A survey of the hold-up problem in the experimental economics literature *

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February 25, 2019

Abstract

This paper reviews experimental studies on the so-called “hold-up problem”. Common features in the experimental design and results are summarized. Most experimental studies show evidence of the hold-up problem, but to an extent less severe than what standard theory predicts. Hold-up occurs at the individual level, but exhibits a less severe pattern than theoretical predictions at the aggregate level. A positive correlation is found between the investment stage decisions and subsequent bargaining behaviors. Social preferences largely influence the results in hold-up games. Remedies that enhance the effect of social preferences can effectively alleviate the hold-up problem. These findings in the laboratory setting are also relevant in a real-life hold-up situation, but differences in the specific institution and environment may require more variations in the experimental design.

JEL Codes: L14, C78
Key words: Hold-up problem, bargaining, social preferences

*I am grateful to my supervisors Jan Potters and Cédric Argenton for their valuable comments and suggestions on this paper. I am also thankful to Lisa Bernstein, Clemens Fiedler, Jens Prüfer, Xiaoyu Wang and other participants at the TILEC seminar who provided valuable feedback on this paper.

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1 Introduction

When multiple parties make non-recoverable relationship-specific investments which generate a joint surplus to be divided through \textit{ex post} bargaining, underinvestment may occur. Since the final allocation is determined by the interplay of \textit{ex post} bargaining power of all participating parties, each agent is unlikely to fully appropriate the return from his investment. Therefore, agents refrain from investing at the efficient level for fear of being held-up by their counterparts. This underinvestment is refereed to as the “hold-up problem” in the economic literature (Che and Skovics, 2008). It is a common phenomenon in bilateral transactions that rely on incomplete contracts. Common examples of the hold-up problem can be found in procurement contracts where the manufacturer needs to make product-specific investment beforehand, employment contracts where the employee needs to invest in firm-specific skills, etc. In these cases, the specific investments are noncontractible, and cannot be appropriated by suppliers or employers if being held-up. As a result, manufacturers and employees may make insufficient investments in the investment stage.

Early theoretical analyses of the hold-up problem can be found in Williamson (1971) and Klein et al. (1978). Grout (1984) and Tirole (1986) modeled the hold-up problem. A simplified version of their two-stage model with one investor (seller) and one proposer (buyer) is summarized by Che and Skovics (2008). A buyer and a seller decide upon a contract to trade a positive quantity $q$ at price $t$. Before the trade takes place, the seller makes a binary investment decision with fixed and non-recoverable costs to increase the joint surplus. The investment choice is observable but not verifiable, thus cannot be contracted upon. The price and quantity to be traded in the second stage are the only contractable variables in this case. The socially optimal solution that maximizes the overall payoff yields the seller to invest. However, Nash bargaining solution at the negotiation stage yields an equal split of the gross surplus between the seller and the buyer. When the seller decides whether to invest in the first stage, he anticipates that he bears the whole investment cost but receives only half of the investment return. There are conditions under which a rational seller refrains from investing in the first stage, despite it being socially optimal. A more general two-agent model is analysed by Grossman and Hart (1986). In the first stage, each agent independently makes an investment decision that contributes to a joint-surplus. Agent $i$ invests $I_i$ with per-unit cost $c$. Investments $I_1$ and $I_2$ together generate a joint surplus $R(I_1, I_2)$, with $\partial R(I_1, I_2)/\partial I_i \geq 0$, and $\partial^2 R(I_1, I_2)/\partial I_i^2 \leq 0$. In the second stage, the two agents negotiate over the division of the surplus. The (Nash) cooperative game solution gives a net payoff of $\frac{1}{2} R(I_1, I_2) - cI_i$ to agent $i$. Using backwards induction,
anticipating the bargaining result, agent $i$ chooses the first stage investment level $I_i$ to maximize the net payoff, resulting in the selection of $\hat{I}_i$ that satisfies the first order condition $\frac{1}{2} \frac{\partial R}{\partial \hat{I}_i} = c$. However, the first-best investment levels that maximize the total payoff $R(I_1, I_2) - cI_1 - cI_2$ are given by $(I^*_1, I^*_2)$ that satisfies the first order condition $\frac{\partial R}{\partial I^*_i} = c$. With the assumptions about the first and second order derivatives of $R(.)$, it can be shown that $\hat{I}_i \leq I^*_i$. In the absence of a contract on \textit{ex ante} investments, undesirable underinvestment occurs.

In recent years, conducting laboratory experiments has become a popular data collecting method among economists. It allows researchers to implement the institutional environment that aligns best with theory, to insert strict control that reduces various confounding factors, and to create counterfactuals that establish causality. These features are usually difficult to obtain with field data. The experimental method has been prevalently applied in examining people’s behaviors in strategic interactions. The typical setting of an experiment on the hold-up problem takes the form of a “nested bargaining game”, as phrased by Sonnemans et al. (2001). Two subjects are paired up to participate in a two-stage game. In the first stage, they make non-contractable investments with fixed and non-recoverable costs. In the second stage, they bargain over the surplus generated from previous investment decisions. The detailed set-up varies across different experiments. Investment may come from both subjects or from only one subject, and could be either a continuous decision where the subject selects a level to invest or a binary decision where the subject selects whether to invest or not. The bargaining mechanism also differs across studies, with ultimatum game, dictator game and alternating-offer Rubinstein (1982) bargaining game as the most common forms. Being a bargaining game with a preceding investment stage, the hold-up problem refers to a very specific scenario. As a consequence, the number of experimental studies which specifically focus on “hold-up” games is limited. 12 experimental papers on the hold-up problem are reviewed in the rest of this paper. By comparing their experimental settings, the typical results, and manipulations they employ to solve the hold-up problem, it is found that social preferences play an important role in mitigating the hold-up problem, the effectiveness of which is found to largely depend on various aspects of the game structure.

To resolve inefficiency, economists have been looking into ways of diminishing hold-up and restore investment incentives. Conventional remedies can be categorized into two major types: organizational remedies and contractual remedies (Che and Skovics, 2008). Laboratory experiment provides a convenient testbed to examine the treatment effect of a certain policy under strictly controlled conditions. Experiments testing the two types of strategic remedies are limited in numbers. Joint ownership and option contracts are found to effectively mitigate the hold-up
problem. In addition to these conventional remedies, behavioral remedies such as observable investment, costly punishment, communication, and the provision of social history are found to have a significant effect through the channel of social preferences.

The rest of the paper is organized as follows. The next section summarizes the experimental studies on the hold-up problem. Experiments are classified based on their experimental design. Section 3 reviews the different remedies for the hold-up problem, which includes conventional remedies as well as behavioral remedies. The main findings and results are summarized in Section 4. Section 5 discusses the generalizability of laboratory results and implications for further research.

