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A solution to the hold-up problem involving gradual investment

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Abstract

We consider a setting in which the buyer's ability to hold up a seller's investment is so severe that there is no investment in equilibrium of the static game typically analyzed. We show that there exists an equilibrium of a related dynamic game generating positive investment. The seller makes a sequence of gradually smaller investments, each repaid by the buyer under the threat of losing further seller investment. As modeled frictions converge to zero, the equilibrium outcome converges to the first best. We draw connections between our work and the growing literature on gradualism in public good contribution games and bargaining games.

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1. Introduction

A standard setting in which the hold-up problem arises involves investment by one party, call it the seller, which benefits another, call it the buyer, where this investment and its associated benefits cannot be verified by a court. Since it may be difficult to specify payment for the investment in a contract, the buyer may not have an incentive to compensate the seller fully; and, consequently, the seller will underinvest.

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To make our subsequent results as stark as possible, in this paper we consider an extreme form of the hold-up problem in which no contracts over investments or its benefits are possible and in which the buyer can appropriate all of the benefits from the seller's investment without providing any compensation. The hold-up problem is so severe in this setting that in the static game typically analyzed, which involves the buyer's paying the seller after the seller's investment is completed, there is no investment in equilibrium.

Interpreting "observability of investment" to mean that the buyer can observe the path of the seller's investment rather than just the aggregate amount, we show that the hold-up problem can be solved (or at least ameliorated) by moving from the static game typically analyzed to a dynamic game. In the dynamic game, the single lump of investment from the static game is divided into a sequence of installments, each consisting of an incremental investment by the seller followed by reimbursement by the buyer. The installments continue until the process breaks down due to exogenous frictions in the environment. Breakdown occurs with positive probability after each installment according to the outcome of a public randomizing device. We show that, for a broad set of parameters, there exists an equilibrium in the dynamic game generating positive investment. We show, further, that there exists an equilibrium of the dynamic game in which investment by the seller comes arbitrarily close to the first-best level as the probability of breakdown approaches zero. These results are striking recalling that the extreme form of the hold-up problem we have assumed yields no investment in the typical static game.

In the dynamic game, the buyer's incentive to pay the seller for each installment stems from the threat that the seller will not continue with further investment otherwise. A given installment is constrained not to be too large relative to future investment or else the buyer's benefit from deviation—its gain from not repaying a particular installment—would exceed the punishment—the loss of further investment. From this insight, one can draw several conclusions about the structure of the equilibrium investment sequence. First, to avoid unraveling, there cannot be a known, finite end to the number of installments. Second, as investment gradually accumulates toward its upper bound, the prospect of losing further investment becomes a less severe punishment, implying that the investment installments must gradually shrink to prevent the buyer from deviating.

The sequential investment equilibrium proposed in this paper as a solution to the hold-up problem shares features of strategies used in practice. The "indefinite delivery/indefinite quantity" strategy, used for billions of dollars of federal, state, and local government projects ranging from construction of passenger rail in Atlanta to renovation of affordable housing in Baltimore [13], is a staged procurement process that allows a party to end the process after each stage conditional on past experience, for example when a buyer decides a seller's quality has been unacceptably low. The literature on procurement management has suggested informally that this strategy, known variously as job order contracting (JOC), delivery order contracting (DOC), and simplified acquisition of base engineering requirements (SABER), may give sellers an incentive to provide high quality without resorting to detailed contracts [17].