government is calculated as the sum of the province's utility from the program and the transfer from the central government after the deduction of the transfer to the local government.

For simplicity, we assume that benefits of the project are the same for both provincial and local governments.<sup>11</sup> As illustrated in Figure 4, the optimal decision of the province in the one period game is to bid the lower bound of the budget range \$1 million, and allocate the low budget to the county if the program is approved by the central government.

In a game of one period, the central government has no prior information about the provinces. Since all provinces will bid the lower bound of the budget range, the central government will select one province out of the pool randomly. In this one-period context, it is highly unlikely that the specified program will be successful.

### **C. Repeated Bidding Game**

In practice, an intergovernmental financial relationship often lasts more than one period. Let us assume that the school in our examples will include two different facilities, for children of different ages. These may be built at the same location, but they could also be located in two different provinces and counties.

In the first period, the counties follow a similar sequence of decisions as in the game of one period. At the end of the first period, an evaluation of the performance is made, and an accountability score is given to the county. This score will affect the probability of winning the next program in the second period through the scale factor (as stipulated in the second part). A good performance history increases the possibility of winning the desired funding.

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<sup>11</sup> The simulation result will not change if the benefits differ.

Thus future contracts serve as “carrots” to encourage local counties to build up good reputation. We show that **the optimal decisions in the first period differ if the counties are heterogeneous in their cost of the program.**<sup>12</sup>

Figures 5–8 in the appendix include four decision trees of four types of counties. Figure 5 represents the decision tree of a county which is low cost in both programs of the two periods; Figure 6 represents the tree of the county which is low cost in the first program, and high cost in the second program; Figure 7 represents the tree of the county which is high cost in the first program, and low cost in the second program; Figure 8 represents the tree of the county which is high cost in both programs of the two periods.

The right-hand column in Figure 8 contains the expected values of the program in the second period. The first column of the total expected end value is calculated as the summation of the end value of the first period and the discounted second-period value.<sup>13</sup> We assume all the agents in the model maximize the expected discount value from their decisions. Applying the method of backward induction, we see that the optimal decisions of different types of counties in the first period differ.

If the county is low cost in the first period, it will bid the lower budget, and will exert high effort if it wins the program. Exerting high effort increases the chance of a good final outcome, thus enhances the chance to win the next program. If the county is high cost in the program of the first period, it will bid the higher budget, thus giving up the chance of winning the program in the first period, but maintain the accountability score at 1. Thus if the winning county missed the objective in the first period, there is a larger chance that the high-cost county could obtain the next program.

**Thus, the selection scheme makes the counties reveal their true type to the provincial government in the first period; and exert high effort in the first period if granted the program. We thus reach the social optimal solution in the first period.**

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<sup>12</sup> In a two-period game where all counties are of the same cost type and obtain the same level of utility from the program, we reach a perfect symmetric Nash equilibrium in the first period in which every local county bids the same budget and puts the maximum effort if it wins the program. The logic is as following: starting at a scenario where all counties put in the same first-period effort at  $t = 1$ , each wins the auction at  $t = 2$  with probability  $1/n$ . But if one county puts in slightly more effort, it can then effectively bid just a little more than all other counties at  $t = 2$ , and thus win with probability 1. Therefore, every county will end up putting in the maximum effort.

<sup>13</sup> We assume that the discount factor equals 0.9. If the county is granted \$5 million in the first period, and it exerts high-effort, the value of the program in the first period equals  $5+5-3= \$7$  million. The expected second-period value is \$5.4 million, thus the total expected end value is  $7+ 5.4*0.9= \$11.86$  million.

It is optimal for the provincial government to report the true local budget information given competition from other provinces in the central auction.<sup>14</sup>

In the second period, which is the last period of the game, all the counties will bid the lower bound of the budget range, and exert a low effort if selected. This reflects a general property of finite, multi-period strategic games: the players will always have incentives to “cheat” in the last round, because there are no more rounds and therefore no further effective sanctions or rewards are available.

Scale factor is the core of the selection scheme. Variations in the functional form to calculate the accountability scores from performance outcome  $g(X_t - X_t^O)$ , and variations in the weights  $w_t$  assigned to each score  $S_t$  provide different incentives to provincial and local governments.

For example, in period 2 bids are scaled by their scale factors. If the scale factor of a high-cost county is sufficiently small, it can effectively outbid a low-cost county for the project. Moreover, the scale factor is calculated as  $1 / \sum (w_t * S_t)$ . If the weight  $w_t$  is large, by putting in maximum effort in the first period, a high-cost county may be able to achieve a scale factor small enough to allow it to effectively outbid a low-cost county for the project at period  $t = 2$ .

Agent’s optimal strategy in period 1 therefore depends on the weight  $w$ . If  $w$  is large, it will pay high-cost counties to “compete” for high-scale factors by putting in more effort than the minimum.

However, if this weight is small, only low-cost regions will “compete” for high-scale factors by putting in more effort than the minimum.

Similarly, variations in the method to calculate the accountability scores will affect the equilibrium behavior of local agents. Thus careful design of the formula in the selection scheme is a craft of real world policymaking.