2 Experiments about hold-up

Experimental studies on the hold-up problem differ in various aspects of their design. Nevertheless they share common features in the basic set-up. A prototypical hold-up experiment consists of two stages: a production stage requiring sunk investments and a subsequent bargaining stage to divide the surplus earned from the joint-production. Following the theoretical model by Grossman and Hart (1986) and Tirole (1986), most experiments pair up two endowed subjects who each decide individually how much of their endowment to be invested in a joint production. In some experiments, the two subjects are explicitly framed as “buyers” and “sellers” (Hackett, 1993, 1994; Sloof et al., 2004, 2007), representing the original incomplete contract problem. Some other experimenters frame the roles as “investor” and “trading partner” (Ellingsen and Johannesson, 2004a,b). In other studies, a neutral framing that labels different roles by different letters is applied to. Only a few early experiments allow both parties to make the investment decisions. In more recent experiments, the more common setting is to allow only one investor. Subjects in all studies are undergraduate students with business and economics majors. A comparison of the general features of experimental design is shown in Table 1.

2.1 Comparison of experimental settings

Despite variation in details, an experiment on the hold-up problem essentially consists of an investment stage and a subsequent bargaining stage. For each of the two stages, experiments differ in whether both subjects or only the non-investor is allowed to take actions and whether the decisions are dichotomous or continuous. In the bargaining stage, the specific bargaining mechanism employed in each study also differs. A summary of the hold-up experiments reviewed in this paper by their
Table 1: Experimental design of the hold-up problem (I)

<table>
<thead>
<tr>
<th>Study</th>
<th>Periods</th>
<th>Matching</th>
<th>Neutral framing</th>
<th>Fixed role</th>
<th>Tested treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hackett (1993)</td>
<td>10</td>
<td>Stranger</td>
<td>No</td>
<td>No</td>
<td>Relative investment incentives</td>
</tr>
<tr>
<td>Hackett (1994)</td>
<td>10</td>
<td>Stranger</td>
<td>No</td>
<td>No</td>
<td>Discount rate, investment observability</td>
</tr>
<tr>
<td>Berg et al. (1995)</td>
<td>1</td>
<td>One-shot</td>
<td>Yes</td>
<td></td>
<td>Social history</td>
</tr>
<tr>
<td>Gantner et al. (2001)</td>
<td>2</td>
<td>Random</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Sonnemans et al. (2001)</td>
<td>18</td>
<td>Block structure</td>
<td>Yes</td>
<td>Within blocks</td>
<td>Level of outside option</td>
</tr>
<tr>
<td>Oosterbeek et al. (2003)</td>
<td>10</td>
<td>Block structure</td>
<td>No</td>
<td>Within blocks</td>
<td>Level of outside option</td>
</tr>
<tr>
<td>Ellingsen and Johannesson (2004a)</td>
<td>1</td>
<td>One-shot</td>
<td>Yes</td>
<td></td>
<td>Communication</td>
</tr>
<tr>
<td>Ellingsen and Johannesson (2004b)</td>
<td>1</td>
<td>One-shot</td>
<td>Yes</td>
<td></td>
<td>Communication</td>
</tr>
<tr>
<td>Sloof et al. (2004)</td>
<td>20</td>
<td>Block structure</td>
<td>No</td>
<td>Within blocks</td>
<td>Level of outside option</td>
</tr>
<tr>
<td>Sloof et al. (2007)</td>
<td>36</td>
<td>Block structure</td>
<td>No</td>
<td>Within blocks</td>
<td>Investment costs and observability</td>
</tr>
<tr>
<td>Fehr et al. (2008)</td>
<td>10</td>
<td>Random</td>
<td>No</td>
<td>Yes</td>
<td>Ownership structure</td>
</tr>
<tr>
<td>Hoppe and Schmitz (2011)</td>
<td>1</td>
<td>One-shot</td>
<td>Yes</td>
<td></td>
<td>Contractual changes</td>
</tr>
<tr>
<td>Dufwenberg et al. (2013)</td>
<td>5</td>
<td>Random</td>
<td>Yes</td>
<td>Yes</td>
<td>Level of outside option</td>
</tr>
</tbody>
</table>

The earliest experiment on the hold-up problem dates back to Hackett (1993, 1994), the design of which closely resembles the model by Grossman and Hart (1986). Hackett conducts ten periods of a two-sided nested bargaining game, using stranger matching, so that each subject will not encounter another subject that he had interacted with twice, to avoid reputation effects. The roles of buyer or seller are randomly assigned to subjects at the beginning of every period. Subjects simultaneously select a value that induces an unrecoverable quadratic cost. The values chosen by both players generate a joint surplus with production cost, the value of which is known to both subjects. Both the surplus and the production cost can be either high or low. The value selected by the buyer corresponds to the probability of a high surplus, and the value selected by the seller corresponds to the probability of low production cost. The second-stage bargaining is a modified version of the Rubinstein (1982) procedure. In his implementation, Hackett fixed
Table 2: Experimental design of the hold-up problem (II)

<table>
<thead>
<tr>
<th>Both propose</th>
<th>Investment Stage</th>
<th>Single proposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both invest</td>
<td>Continuous</td>
<td>Dictator game</td>
</tr>
<tr>
<td>Continuous</td>
<td>Ellingsen and Johannesson (2004a)</td>
<td></td>
</tr>
<tr>
<td>Only one invests</td>
<td>Continuous</td>
<td>Ultimatum game</td>
</tr>
<tr>
<td>Continuous</td>
<td>Sonnemans et al. (2001)</td>
<td>Dufwenberg et al. (2013)</td>
</tr>
<tr>
<td>Binary</td>
<td>Oosterbeek et al. (2003)</td>
<td>Ellingsen and Johannesson (2004b)</td>
</tr>
<tr>
<td>Single proposes</td>
<td>Level Offer</td>
<td>Hoppe and Schmitz (2011)</td>
</tr>
<tr>
<td>Dictator game</td>
<td>Gantner et al. (2001)</td>
<td></td>
</tr>
</tbody>
</table>

the maximum number of allowed bargaining rounds without informing the subjects, following the setting of Binmore et al. (1991), so that the subjects only know that there is a positive probability of a forced breakdown after each bargaining round. Before the bargaining stage, subjects each can decide whether to enter the bargaining stage or not. One or both subjects opting out terminates the game, and allocates all the surplus to the buyer and all the costs to the seller. Bargaining only proceeds when both parties agree to bargain. Subjects alternate in making offers, with the buyer proposing first in all odd-numbered periods and the seller proposing first in all even-numbered periods. In each bargaining round, the responder chooses whether to accept or to reject and come up with a counter-offer in the next bargaining round. The disagreement payoff is the same as the opting out results. After the allocation of the surplus is finalized, each subject has an independent option to veto the results. Selection of veto by at least one subject eradicates all surplus and production cost, leaving both subjects zero payoffs.

