OPTIMAL CONTRACTS WHEN ENFORCEMENT IS A DECISION VARIABLE: A REPLY

STEFAN KRASA   ANNE P. VILLAMIL*

June 27, 2002

*We thank Eddie Dekel, Karol Janda, and Tridib Sharma for helpful comments and discussions.

1 Introduction

In a simple debt contract the investor seizes all of a firm's assets when the project return is below some threshold and receives a constant payment when the return is higher. Krasa and Villamil (2000) show that simple debt contracts *that are optimal (i.e., give the investor the highest payoff)* among the class of deterministic contracts in the costly state verification model, and that satisfy technical conditions (A1), (A2), and a reservation utility constraint, are optimal in a more general costly enforcement model even when stochastic monitoring is possible.[1] The italicized segment of this statement was not made explicit in Theorem 1 in Krasa and Villamil (2000). As Sharma points out, this restriction is necessary for the result to hold. Sharma also points out that assumption (A2) had a typographical error. Assumption (A2) in Krasa and Villamil (2000) should have appeared as $x_0 < \sum_{x<x_k}(x-c)\beta(\{x|x<x_k\})$, where $c = c_I + c_E$.

By showing that simple debt contracts are robust to stochastic monitoring, Krasa and Villamil address the well known Mookherjee and Png (1989) critique that when stochastic monitoring is possible in the costly state verification model, simple debt contracts are no longer optimal.[2] As stated above, Krasa and Villamil (2000) proved that those simple debt contracts that are optimal among deterministic contracts remain optimal when stochastic monitoring is possible. Thus the main point in Krasa and Villamil (2000) not only remains valid but is unchanged. The assumption that Sharma shows is necessary (i.e., optimal simple debt contracts) is implicit in the proofs in Krasa and Villamil (2000), but was not stated explicitly. In the remainder of this reply we clarify the relationship between Sharma's example and our results.

[1] The costly enforcement model extends the Townsend (1979) costly state verification model in two ways: (i) enforcement is a decision variable, and (ii) agents can renegotiate contracts.

[2] In classic papers, Gale and Hellwig (1985) and Williamson (1986) showed that simple debt contracts are optimal *when monitoring is assumed to be deterministic.* The optimal stochastic contract does not resemble a standard loan contract because the stochastic contract is highly state-contingent (i.e., it does not have the fixed payoff that characterizes debt in most states). Stochastic contracts are studied in Section 3.2 of Krasa and Villamil.

2 The Optimal Contract

The crucial difference between the analysis in Krasa and Villamil and Sharma lies in the role of the renegotiation proofness constraint, i.e., equation (1.4). In both papers, (1.4) rules out stochastic contracts. Thus attention can be restricted to deterministic contracts, thereby addressing the Mookherjee and Png (1989) critique. However,

- For the investment projects in Krasa and Villamil (2000), constraint (1.4) is slack when only deterministic contracts are considered.
- Sharma (2002) studies the more general case where (1.4) binds for deterministic contracts.

The implication for investment projects in Krasa and Villamil (2000) is embedded in assumption (A2). Specifically, Proposition 2 in Krasa and Villamil (2000) shows that deterministic contracts from the costly enforcement model can be mapped one-to-one into deterministic contracts in the costly state verification model.[3] As a consequence, an optimal deterministic contract in the costly state verification model is optimal in the costly enforcement model if that contract is renegotiation proof. Assumption (A2) applied to this optimal contract from the costly state verification model is a sufficient condition for renegotiation proofness constraint (1.4) to be satisfied.

In contrast, assumption (A2) is satisfied in Sharma (2002) for an alternative simple debt contract $A(\cdot)$ but not for the simple debt contract that gives the investor the highest payoff $R(\cdot)$. These contracts are depicted in Figure 1,[4] where $R(\cdot)$ and $A(\cdot)$ are simple debt contracts with face values $\bar{R}$ and $\bar{A}$, respectively. $\bar{R}$ is the face value of the optimal simple debt contract in a costly state verification model with deterministic contracts because it minimizes the bankruptcy set B_R, subject to a reservation utility constraint for the entrepreneur. In Sharma's example the investor's expected payoff from enforcement over region B_R, net of total enforcement costs $c = c_I + c_E$,

[3] We thank Karel Janda for the following comments on the proof of Proposition 2. There is a sign error in (ii); it should read $R(x) \leq \bar{R} - c_E$ on B. The new contract should read $R'(x') = R(x' + (\bar{x} - c_E))$ if $x \in B^c$. In (b) the first case should be $x \in B$, and if $x \in B^c$ then $R'(x') = R(x' + (\bar{x} - c_E)) \leq x' + (\bar{x} - c_E) - \bar{x} - c_E) = x'$. Finally, (c) should read $R'(x') = R(x' + (\bar{x} - c_E)) + c_E \leq \bar{R} = \bar{R}'$.