#### IV. IMPLICATIONS OF THE MODEL

The situation in our simulation is similar to the classical “prisoner’s dilemma.” It is generally not possible to obtain an efficient solution in a one-period game of this type. Unless the game

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<sup>14</sup> The role of provincial government is highly simplified in this model in order to reach a clear-cut solution. Being in the middle layer of the political power structure, a provincial government has the agenda control power over local counties, while it is also subject to the control of the central government. Though it is reasonable to assume that the central government requires provinces to follow the selection rules set by the center, allowing provincial government the power to decide on their own agendas will complicate the model in more than one dimension.

is repeated or constricted in some other way, the players will take decisions that are individually rational but which lead to suboptimal solutions to obtain efficiency. ***There must be multiperiod interactions among the different levels of government.*** If the game is of only one period, the local governments will bid as low as possible to obtain the transfer; and will not exert proper effort after receiving the transfer. In a multiperiod game, where the governments care for their reputation in the future, the selecting scheme will help to identify the low-cost agents, and to mitigate moral-hazard behavior.

**In order to mitigate problems of asymmetric information, there must be some element of competition between the different governments at the same level.** There should be more than one province bidding for the program in the central selection, and more than one county bidding in the provincial selection. In addition, not every province or county will receive the transfer. The competition among the agents prevents them from inflating their budget.

To avoid moral hazard, **the transfer scheme must include elements of punishment and rewards from the upper administration** to the lower levels of government, based on the evaluation results of the final outcome. In the above scheme, the scale factor serves as either carrot or stick through its impacts on the agents' probability of winning future programs. The scheme also provides a "learning mechanism," where the outcomes in one period have impacts on the central government's assessment of the abilities of lower levels of government to meet their objectives in subsequent periods. In real-life situations, intergovernmental relations may include a series of different programs. It is reasonable to assume that there is likely to be a correlation between the local accountability of different types of program. Previous experience from one type of program can provide information on the scale factor for another type of program, though probably to a lesser degree than if the two programs are of the same kind.

In order to be able to select the program bids through a competitive process, **the central government must be able to define the specifications of programs very precisely, and to monitor the degree of compliance against these specifications.** The objectives of the program should be measurable, standardized across the counties, and should involve as little subjective judgment as possible. After implementation, it should be possible to evaluate whether objectives are achieved with minimal ambiguity. Unless these conditions are met, agents may be able to influence the central governments' selection of program sites by providing substandard services in areas that are insufficiently defined in the program specifications.

## V. POSSIBLE APPLICATIONS AND EXTENSIONS OF THE MODEL

This section discusses possible applications extensions of the model along two different dimensions. The first subsection outlines how the model can be applied to other areas of intergovernmental finance within a country. The second explores how the model can be

applied to financial relationships between international organizations and governments, specifically in the context of the HIPC initiative.

### **A. Applications to Intergovernmental Transfers**

The model described in this paper, and the conclusions from the analysis, should be relevant for a broad range of mechanisms for intergovernmental transfers. The model could be applied directly to all schemes that include the design and implementation of specific programs or provision of specific services in accordance with predetermined objectives and specifications. These are likely to include most investment programs that are carried out by local governments, but where at least part of the financing comes from the central government, and could cover road programs, regional education and healthcare facilities, and museums and other cultural facilities. For all such programs, the central government could be able to improve the efficiency in program selection and implementation by ensuring that there is competition among potential program locations, and by ensuring that the performance in the implementation of previous programs is taken into consideration when new programs are awarded.

In some cases, special-purpose grants have some similarities with capital-financing programs. The financing might be linked to specific objectives and deliverables, and it is often possible to monitor the achievement of the objectives. However, special-purpose grants are often given to all local governments, or to all governments of a specific type (for instance location), according to objective criteria. It will usually not be possible to create direct competition between different local governments in the same way as for capital investment, and it might be difficult to give the local governments effective incentives for efficient implementation of the objectives related solely to the special-purpose grants.

One possibility could be to combine the special-purpose grants with a bonus scheme, which creates a certain degree of competition. Local governments that surpassed certain performance thresholds would receive an additional bonus. For instance, if the special-purpose grant is meant to support education facilities for disabled children, the objective might be that 90 percent of all disabled children should have received six years of schooling by the time they were 13, or that the literacy rate among disabled children should be 95 percent. If a local government ensures that 93 percent of the children receive schooling, or that literacy is above 97 percent, they would receive a bonus payment.

An alternative, or supplementary, approach could be to create incentives by allowing local governments to build track records across different types of intergovernmental finance schemes. For instance, the county that performed well in providing schooling to disabled children under a special-purpose grants scheme could see this reflected in an improved scale factor for future capital-investment grants. Thus, the possibility of applying “local reputation” for the sizable capital grants could be used to leverage better performance in the areas of special purpose transfers for basic health care and education, which may otherwise be taken for granted.

## B. Applications to International Financing Issues

The model and the results should also be relevant in situations where international organizations or bilateral donors provide financial support to developing countries. One prominent example of such financing schemes is the HIPC scheme, where the World Bank, the IMF and several bilateral donors provide debt relief to the least developed countries, in order to reduce their total debt burden to a sustainable level. The debt relief is conditional on implementation of national programs for poverty reduction, financed by the funds made available through reduced debt-service payments.