In retrospect, there are many unique features in the design of Hackett (1993, 1994). Both the production function and the sunk cost function are non-linear, while most later studies use either a linear function or a binary choice for these two decisions. Roles are reassigned at the beginning of every period, indicating that it is possible for the same subject to play both roles, while most later studies have fixed roles for the subjects for the whole session. Different from one-round simple bargaining mechanisms as employed in many later experiments, Rubinstein alternating offer procedure is implemented in Hackett (1993, 1994), allowing him to gather more information on the bargaining behavior and examine the effect of discount rate on the results by manipulating the maximum allowed bargaining
rounds. In his “high discount rate” treatment, the maximum number of allowed bargaining round for some periods is fixed to be one, which is equivalent to a one-round ultimatum game as in many other studies. Apart from the above three aspects, the most distinctive feature of Hackett (1993, 1994) is the inclusion of a veto option. The hold-up behavior on the buyer’s side could take two different forms: a disadvantageous allocation in the bargaining or choosing to opt out before bargaining stage starts. The veto option also increases the bargaining power of the seller.

A later experiment by Gantner et al. (2001) has a more standard experimental setting. Similar to Hackett (1993, 1994), two randomly matched subjects bargain over a joint surplus generated from their preceding investments. The joint production function is a linear combination of investments from both subjects. Subjects paired together differ in marginal productivity. This manipulation alters the bargaining balance between the two partners and makes room for different equity standards. The bargaining stage takes two forms: an ultimatum game and a Nash demand game. Each subject participates in both games with different partners. The two possible orders of combination are both included to exclude order effect. In the bargaining stage, subjects simultaneously select a demand and a lowest acceptance bound. The roles of a proposer and a responder are assigned to each subject after the values are chosen. In the ultimatum game setting, the demand of the proposer is matched with the lowest acceptance level of the responder. An agreement is reached if and only if the sum of the two values is less than the total surplus, resulting in an allocation that gives the demanded amount to the proposer and the residual to the responder. In the Nash demand game, the demand of both subjects are matched first. If the sum does not exceed the total gain, an agreement is reached and subjects receive their respective demand, with the efficiency loss of any unclaimed amount. Otherwise their least acceptance bounds are matched and the surplus is distributed by the same method in the case of an agreement. Under both schemes, the disagreement payoff is zero for both subjects.

In the two experiments discussed above, both subjects invest and have the chance to propose an allocation, therefore, they both have an incentive to hold-up the partner and the possibility to become a potential victim to hold-up. In a number of more recent experiments, only one party makes the investment decision, while the other party proposes an allocation. Under this design, the incentive to hold up his counterparty only falls on the non-investor. This design fits the model by Hart (1995). Under this design, it is easier to distinguish the motives and behaviors of the two parties. A prevalent form of such experiments combines a single-party investment stage with an ultimatum bargaining stage, where the non-investor proposes an allocation and the investor decides whether to accept
or to reject. Rejection leads to zero payoff to both parties. The three examples with this setting (Ellingsen and Johannesson, 2004b; Sloof et al., 2007; Hoppe and Schmitz, 2011) both adopt a binary decision in the investment stage, where the investor decides whether to invest a fixed amount or not, instead of how much to invest. Dufwenberg et al. (2013) use binary choices in the bargaining stage as well: instead of having to come up with his own allocation scheme, the non-investor chooses between an equal split and an option to “hold up” the investor by exploiting his payoff to almost zero. The investor then chooses between two allocations which are equivalent to accepting an unfair offer and punishing the unfair non-investor at his own cost in a standard ultimatum game.

Some other experiments further reduce the bargaining power of the investor by adopting a dictator game in the bargaining stage, so that the investor no longer has the possibility to reject an offer made by the non-investor. The trust game can be regarded as a special case of such experiments. The typical trust game was designed and conducted by Berg et al. (1995). The investor first decides a proportion of his show-up fee to be transferred to the non-investor, the amount of which will then be tripled by the experimenter. The non-investor then decides how much of the tripled amount to be sent back to the investor. Since the “investment stage” is explicitly framed as sending money to the partner, there is a stronger focus on willingness to trust and reciprocity in trust games. In addition, the incentive to hold up is stronger in this case, since the non-investor can propose any allocation without the fear of being rejected. Despite these differences, the trust game still constructs a hold-up situation. This experiment has been replicated by a large number of researchers as summarized in the meta study of Johnson and Mislin (2011). These subsequent studies closely follow the basic design of the Berg et al. (1995) experiment, with variations in minor setting details such as rate of return, location, subjects’ demographic heterogeneity, etc. Therefore, in this paper, only Berg et al. (1995) is selected as a typical example. Sloof et al. (2007) is an example with a trust game structure and a framing that resembles the incomplete contract situation more closely. Subjects are assigned roles of a buyer and a seller, as in the Hackett (1993, 1994) experiments. The buyer first makes a binary investment decision which increases the value of the trading product by a fixed amount. Then, in the bargaining stage, the non-investing seller demands a price from the buyer in exchange for the product, which essentially has the dictator game structure.

Some other experiments use a single-party investment stage, following such bargaining mechanisms where both parties have symmetric bargaining power. One such example is the Nash demand game, as employed by Ellingsen and Johannesson (2004a). Another example is a multi-round alternating offer game. Experiments by Sonnemans et al. (2001), Oosterbeek et al. (2003), and Sloof et al. (2004)
fall in this category. In the investment stage, Sonnemans et al. (2001) and Sloof et al. (2004) allow investors to choose an investment level that generates a joint surplus through the same linear production function, while Oosterbeek et al. (2003) employs a binary decision that generates a fixed payoff. The bargaining stage of the three experiments all consists of ten maximum allowed bargaining rounds. Subjects alternate in making offers to divide the joint surplus. Sonnemans et al. (2001) and Oosterbeek et al. (2003) let the non-investor make the first offer, while Sloof et al. (2004) let the investor offer first. The bargaining procedure is similar to the Rubinstein procedure as applied by Hackett (1993, 1994), except that here the maximum number of allowed rounds is fixed to ten and is known to all subjects. In each bargaining round, the responder decides whether to accept the offer and end the bargaining, or to reject with a counteroffer in the following round (if applicable) at the cost of receiving the disagreement payoff. In some treatments of Sonnemans et al. (2001) and Sloof et al. (2004), subjects also have the option to opt out and end the bargaining stage in each round. The outside option of Sonnemans et al. (2001) leaves a positive amount to the investor and zero to the non-investor, while the contrary is the case for Sloof et al. (2004). Sonnemans et al. (2001) and Sloof et al. (2004) employ a special “block” structure in their experiments. They divide their multiple periods into blocks: Sonnemans et al. (2001) had two blocks of nine periods and Sloof et al. (2007) had four blocks of five periods. This “block” structure allows the experimenters to adopt perfect stranger matching within each block to avoid reputation effect and gives them room for testing within subject treatments. Oosterbeek et al. (2003) adopt perfect stranger matching in all ten of their experimental periods. However, subjects participated as both roles: they were assigned one role for the first five periods and the other role for the remaining five periods.

2.2 Stylized findings

The hold-up experiments discussed above adopt different experimental settings. Some experimenters also introduce variations to test for a solution. Therefore, it is difficult to quantitatively compare the results. However, a qualitative comparison of the simple hold-up game in the baseline treatment of these experiments yield some general results that hold across different studies.