[4] To simplify the graph, assume that both the amount of funds that the entrepreneur can hide $\bar{x}$ and the entrepreneur's monitoring cost c_E are positive but small.

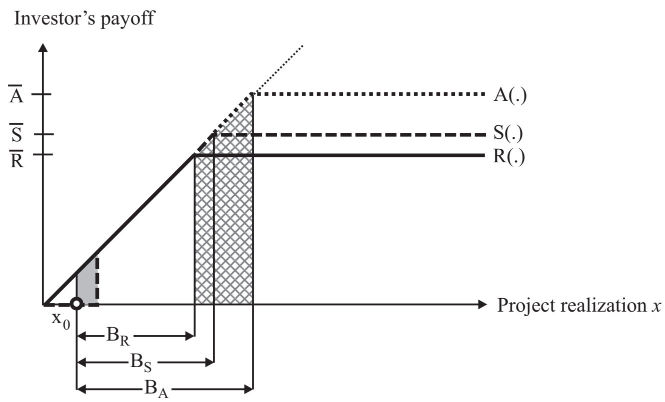

Figure 1: Optimal Debt Contracts

is small relative to x_0, the minimum amount of entrepreneur assets that are available with certainty. Thus contract $R(\cdot)$ does not satisfy assumption (A2), and as a consequence the investor does not have an incentive to request costly enforcement (i.e., contract $R(\cdot)$ is not time consistent). Alternative simple debt contract $A(\cdot)$ satisfies (A2) because contract $A(\cdot)$ includes the cross-shaded area in Figure 1 which adds high realizations states, thereby raising the investor's expected return net of costs c. However, $A(\cdot)$ is not optimal among all deterministic contracts because it does not minimize the bankruptcy set.

Sharma finds an optimal contract $S(\cdot)$, which is not a simple debt contract, that lies between $R(\cdot)$ and $A(\cdot)$. Figure 1 shows that contract $S(\cdot)$ balances the tradeoff between minimizing expected bankruptcy costs and renegotiation proofness, which arises when (1.4) binds. Contract $S(\cdot)$ is a debt contract, but not a simple debt contracts because it assigns all assets in the solid shaded area to the firm. Debt contract $S(\cdot)$ weakens the renegotiation proofness constraint because the entrepreneur retains assets in bankruptcy states. Renegotiation proofness means that agents cannot find a feasible contract that both prefer. To find such a contract it must be common knowledge that both agents can be made better off when bankruptcy occurs. If the entrepreneur retains all assets in a bankruptcy state, it is more difficult to induce the entrepreneur to renegotiate. This weakens the renegotiation proofness constraint and allows both agents to receive higher payoffs, as Sharma's example shows.

3 Concluding Remarks

The tradeoff between minimizing the bankruptcy set and renegotiation proofness, which is the driving force of Sharma's example, is an interesting point that is not investigated in Krasa and Villamil (2000). Theorem 1 was motivated by the Mookherjee and Png critique — do conditions exist in the costly state verification model under which simple debt contracts are robust to stochastic monitoring? The tradeoff explored by Sharma does not exist in the costly state verification model, and hence was not considered in Krasa and Villamil (2000). This indicates that the costly enforcement model is therefore applicable to a wider set of scenarios than it was originally intended to handle.

Department of Economics, University of Illinois, 1206 South 6th Street, Champaign, IL 61820-6978 USA, http://www.staff.uiuc.edu/˜skrasa

Department of Economics, University of Illinois, 1206 South 6th Street, Champaign, IL 61820-6978 USA, avillami@uiuc.edu

4 References

GALE, D. and HELLWIG, M. (1985): "Incentive-Compatible Debt Contracts: The One Period Problem," *Review of Economic Studies,* 52, 647–663.

KRASA, S. and A. P. VILLAMIL (2000): "Optimal Contracts When Enforcement is a Decision Variable," *Econometrica,* 68, 119–134.

MOOKHERJEE, D. and I. PNG (1989): "Optimal Auditing, Insurance, and Redistribution," *Quarterly Journal of Economics,"* 104, 399–415.

SHARMA, T. (2002): "Optimal Contracts When Enforcement is a Decision Variable: A Comment," *Econometrica,* this issue.

TOWNSEND, R. M. (1979): "Optimal Contracts and Competitive Markets with Costly State Verification," *Journal of Economic Theory,* 21, 1–29.

WILLIAMSON, S. (1986): "Costly Monitoring, Financial Intermediation, and Equilibrium Credit Rationing," *Journal of Monetary Economics," 18, 159–179.*