Debt relief under the HIPC initiative can be modeled as a multilayered strategic game, of the type discussed in this paper. In each country, there are clearly defined objectives and deliverables for the financing provided. It could be argued that the objectives of the HIPC initiatives are clearly in the direct self-interest of the countries, and that no further incentives should be necessary. Unfortunately, experience from the first two years of the initiative suggests that there are major differences in the quality of program implementation in different countries, and there is a clear need to give stronger incentives for efficient implementation of the poverty-alleviation measures. As demonstrated previously in this paper, the fact that the level of government that implements a program receives benefits from it is not sufficient to ensure that the most well-designed programs are selected or that the implementing government will put in the level of effort that is optimal from a national perspective.

In order to maximize the benefits of the HIPC initiative, the following lessons could be of relevance:

- *The initiative should be formulated as a multiperiod game.* If it is perceived as a one-time payment, the countries will have limited direct incentives for efficient implementation of the targets. If possible, transfers to finance debt relief in one period should be contingent on the implementation of the poverty-reduction programs in the preceding period.
- *Introducing an element of competition between the potential beneficiaries could enhance efficiency.* Owing to the humanitarian nature of the initiative, it is not possible to refuse to give eligible countries access to the scheme. Competition would have to be created through other means. One option is to introduce a bonus scheme, of the type discussed above for special-purpose grants in a national context. Another option could be to ensure that high-performance countries were able to capitalize on their performance in other areas, for instance in their access to other international-financing mechanisms, or eventually a ratings system affecting access to capital markets.
- *Great care should be taken in selecting performance indicators* for implementation of the poverty-relief programs. So far, significant attention has been given to tracking the input side, in the form of funding provided to different expenditure programs.

This form of tracking serves a custodial purpose, but it does not give any strong incentives toward achieving the objectives of the program. A stronger focus on objectives and deliverables, including by linking the incentive structures to these parameters, might help the different levels of government to internalize the objectives and enhance their performance in achieving these.

- There would be an incentive for national governments, and multilateral and bilateral technical assistance, *to institute credible audit functions*, and to provide improved information on poverty-related outcomes.