2.2.1 Evidence of hold-up

The surveyed studies all find evidence showing that the hold-up problem does exist. The most straightforward representation of hold-up lies in proposals made in the bargaining stage. In experiments where only one subject is allowed to
propose an allocation, cases of exploitation are found in a number of studies. Dufwenberg et al. (2013) find that more than half of non-investors choose to exploit the investors by choosing the allocation that leaves only a minimum amount to the investor. Ellingsen and Johannesson (2004b), Berg et al. (1995), and Sloof et al. (2007) also find quite a few cases where the non-investor extracts all payoffs from the investor. Fehr and List (2004) find that on average non-investors only offer a small proportion of the total surplus to the investors. In experiments with multi-round bargaining, Oosterbeek et al. (2003) find that a majority of the first proposals by the non-investor leaves a less than equal-split amount of the surplus to the investor, which indicates that non-investors take the chance to hold up the sunk investment of the investors. In experiments where both parties can propose an allocation, evidence of hold-up is also found on both sides. Ellingsen and Johannesson (2004a) find a number of cases where the claims from both parties add up to more than the total surplus to be divided. Gantner et al. (2001) also find a few allocations that fit the game-theoretic predictions.

For fear of being held-up by their partners, underinvestment on the investors’ side occurs accordingly. In the studies reviewed, different degrees of underinvestment is found on the investors’ side. Hackett (1993, 1994) finds that a substantial amount of subjects choose investment amounts below the efficient level. Gantner et al. (2001) also discover a few occurrences of low investment or even zero investment. Sonnemans et al. (2001) and Sloof et al. (2004) find that the average investment levels in all treatments are below the socially efficient level. In Sonnemans et al. (2001), the majority of individual investments falls below the efficient level. In experiments with binary investment choices, a substantial amount of investors refrain from investing in the first stage of the game (Dufwenberg et al., 2013; Oosterbeek et al., 2003; Ellingsen and Johannesson, 2004b,a; Sloof et al., 2007). In the two trust games of (Berg et al., 1995), quite a number of investors invest below the efficient level.

2.2.2 Discrepancy with theoretical predictions

In spite of the individual occurrences found in a number of experiments, on the aggregate level, the hold-up problem is found to be less of a concern than in theoretical models. Underinvestment, although present, is found less severe than what standard theory predicts. Hackett (1993, 1994) finds that the average investment levels in the investing stage by both parties lie between the strategic predictions and the socially optimal level, with a substantial portion of cases above the strategic predictions. Gantner et al. (2001) find that the efficient investment level is selected in most cases. In experiments with binary investment choices
underinvestment occurs less frequently than in the game theoretic prediction. Berg et al. (1995) and Fehr and List (2004) also find that a large proportion of investors trust their partners with the majority of their endowment.

In the bargaining stage, evidence also shows that exploitation of the investors is less severe than standard theory predicts. In experiments where only one party is allowed to make an offer in the bargaining stage, namely the experiments using an ultimatum game (Gantner et al., 2001; Ellingsen and Johannesson, 2004b) or a dictator game (Sloof et al., 2007; Berg et al., 1995; Fehr and List, 2004) as the bargaining mechanism, the proposer offers a positive amount to the partner under most circumstances. In the experiment by Ellingsen and Johannesson (2004b), the most common offer by the proposer is one that allocates equal net profit to both parties, chosen by almost 50 percent of the proposers. Consistent with the common robust results in pure ultimatum game or pure dictator game (Fehr and Schmidt, 2006), the majority of bargaining outcome in these experiments exhibit a deviation from the subgame perfect prediction of full exploitation. In addition, similar results are also found in experiments with repeated alternate offers. Hackett (1993) finds equal split of the total surplus to be the most frequent among all successfully negotiated final allocations, with other allocations clustered around it. Sonnemans et al. (2001) also find the finally agreed allocations to be different from the game theoretic predictions. Instead of an equal split of the total surplus, they find the average value of the final allocations closer to the “split-the-difference” result, which is defined as “both players receiving their no-trade pay-offs plus 50% of the remaining surplus”.

A third discrepancy with theoretical predictions is found in the link between investment behavior and bargaining results. Various experimental results exhibit a close positive correlation between the investment level and the allocation results (Hackett, 1993, 1994; Gantner et al., 2001; Oosterbeek et al., 2003; Ellingsen and Johannesson, 2004a). Hackett (1993) finds that the difference in the sunk investment cost has a significant and positive effect on the bargaining outcomes. The bargaining outcome suggests the existence of an equity rule where the party investing the greater share receives the larger proportion of the surplus. Hackett (1994) discovers strong support for subjects adjusting their investment decisions after anticipating a linkage between observable investment levels and resulting allocations. In experiments with a Nash demand bargaining stage, the Nash cooperative bargaining solution predicts the unique equilibrium outcome of an equal split of the surplus, regardless of what happens in the investment stage. However, Gantner et al. (2001) find the share of surplus that subjects claim in the bargaining stage to be positively correlated with their share of input in the investment stage. The
results of Ellingsen and Johannesson (2004a) also indicate that subjects take into consideration the sunk cost of the investors during the bargaining stage.

2.2.3 Social preferences

The discrepancy with theoretical predictions in many of the experiments above indicates that subjects’ decisions in hold-up games are influenced by more than just strategic concerns. Many economists explain this discrepancy through the channel of social preferences. Researchers fit their experimental results with predictions from standard game theoretic models and social preference models. They typically find that various selected social preference models fit the results better (Berg et al., 1995; Gantner et al., 2001; Fehr and List, 2004; Sloof et al., 2004; Dufwenberg et al., 2013). Some of the patterns discovered in the bargaining stage of hold-up experiments are similar to findings in respective simple bargaining games. In studies of simple ultimatum games, there is a common trend that responders reject strictly positive offers, and offers made by the proposers are clustered around the equal split and skewed to the left (Fehr and Schmidt, 1999), which is against standard theoretical predictions based on material payoffs. Similar results are found in hold-up experiments with an ultimatum bargaining stage. Ellingsen and Johannesson (2004b) and Sloof et al. (2007) both find that subjects reject unfair positive material offers. On the other hand, some findings are particular to hold-up experiments due to the distinct settings. For instance, Ellingsen and Johannesson (2004b) shows that instead of an equal split of total surplus, the most common offer is an equal split of the net surplus, indicating that the proposer takes into account not only the final payoff but also the sunk investment cost of the investor.

