1 Introduction

Relation-specific investments often cause holdup problems when contracting is incomplete. Suppose as an example that a seller has an opportunity to make an investment which creates more value inside its relationship to a particular buyer than outside. Relation-specific nature of the investment may result in the buyer's opportunistic behavior. Contracts contingent upon investment-related information could protect the seller, but this is often difficult in reality. Without adequate contractual protection, the seller's anticipation of the opportunistic behavior results in less ~~than~~ ~~the~~ socially optimal level of investment. The holdup problem has played a central role in the economic analysis of organizations and institutions, ~~where~~ many authors proposed various organizational interventions, such as vertical integration (Klein et al., 1978; Williamson, 1985), as remedies to the problem.

In the holdup literature, a fundamental ~~driving force of the inefficiency~~ has been the assumption that contracts contingent upon the nature of relation-specific investment are infeasible, which is a realistic assumption in a wide variety of real-world bilateral trade. On the other hand, the courts can often verify delivery of the goods by the seller, and hence simple noncontingent contracts based on product delivery are often feasible. ~~Recently~~, several articles have studied the roles that formal noncontingent price contracts can play in ~~the resolution of~~ the holdup problem under *spot transaction* (see Section 2 for details).

The present paper offers new perspectives on the roles that such simple noncontingent contracts can play in ~~the resolution of~~ the holdup problem. In particular, we study *repeated transaction* between a seller and a buyer, and demonstrate that a formal noncontingent price contract can help resolving the holdup problem by mitigating the buyer's temptation to renege on ~~its~~ informal agreement with the seller.

In reality, relation-specific investments are often made ~~under~~ long-term and repeated interaction between parties. Coase (1988) pointed out that A.O. Smith, a

large independent manufacturer of automobile frames, had invested in expensive equipments that ~~were~~ highly specific to its main customer such as General Motors for more than fifty years. Also, Coase (2000) found that prior to the acquisition of Fisher Body by General Motors in 1926, Fisher Body had repeatedly made location-specific investments for General Motors. Regarding Japanese manufacturer-supplier relationships, Asanuma (1989) studied the Japanese automobile and the electric machinery industries and ~~found~~ that long-term relationships were more likely to be ~~observed~~ in the transaction of intermediate products that require higher degree of relation-specific investments. According to Holmström and Roberts (1998, p.83), "Nucor [the most successful steel maker in the United States over the past 20 years] decided to make a single firm, the David J. Joseph Company (DJJ), its sole supplier of scrap. Total dependence on a single supplier would seem to carry significant hold-up risks, but for more than a decade, this relationship has been working smoothly and successfully."

Despite the important connection between relation-specific investments and long-term relationships, to the best of our knowledge there ~~are~~ very few theoretical analyses that have ~~previously~~ addressed the holdup problem under infinitely repeated interaction.[1] This might be because, ~~due to~~ the "Folk Theorem" ~~type reasoning,~~ the holdup problem ~~could~~ obviously be resolved under infinitely repeated interaction if the discount factor is high enough. We show that when the discount factor is not ~~so~~ high enough, formal fixed-price contracts can ~~play a crucial role in~~ determining the range of the discount factor in which the holdup problem is resolved.

Along with the repeated interaction, another key element of our analysis concerns the effect of relation-specific investment on the alternative-use value. Most previous theoretical models in the holdup literature assumed, implicitly or explicitly, that

[1]Note that while several recent papers introduce dynamic structures into the analysis of the holdup problem (Che and Sákovics, 2004; Gul, 2001; Pitchford and Snyder, 2004), they study repeated offers rather than repeated transaction.

relation-specific investment *increases* the value of the asset not only within the relationship but also in alternative uses. However, an equally plausible assumption is that the investment *reduces* the value of the asset in alternative uses. For example, if a seller locates its plant adjacent to a buyer, the seller ends up increasing the distance from the plant to alternative buyers. That is, location-specific investment decreases the value of the asset in alternative uses. Rajan and Zingales (1998) an important exception in the existing literature argue that relation-specific investments in a physical asset imply, almost by definition, a reduction in the outside value of the asset. We find that this distinction is important when we investigate the value of formal contracting.[2]

In our analysis of the repeated interaction between a seller and a buyer, formal contracting can reduce the buyer's temptation to renege on its informal agreements with the seller when the relation-specific investment reduces the renegotiation price. And ~~a necessary condition for~~ the renegotiation price ~~being~~ decreasing ~~is that~~ the investment reduces the alternative-use value, which is a plausible case as we discussed above. The result is that a formal fixed-price contract, combined with informal agreements sustained by the value of future relationships, can help resolving the holdup problem. A higher investment can be implemented for a wider range of parameter values (e.g., discount factor) with a combination of a formal contract and informal agreements than with informal agreements only. In other words, formal contracting can ~~play a complementary role of~~ relaxing the self-enforceability condition for informal agreements. At the same time, we also find that there is a certain alternative range of parameterizations in which formal contracting has either no value, or even negative value (in the sense that a higher investment can be implemented only if no formal price contract is written).

[2]Segal and Whinston (2000) find that the value of exclusive contracts depends on whether the outside value of the asset is increasing or decreasing in investment. We assume that exclusive contracts are infeasible because whether or not each party transacts with an alternative outside party is not verifiable.