Figure 2. County A (Low Cost): Game of One Period

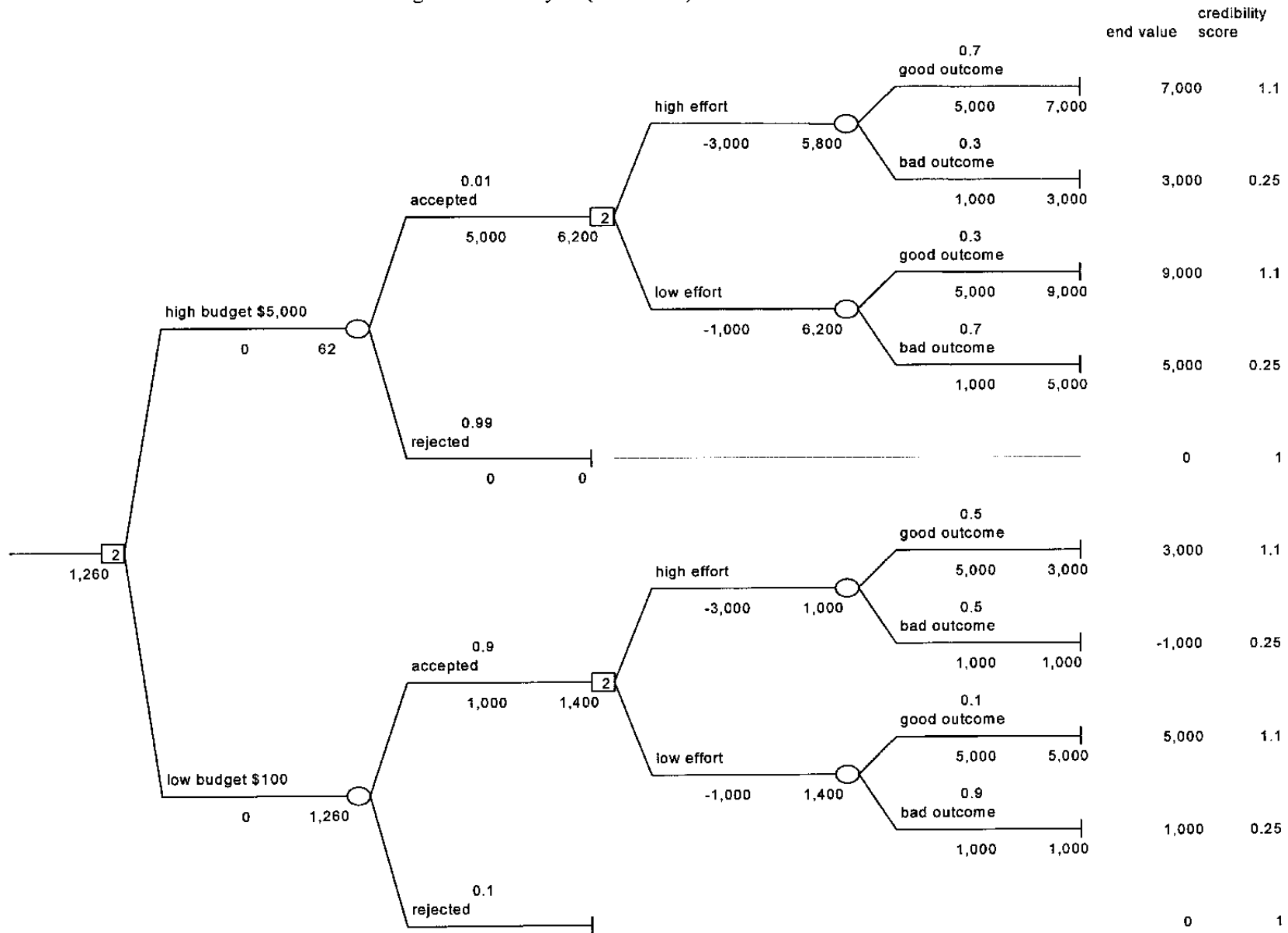




Figure 3. County B (High