Though predictions from models of social preferences fit many experimental findings, the specific mechanism through which social preferences work still remains to be identified. Various models are selected to fit the data from different experiments. Dufwenberg et al. (2013) use their intention-based reciprocity model (Dufwenberg and Kirchsteiger, 2004) to explain investors selecting an allocation to punish the non-investor at their own costs. Gantner et al. (2001), Ellingsen and Johannesson (2004b), and Sloof et al. (2004) show that different variations from the inequality aversion model (Fehr and Schmidt, 1999) can explain the behaviors observed in their experiments. Fehr et al. (2008) find that their results largely depend on the individual heterogeneity in the degree of fair-mindedness among subjects. They claim that the behaviors they observed are results of the interaction between self-interested and fair subjects. These experimental results provide further support for the advantage of various social preference models over self-interest material payoff models in explaining people’s behavior in hold-up situations.
In addition to individual heterogeneity in the level of fair-mindedness, differences also arise in equity standards that individuals apply to their decisions. Individuals may have different understandings of what constitutes a fair allocation. Ellingsen and Johannesson (2004b,a) find that despite an equal split of the net surplus being the most common allocation, some subjects are found to demand an equal split of the total surplus, which lead to disagreement in a number of cases. By introducing asymmetric marginal contribution rate, Gantner et al. (2001) find three different equity standards among subjects whose decisions could be regarded as “equitable”. In addition to whether it is the net surplus or the total surplus to be divided, subjects also disagree on whether their contribution should be in line with their productivity, whether the surplus should be divided in proportion to their contribution, etc. Differences in equity standards create additional obstacles to reach an agreement in the bargaining stage, thus undermining the effect of social preferences on mitigating the hold-up problem. Furthermore, it also creates some moral wiggle room which a self-interested subject can exploit by choosing the equity standard to his own advantage.

2.2.4 Summary

Results from various hold-up experiments provide evidence for the existence of the hold-up problem, as well as a general pattern indicating that the problem is less severe than theoretically predicted. The few cases of complete hold-up occur only on the individual level in most experimental studies, while on the aggregate level, the investment level lies in between the strategic prediction and the social optimal level. Most subjects take into account the link between investment decisions of both subjects and the allocation results. Models of social preferences explain the findings better than models of self interest. Social preferences open a new channel that mitigates the hold-up problem. However, the detailed mechanism still remains to be understood. Individual heterogeneity in social preferences and equity standards may undermine the effect of social preferences.

3 Remedies for the hold-up problem

Che and Skovics (2008) clarify remedies for the hold-up problem into two categories: organizational remedies, such as vertical integration as proposed by Klein et al. (1978), and contractual remedies, such as contracting on the allocation before the investment decision is made. The number of experiments examining these two types of remedies is limited. Only two experimental studies examine these two types of remedies altogether (Fehr et al., 2008; Hoppe and Schmitz, 2011). In
addition, the effectiveness of organizational remedies depends on the structure of the game, especially the outside option (Che and Skovics, 2008). A series of experiments by Sonnemans et al. (2001), Oosterbeek et al. (2003), and Sloof et al. (2004) study the effect of changing the outside option level. As shown from the stylized findings, social preferences could mitigate the hold-up problem. Agents take into consideration contributions from their trading partners and avoid full exploitation of their partners’ investment. Therefore, just as in many other strategic interactions, methods that are conventionally considered ineffective could play a role in mitigating the hold-up problem. Economists adopt various manipulations on the experimental environment to test the effectiveness of such behavioral remedies as observable investment decisions, punishment, and cheap talk.

3.1 Conventional remedies

3.1.1 Organizational remedies

As argued by Hart (1995) and Grossman and Hart (1986), changes in the organizational structure can help mitigate the hold-up problem. They argue that joint-ownership gives most room for underinvestment incentives to take effect, since both parties have the chance to hold up their partners in post-production renegotiations. On the contrary, single-party ownership solves this problem since the incentive is not eroded by allocating the ownership to only one party.

Fehr et al. (2008) conduct several experiments to examine the effect of different ownership rights on subjects’ investment behaviors. Their basic experimental setting is a two-party joint production game, with a stage to determine the ownership rights and a subsequent investment stage. In the first stage, subjects start with an initial ownership scheme, and then one subject has the option to switch to a different ownership scheme by selling his share of the surplus in exchange for a fixed fee. In the investment stage, subjects act sequentially instead of simultaneously as the case in other hold-up experiments. The subject who does not act in the first stage first chooses an investment level, which is observable to both subjects. After that, the other subject chooses his investment level. The final surplus generated by the investments is then divided according to their agreed ownership scheme in the first stage. Joint ownership is associated with an equal split of the surplus, while with single ownership, the owner receives all the surplus at the cost of a fixed fee which is paid to his partner in order to obtain ownership. There are three treatments in the experiment. In one treatment, subjects start with single ownership by one subject, and the owner decides whether to give half of the ownership to his partner or to retain single ownership and pay a fixed wage to his partner. Failure to agree on the ownership change leaves zero payoff to both
subjects. In the other two treatments, subjects start with joint ownership, then one subject decides whether to offer a fixed price to sell his share or to retain joint ownership. The two treatments with this setting differ in the disagreement payoff. In one treatment, the disagreement payoff is zero for both subjects, as is in the single initial ownership treatment. In the other treatment, the game continues and remains in joint ownership after a rejection. In this case, the owner does not have to worry about being rejected with making an offer for single ownership.

Fehr et al. (2008) find that joint ownership is most frequently selected by the subjects, even though they start from different initial ownership schemes. In the joint initial ownership treatment, the majority of the subjects choose to maintain the initial ownership scheme. Among those who offer to purchase the ownership of their partners, the offer is rejected in 30% of the cases. In the single initial ownership treatment, the majority of initial owners offer joint ownership to their partners. Under joint ownership, the investment behaviors are the same no matter what initial ownership scheme they start from. There is a strong positive relationship between the investment level of the first mover and the second mover, indicating a reciprocal pattern. The efficient investment level is chosen by most of the first movers, and the second mover responds by choosing the efficient level as well, while only a small proportion of second movers exploit the first mover by choosing the minimal investment level. Fehr et al. (2008) find that in spite of different initial conditions, joint-ownership prevails as the most selected ownership structure and efficient investment is achieved in most cases under joint ownership. Thus, contrary to the predictions by Grossman and Hart (1986), joint-ownership is found to be the most efficient ownership structure.

The only experimental study on organizational remedies for the hold-up problem exhibits contradicting results from the arguments by Hart (1995) and Grossman and Hart (1986). Nevertheless, it provides evidence that changing the ownership structure can affect investment incentives and thus provide a solution to the hold-up problem. It is far from sufficient to make a decisive claim. There is also the residual risk of free riding under joint ownership. Fehr et al. (2008) find that a few cases underinvestment still occurs due to insufficient incentive. Their findings are only valid when the number of partners is small, or if the free-rider problem is not too severe, and if there is no other way of contracting on the relationship specific investment. Fehr et al. (2008) find that the fact that joint ownership turns out to be the most efficient ownership scheme is attributed to different fairness concerns among subjects, but the effect is limited to cases with less strong free-rider incentives.
3.1.2 Contractual remedies

Another type of remedies for the hold-up problem is contractual changes. The source of the hold-up problem lies in the fact that investments are non-contractable in the first place, and thus both parties may have insufficient incentives to invest the efficient level. A natural solution would be to contract on the allocation of the surplus prior to the investment decision. Whether contracts can effectively mitigate the hold-up problem is widely debated in economics literature. Maskin and Moore (1999) initiated the argument that contracts can solve the hold-up problem. Nöldeke and Schmidt (1995) discuss the possibility of using an option contract to solve the hold-up problem. Rogerson (1992) also discusses the contractual solution to the hold-up problem. According to Hart (1995), contractual solution is effective only in two limited cases: either when the widget type can be described in advance, or when the investment can be verified.