Cost): Game of One Period

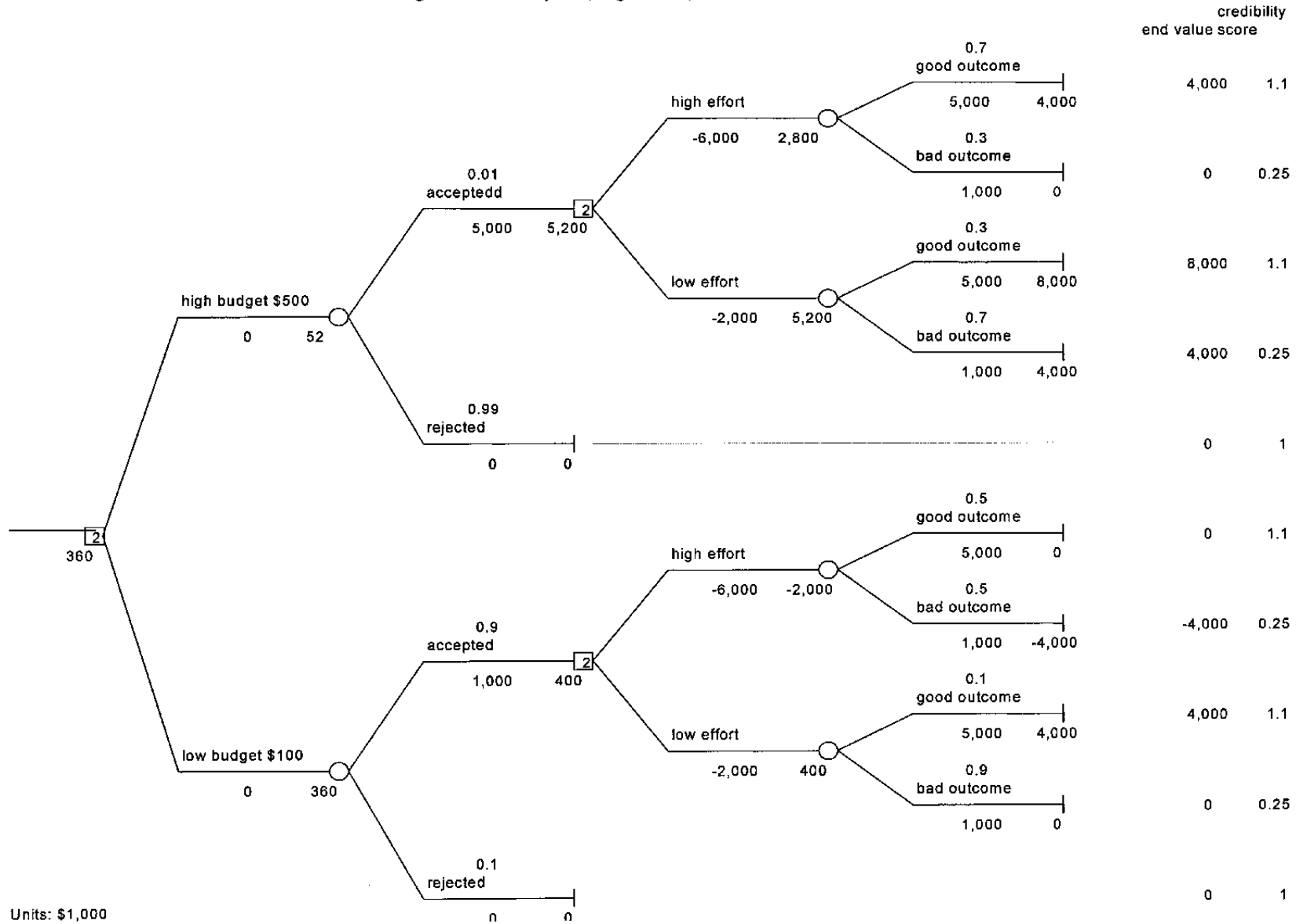


Figure 4. Province I: Game of One Period