Hoppe and Schmitz (2011) conduct several hold-up experiments with an additional contracting stage to compare the effectiveness of different contractual arrangements. The benchmark treatment is a typical one-shot hold-up experiment with a single-party investing stage and an ultimatum bargaining stage. The investment decision is a binary choice between two given investment levels. The results from the baseline treatment fit the general stylized findings of hold-up experiments: around 40% investors already choose the high investment. In three other treatments, Hoppe and Schmitz (2011) add a contracting stage where the subjects decide whether to accept a contract on how to divide the surplus. The three different contractual treatments include a fixed-price contract where the non-investor pays a fixed price to the investor, an option contract, where the non-investor has the option to pay the same fixed price but can decide whether to exercise the contract or not, and an option contract with renegotiation where the non-investor can make another offer should he choose not to exercise the option contract. According to theoretical predictions, only the option contract can ensure sufficient investment incentive. The findings of Hoppe and Schmitz (2011) are consistent with the predictions. The fixed-price contract does not induce higher investments than the baseline no-contract treatment. The option contract significantly increase the investment incentive. In the option contract treatment, all contracts were accepted and around 90% investors choose the high investment. Allowing renegotiation undermines the effect of an option contract. In the treatment of renegotiable option contract, the frequency of high investment is lower than that in non-renegotiable option contract treatment. However, the investment level is still higher than that in both fixed-price contract treatment and the baseline treatment. Hoppe and Schmitz (2011)’s findings indicate that option contract significantly improves in-
vestment incentives and can effectively mitigate the hold-up problem. Allowing for renegotiation undermines the effect, but not as severely as theory predicts.

### 3.1.3 No-trade payoff

Che and Skovics (2008) make a remark that the effects of organizational remedies may depend on the bargaining solution. As is already evident from stylized findings, whether there exists an outside option or not affects investors’ behaviors in games with an ultimatum bargaining stage and a dictator game bargaining stage and can in turn have an important effect on the investment incentives. Changing the no-trade payoff of a bargaining game can effectively change the severity of the hold-up problem. Sloof et al. (2004), Oosterbeek et al. (2003), and Sonnemans et al. (2001) conduct a series of experiments examining how a change in the no-trade or disagreement payoff can affect the experimental results. The three experiments are similar in design, all are single-party investing experiments with multi-round alternate offering bargaining. For an alternate offering multi-round bargaining game, these studies add an additional offer of dropping out and end the game, in addition to the original two options of accepting or rejecting with a counteroffer in the next round. Sonnemans et al. (2001) study the effect of various outside options on the investors’ side. They compare the results from a treatment with an outside option with those from a baseline treatment without an outside option. In the outside option treatment, they include three different levels of the outside payoff; while in the treatment without outside option, there are three different levels of disagreement payoff. The outside option or the disagreement payoff always ensures a positive payoff for the investor, but zero payoff for the non-investor. Sonnemans et al. (2001) find that investment incentive is stronger when opting out is not possible. The average level of investment is higher when investors cannot leave the game for a positive payoff. The relationship between the level of the outside option and the investment level differs between the two treatments. When opting out is allowed, investment levels decrease as the value of the outside option increases. When the outside option is not available, the average investment level increases when the no-trade payoff increases.

A more straightforward perspective is changing the outside option of the non-investor. This stems from the Outside Option Principle (Binmore et al., 1989). When the non-investor has an outside option, especially when it is binding, the investment incentive is stronger, and can even induce the efficient level investment. When one party is made residual claimant of the surplus, he then has the incentive to invest. On the other hand, the hold-up problem occurs when the non-investor’s outside option is non-binding. Sloof et al. (2004) and Oosterbeek et al. (2003)
focus on the outside option of the non-investor. Sloof et al. (2004) adopt a within subject design, where each subject is faced with both the high outside option and the low outside option. They find little effect of different levels of the outside option. The overall investment level is constant over different values of the non-investors’ outside option. However, results that may counter to the Outside Option Theory are found. The hold-up problem is more severe when the non-investors’ outside option is high and binding, and less severe when the non-investor’s outside option is low and non-binding. There is no opting out in the Oosterbeek et al. (2003) experiment. They study the effect of three different levels of disagreement payoff for the non-investor. Their findings on the disagreement payoff levels are consistent with the findings of Sloof et al. (2004). The investment choice is selected more frequently when the disagreement payoff for the non-investor is low.

3.1.4 Summary

The number of experimental studies examining the effectiveness of conventional remedies is limited. Evidence against theoretical predictions is found about organizational remedies and changing outside options. Joint ownership is found to be the most efficient ownership structure that significantly mitigates the hold-up problem. The hold-up problem is less severe when the outside option of the non-investor is low and non-binding. Experimental results of contractual remedies are consistent with theoretical predictions. An option contract on the post-investment allocation most effectively solves the hold-up problem. Renegotiation undermines the effectiveness of that contractual agreement but does not cancel it altogether.

3.2 Behavioral remedies

3.2.1 Observability of investment

Standard theory predicts that the hold-up problem can be alleviated by making specific investment unobservable, since private information can create an informational rent that boost investment incentives. Sloof et al. (2007) conduct an experiment altering the observability of the first-stage investment to examine this. They also include changes in the cost of investment to test for the interplay of the two effects. They show that the effect of investment observability depends on the level of the sunk investment cost. Making investment unobservable can mitigate the hold-up problem when the cost of investment is high, while observability does not play a significant role when the cost is relatively low. When investment costs are high or intermediate, unobservable investment leads to higher investment levels. When investment costs are low, information condition does not significantly alter
investment levels. The average investment levels are close to the predictions of standard economic theory. When investment is observable, after observing the investment choice not selected, non-investors always demand full exploitation. After observing investment, non-investors leave room to cover the investment cost of the investor. The results suggest that private information may partially crowd out the positive investment incentive effect of fairness and reciprocity motivations. Making investments unobservable also makes it difficult to determine whether the investor is being fair or not. As a result, unobservable investments interfere with the social preference effects, and undermines the effect of social preferences. Unobservable investments boost investments only when the costs of investment are relatively high, and thus there is insufficient scope for social preferences. It indicates that making investments observable might be a better remedy for the hold-up problem under the effect of social preferences.

In one treatment of Hackett (1993), he explicitly tests whether making observable investment is indeed an effective solution. Both players are informed of the investment decision by himself as well as by the partner. He finds that final bargaining allocation tends to be in line with ex ante investment. Especially in the treatment where information about investment is made observable to the players. Hackett (1994) provides more supporting evidence that subjects in the treatment when investment is observable invest ten to eight percentage points more than subjects in treatment when investment is unobservable. With observable investments, subjects observe whether their counterparts have made a sufficiently “fair” investment, and reciprocate with respective “fair” allocations. Hackett (1993, 1994) also provide evidence that the treatment effect is larger when the investment cost is high, which is consistent with the findings of Sloof et al. (2007). The above experimental evidence indicates that the effectiveness of making investments common knowledge as a remedy for the hold-up problem largely depends on whether social preference is strong enough. When the investment cost is high, it is more likely for social preference to take effect. Therefore, making investments observable reinforces the effect of social preferences and can effectively increase investment incentives. On the other hand, when the investment cost is low, there is limited room for social preferences. In this case, making the investments unobservable can better alleviate the hold-up problem.