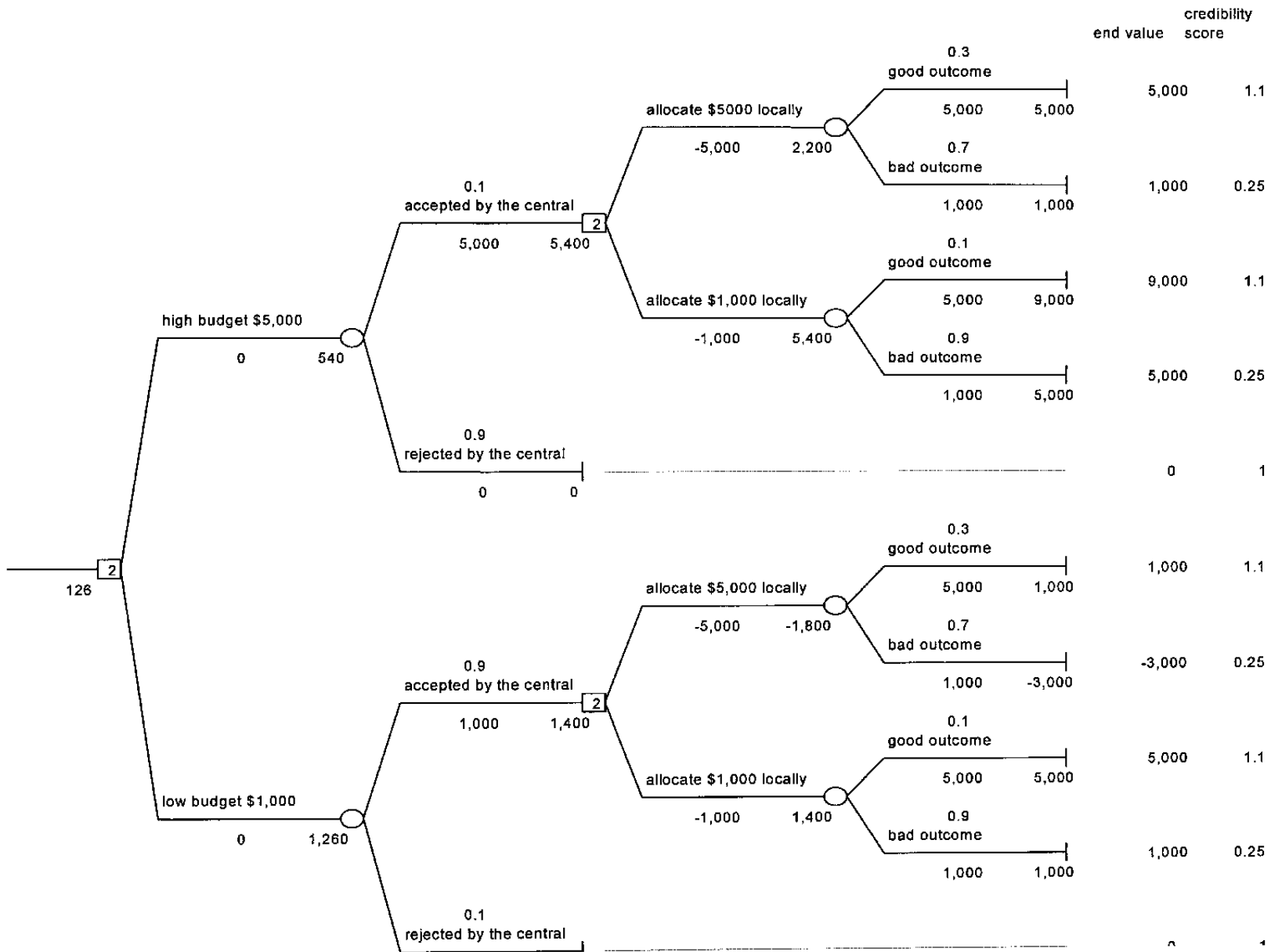
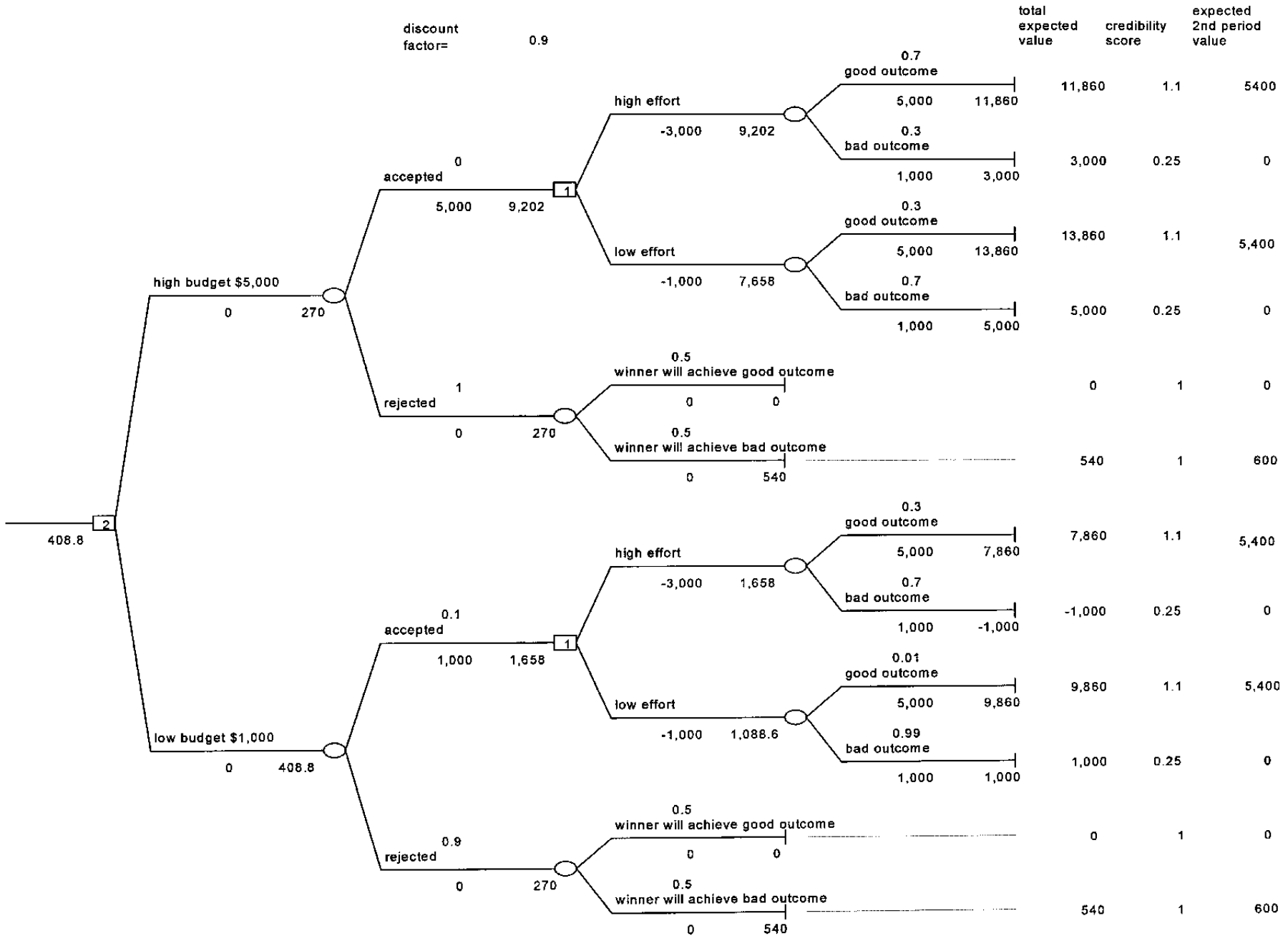
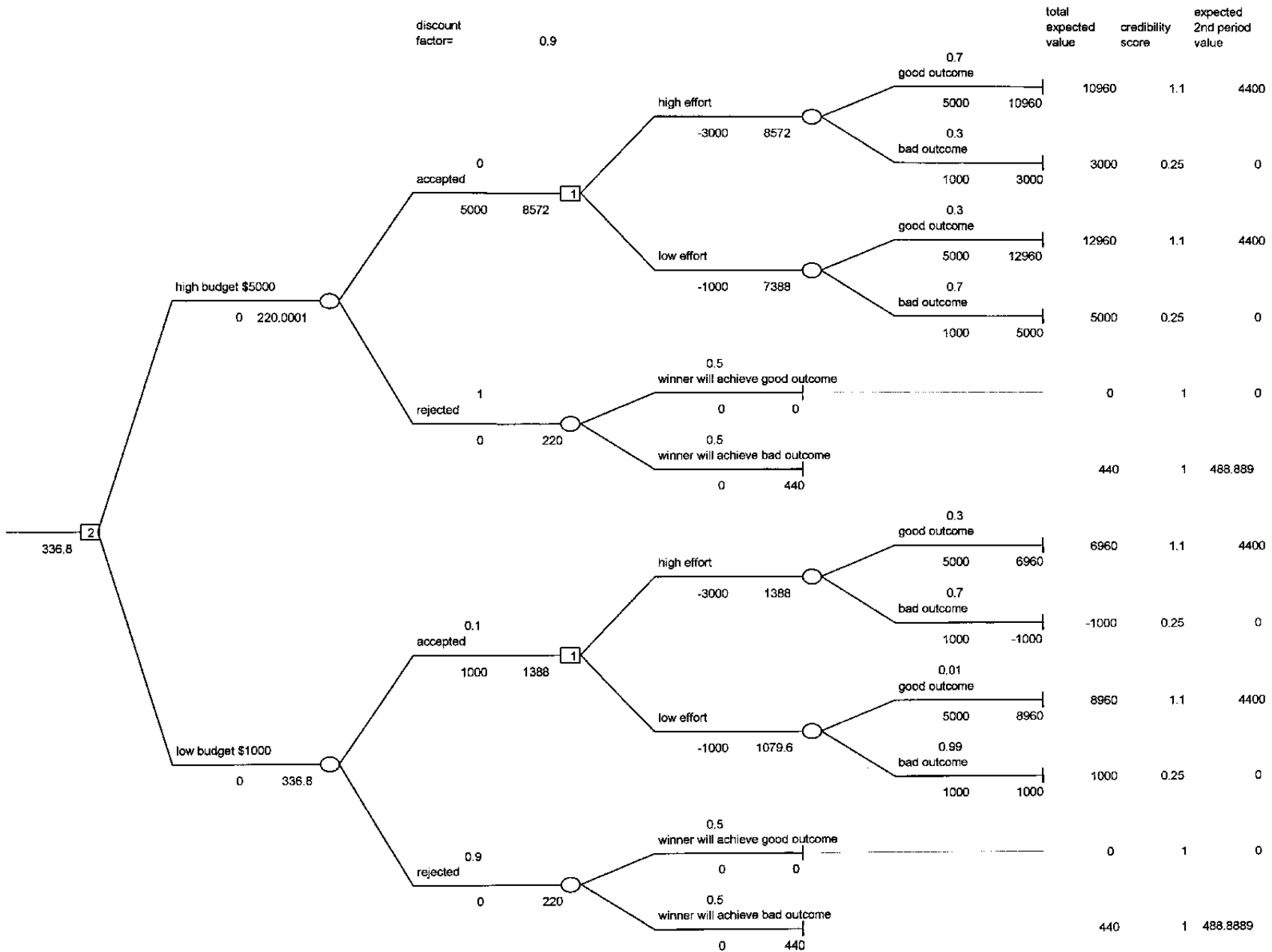


Figure 5. County 1 (Low Cost in Both Projects): Game of Two Periods



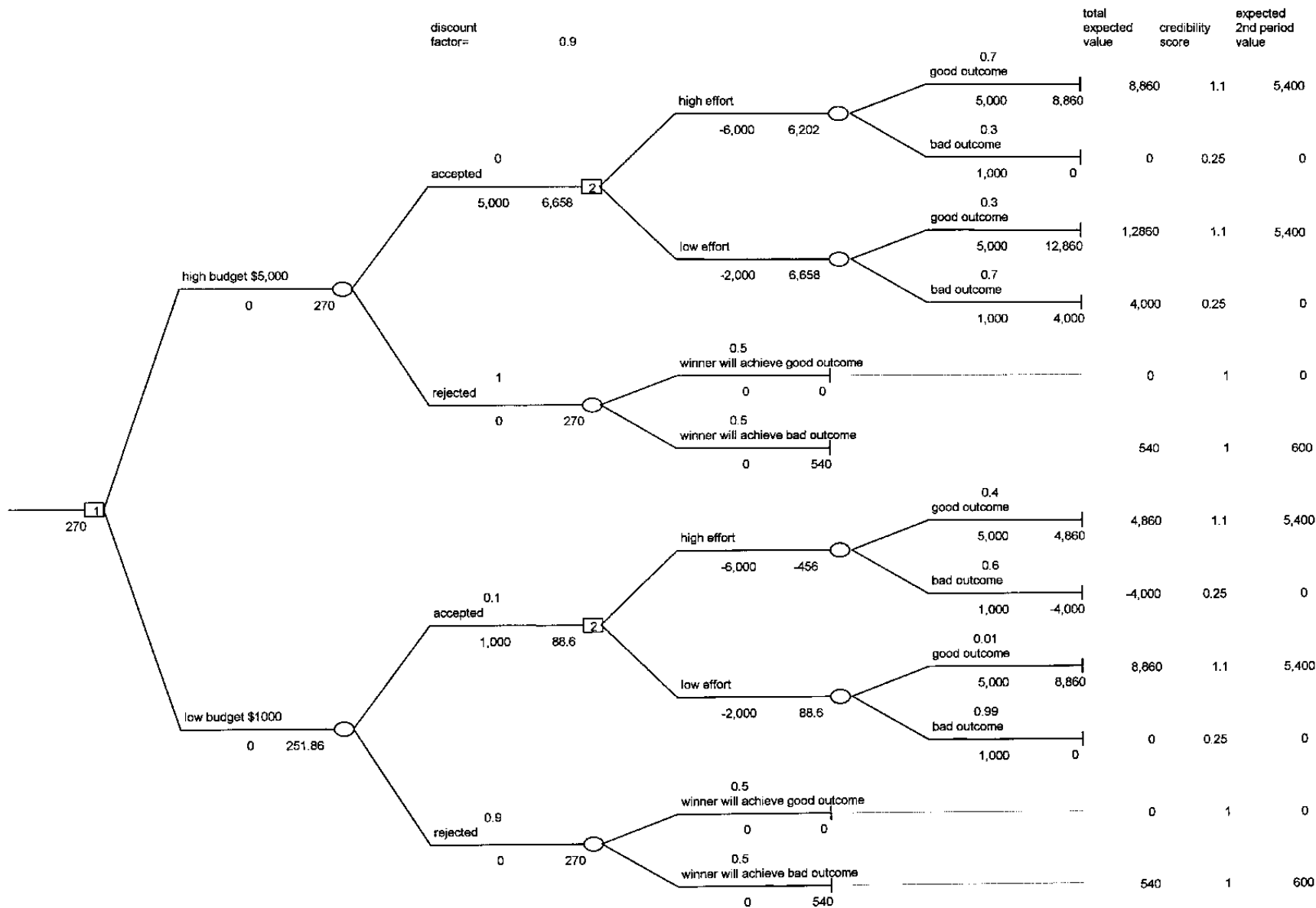
Units: \$1,000

Figure 6. County 2 (Low Cost of the 1<sup>st</sup> Project, High Cost in The 2<sup>nd</sup> Project): Game of Two Periods