3.2.2 Punishment

The possibility for the responding party to reject a disadvantageous proposal can work as a tool of punishment that prevents the proposing party from holding up the partner. Hackett (1993, 1994) adds an additional veto option after the
bargaining process, where subjects can choose whether to veto the bargaining results and receive zero payoff instead. In his experiment, both players have the incentive to hold up. The incentive for the buyer is stronger since the no trade payoff of the bargain allocates all the gain from investment to the buyer and all the cost to the seller. Therefore, the buyer has an incentive to reject the proposals of the seller and receive the no-trade payoff. Veto on the sellers’ side gives credible threat when no agreement is reached or when the buyers choose not to bargain, but also acts as a non-credible threat when an agreement is reached.

Experiments on social preferences show that people are willing to punish others by sacrificing their own payoffs (Fehr and Schmidt, 2006). In one of the treatments of Dufwenberg et al. (2013), after the non-investor not choosing the equal allocation, the investor is given an option to reduce the payoff of the non-investor to a large extent at the cost of losing all of his own payoff. In the control treatment, if the non-investors attempt to hold up the investors, the investors are not able to effectively reduce the payoff of the non-investors. The possibility of costly punishment largely increases the number of investors who chose to invest in the first stage. The number of investors who chose to invest in the control treatment is only a half of that in the treatment with punishment opportunity. In the punishment treatment, among those pairs in which the investors have chosen to invest, only half of the non-investors chose to hold-up their partners. On the contrary, a 100% rate of hold-up is discovered among those invested pairs in the control treatment. Costly punishment effectively stops a proportion of hold-up behaviors and as a result restores investment incentives.

Similarly, Fehr and List (2004) include a treatment where the investor is allowed to impose a fixed fine on the non-investor if the payback amount is lower than a “desired back-transfer” amount as announced by the investor. They also find non-investors send back a higher amount of money to the investors when the punishment option is available. Moreover, within the punishment treatment, the amount sent back is higher when the punishment option is not enacted. Their results suggest that the existence of a costly punishment option can prevent hold-up behaviors, even though it is a non-credible threat and the investor chooses not to exercise it.

3.2.3 Communication

The punishment option show that a threat can effectively mitigate the hold-up problem. When the threat is made more explicit through communication, it can also effectively mitigates the hold-up problem. Ellingsen and Johannesson (2004a,b) conduct a series of experiments to test the effectiveness of cheap talk
communication in mitigating the hold-up problem. They find that cheap talk is indeed effective in mitigating the hold-up problem. Ellingsen and Johannesson (2004b) use an ultimatum game in the bargaining stage, while Ellingsen and Johannesson (2004a) uses the Nash demand game as the bargaining stage. Therefore, the mechanism of how communication works in the former case is mainly through non-credible threat, while in the later as a coordination device. In the two communication treatments, one subject can send a message to his partner before that other subject takes an action. In one treatment, the investor sends a message to the non-investor simultaneously as he makes the investment decision. In the other treatment, the non-investor sends a message before the investor makes the investment decision. There are no restrictions or suggestions regarding the content of the message. The former could be viewed as a threat while the latter could be viewed as a promise. They find that both communication treatments increase the offers made by the non-investors to the investors, though the difference is insignificant, partly due to the small number of observations. They also find that the treatment with non-investor communication leads to highest offers to the investors than the treatment with investor communication. Comparing the consistency between the message being sent and the actions taken by the party who sends the message, promises are shown to be more credible than threats, since none of the promises were violated, while less than half of the threats that explicitly states that any offers less than the denoted amount will be rejected are executed. Applying the inequity aversion model by Fehr and Schmidt (1999), they show that inequity aversion makes promises by the non-investors more credible and threats by the investors less credible.

Ellingsen and Johannesson (2004a) find similar results. Communication increase the investment rate, and increases the investor’s profit from negative in treatments without communication to positive in treatments with communication. The rate of bargaining breakdowns is much lower when communication is allowed. Comparing the two studies, the increase in the rate of investment by introducing communication to the Nash demand game is higher than that by introducing communication to the Ultimatum game. Communication works as a device to improve coordination. However, Ellingsen and Johannesson (2004a) also show that communication cannot fully eliminate the hold-up problem caused by coordination failure. There are still cases of investors refraining from investing in the investor communication treatment. Together, these two experiments show that cheap talk plays a role in mitigating the hold-up problem.
Norm following

Besides other-regarding preferences, another important representation of social preferences lies in norm following. Economists have developed models showing that people get disutility from deviation from the behaviors of most other people (Bénabou and Tirole, 2006). Berg et al. (1995) show that a social norm of trust and cooperation can help initiate more trusting and cooperative behaviors from individuals, and thus mitigates the hold-up problem. In one treatment, subjects are given a summary of behaviors from subjects that have participated in previous sessions of the experiment without the social treatment. For each possible amount to be sent, the report details the frequency of every amount, as well as the average payback amount and net return. They find that after the social history treatment is introduced, there is a slight increase in the frequency of equal amount sent, as well as an increase in the frequency of higher amounts to be sent back by the non-investor. Although isolated, their findings suggest that social history tend to reinforce the effects of trust and reciprocity in mitigating the hold-up problem.

Summary

Experimental evidence has shown that the hold-up problem is less serious than theoretical predictions due to the fact that individuals take into consideration the payoff of their counterparts and will reciprocate in response to their counterparts' behaviors. Methods that enhance this channel can effectively alleviate the hold-up problem. Making investments observable, giving subjects an option to punish “unfair” behaviors, and allowing cheap talk before any decision is made all prove to significantly improve investment incentives. Individuals’ behaviors in hold-up situations are also influenced by social history and social norms.

Conclusion

Being a nested bargaining game, experiments on the hold-up problem are more complicated and less commonly conducted than other simple bargaining games. This paper reviews 12 papers on hold-up. Experiments on the hold-up problem take various forms, resulting in different representations of the problem. Though they differ in various aspects, these experiments share the same essential game structure as well as some common patterns in their results. Individual occurrences of hold-up and underinvestment have been discovered, whereas on the aggregate level the problem is less severe than theory predicts. The overall behavior lies in between the social optimum and the strategic equilibrium. Subjects’ behaviors are believed to be strongly influenced by other regarding preferences and reciprocity.
A positive correlation between investment decision and bargaining results is discovered in many experiments. Individuals are found to take into consideration the investment level of their counterparts and incorporate it in their bargaining behaviors. On average, the experimental results on the hold-up problem are strongly influenced by social preferences and thus exhibit an overall pattern which is less bleak than predicted by theory.