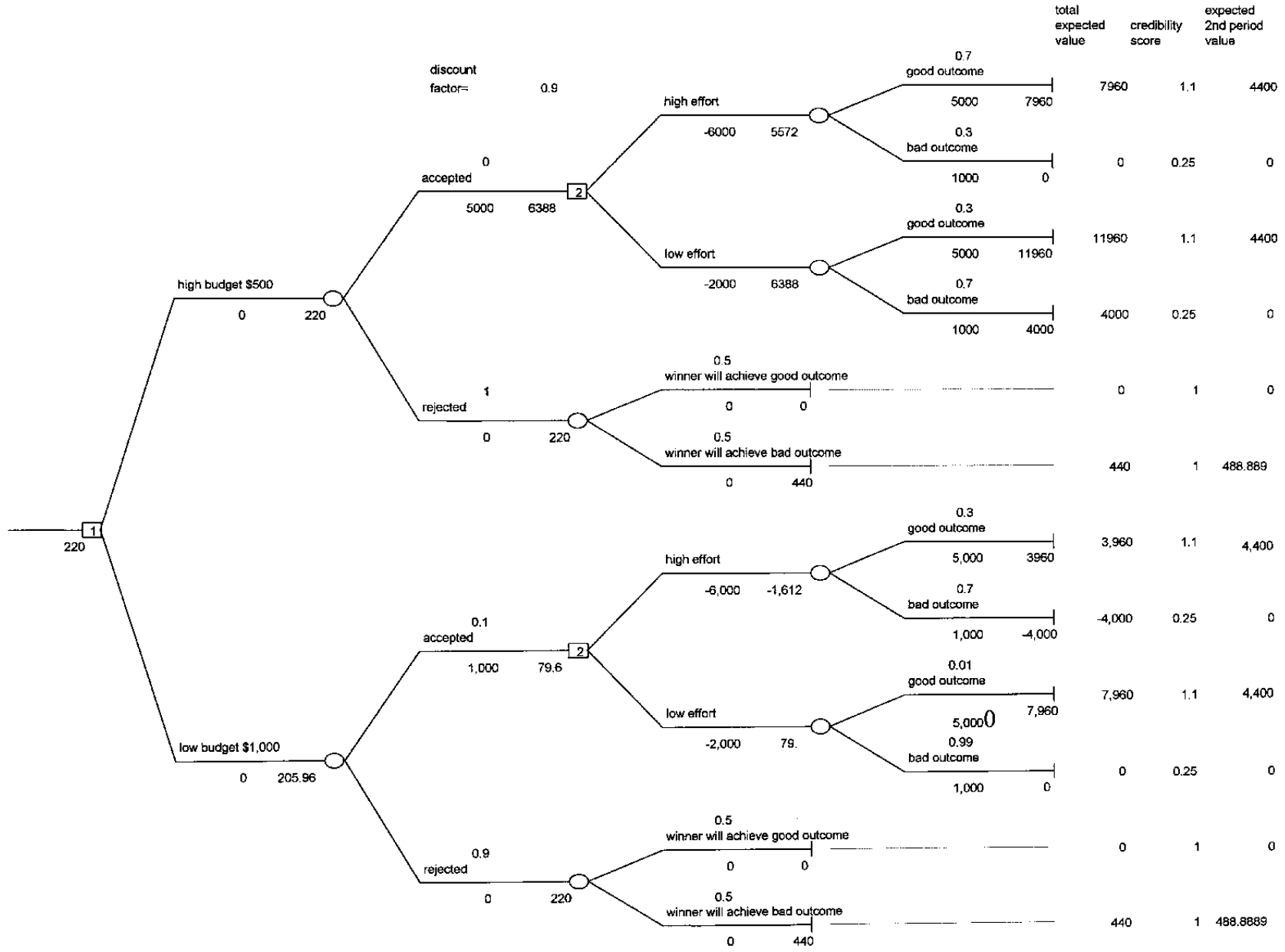
Units: \$1000

Figure 7. County 2 (High Cost in the 1<sup>st</sup> Project, Low Cost in the 2<sup>nd</sup> Project): Game of Two Period



Units: \$1,000

Figure 8. County 2 (High Cost in Both Projects): Game of Two Periods



Units: \$1,000

## References

- Ahmad, Ehtisham and Vito Tanzi, eds., 2002, *Managing Fiscal Decentralization*, (London and New York: Routledge).
- Bird, Richard M., 1995, "Decentralizing Infrastructure: For Good or For Ill?" in *Decentralizing Infrastructure: Advantages and Limitations*, ed. by Antonio Estache, World Bank Discussion Paper 290 (Washington: World Bank).
- Cramer, Jacques, Antonio Estache, and Paul Seabright, 1995, "The Decentralization of Public Services: Lessons from the Theory of the Firm," in *Decentralizing Infrastructure: Advantages and Limitations*, ed. by Antonio Estache, World Bank Discussion Paper 290 (Washington: World Bank).
- De Groot, Hans, 1988, "Decentralization Decisions in Bureaucracies as a Principal Agent Problem," in *Journal of Public Economics*, Vol. 36 (August), pp. 323–37.
- Diamond, Jack, 2002, "The Role of Internal Audit in Government Financial Management: An International Perspective," IMF Working Paper 02/94 (Washington: International Monetary Fund).
- Humplick, Frannie, and Antonio Estache, 1995, "Does Decentralization Improve Infrastructure Performance?" in *Decentralizing Infrastructure: Advantages and Limitations*, ed. by Antonio Estache, World Bank Discussion Paper 290 (Washington: World Bank).
- Kofman, Fred, and Jacques Lawarre, 1993, "Collusion in Hierarchical Agency," in *Econometrica*, Vol. 61 (May), pp. 629–56.
- Lockwood, Ben, 2002, "Distributive Politics and the Costs of Centralization," in *Review of Economic Studies*, Vol. 69, pp. 1–25.
- Rao, Govinda, 2002, "Fiscal Decentralization in Indian Federalism," in *Managing Fiscal Decentralization*, ed. by Ehtisham Ahmad and Vito Tanzi (London and New York: Routledge).
- Seabright, Paul, 1996, "Accountability and Decentralization in Government: An Incomplete Contracts Model," in *European Economic Review*, Vol. 40, pp. 61–89.
- Tanzi, Vito, 2002, "Pitfalls on the Road to Fiscal Decentralization," in *Managing Fiscal Decentralization*, ed. by Ehtisham Ahmad and Vito Tanzi (London and New York: Routledge).