Different variations are introduced in the experiments to examine how different types of remedies can mitigate the hold-up problem. Experimental results provide some evidence for the contractual solutions and organizational solutions. Joint ownership is shown to be the most efficient ownership structure, which is contrary to theoretical results. An option contract is found to significantly boost investment incentives both when renegotiation is forbidden and allowed. However, due to the limited number of studies, neither of these two findings is conclusive. Further research needs to be done to study the effectiveness of these conventional remedies as well as their interplay with social preferences.

On the other hand, a number of experiments focus on behavioral remedies. The hold-up game is essentially a bargaining game embedded in an investment game. Results from other simple bargaining games can also be applied to the bargaining stage of the hold-up game. Methods that are shown to instigate or to reinforce a “fair” allocation in other experiments on ultimatum games, dictator games, trust games, etc. can also be applied to the hold-up game. Changes in experimental settings such as making investment decision observable, threat of rejection or costly punishment, and cheap talk are found to effectively mitigate the hold-up problem. These remedies work through various aspects of social preferences. However, further study is needed to better understand how social preferences can affect individuals’ behaviors in the hold-up problem. Various models of social preferences have been fitted with experimental data, but there is not conclusive evidence about the mechanism through which social preferences actually alters individuals’ behavior. In addition, individual heterogeneity in the degree of social preference and the judgement of fair allocations makes it more complicated to examine the social preference channel. The interplay of these individual heterogeneities create a moral wiggle room which less prosocial individuals can exploit. Further research on the effectiveness of social preferences in hold-up situations can focus more on these heterogeneities.

5 Discussion

Laboratory experiments have many obvious advantages in collecting data for research on the hold-up problem. They enable researchers to easily implement the
institutional environment that is aligned with theory, and to insert strict controls that reduce confounding factors. Though experiments on the hold-up problem are limited in numbers, they provide important insights about individuals’ behaviors in a hold-up situation. Most importantly, laboratory experiments make it easier to examine the treatment effect of a remedy for the hold-up problem. Various experimental results have provided important information to better understand the hold-up problem.

This being said, a few aspects of laboratory experiments raise concerns about the external validity of their results. The generalizability of applying laboratory results to the field is one of the most common criticism of laboratory experiments. Laboratory experiments are mostly conducted with student subjects in a controlled environment, whose behaviors may differ from other economic players in real world transactions from naturally occurring environments (Levitt and List, 2007). As a consequence, there have been questions about whether the results of laboratory experiments also pervade to similar situations in the real world. Among the hold-up experiments reviewed, Fehr and List (2004) address this issue by conducting the same trust game with both student subjects and CEOs from the coffee mill sector in Costa Rica. By comparing the results from the two different subject pools, they find that CEO subjects exert more trust and exhibit more trustworthiness than student subjects. On average, CEO investors invest a larger share than students, and CEO non-investors offer back a larger share than students for any given investment level. This suggests that the hold-up problem could be less serious among CEOs. Though the difference could be partly due to the fact that the stakes used in the experiment may be considered too small to the CEOs but not to the students, the result provides an implication that there may be a discrepancy between lab results and real world observations for hold-up games. Therefore, it is worth taking extra caution when attempting to draw implications from laboratory experiment results.

In addition to different subjects, laboratory experiments differ from real life situations in various ways. The hold-up problem can take on many different forms under different settings. The complications in institution and environment may not be fully abstracted in the current simple laboratory experiment. One example where the hold-up problem has been alleged to be present can be found in the standardization process of Standard Setting Organizations (SSOs). When the candidate technology to be incorporated in the standard is patent protected, the hold-up problem takes the form of patent hold-up, where patent owners fail to impose royalty fees according to the FRAND terms and charge high royalty fees; or it can also take the form of so-called “patent ambush”, in which patent owners withhold information about the patent in the standard setting process. Some
results from the hold-up experiments in the laboratory could offer implications to the functioning of SSOs. The fair, reasonable, and non-discriminatory terms (FRAND) as is often imposed by most SSOs on members is an example. Members participating in the standard-setting process typically commit to charging license fees for their patents according to FRAND terms. The enforcement of FRAND terms reflects fairness concerns. Punishment of violating the FRAND terms can also work as a non-executed threat for the patent holding parties to enforce FRAND terms. However, due to heterogeneity of equity standards (Ganter et al., 2001), there could be different interpretations of the FRAND standard, which leads to difficulty in implementation. Different parties may have different interpretations of the FRAND pricing, which may still lead to some degree of patent hold-up. On the other hand, apart from different background of subjects, there are many more differences between actual SSOs and general laboratory hold-up experiments. First, in all laboratory experiments discussed above, each subject makes a decision individually in his or her own interest, while in the standard setting process, or many other real life firm decisions, choices are decided collectively by a group within a firm. In the standard setting example, the decision right is often delegated to a certain group of officers. There is already a large amount of literature studying the difference between individual and group decision making in non-strategic individual decisions such as risk and ambiguity attitudes. They seem to suggest that individuals act as if less risk averse and more ambiguity averse when they are part of a group than when they act individually (Brunette et al., 2015). Another common finding is that the degree of difference depends on the group decision rule. Studies comparing individual and group decision making on strategic social interaction games are quite limited in numbers. A recent study (Ambrus et al., 2009) also suggests that in a gift exchange game individuals act differently depending on the group decision rule. Whether social preferences prevail under group decision is essential to mitigating the hold-up problem. To study the individual-group decision difference in the hold-up game can offer implications to solving real life problems such as patent hold-up. Similarly, the literature on delegation (Hamman et al., 2010; Bartling and Fischbacher, 2011) shows that due to responsibility shifting, “unfair” and “immoral” decisions are chosen more frequently under delegation. These studies focus on bargaining behavior in a dictator game. It is possible that delegation can also affect the investment behavior. As the behavioral remedies for the hold-up problem work through the channel of social preferences, studying how delegation affects behaviors in both stages of a hold-up game can have an essential impact on finding a solution for the hold-up problem.

Another important difference lies in the decision process. In all experiments reviewed in this paper, subjects make decisions facing a computer screen or a
paper questionnaire, without direct face-to-face interaction with their partners. Anonymity is strictly enforced in the laboratory. In addition, most experiments use a stranger setting, so that subjects interact with the same partner only once. A typical laboratory experiment usually takes no more than two hours, which limits the time span of the experiment. In the example of real business interactions, most interactions are conducted face-to-face through frequent meetings in as long as several months or even a few years. With face-to-face repeated interaction, it is possible for reputation or “self-image” effect to kick in, which may in turn strengthen the social preference channel. Therefore, whether hold-up in real life interactions is similar to that in laboratory experiments remains an open issue.

The laboratory experiment is a simplified prototype of the real problem. This simplification is a double-edge sword that makes it possible for all the advantages of laboratory studies to be achieved, but on the other hand also ignores some complications that could potentially induce different results. Current laboratory experiments provide important empirical evidence on subjects’ behaviors and possible remedies of the hold-up problem with the basic structure. It is promising to continue adopting experimental methods for further understanding of the underlying mechanism behind the experimental evidence. Future experimental studies can gradually expand the scope by including variations that more closely resembles the real situation. For example, group decision and delegation could be introduced to the experimental process. In addition, a competitive environment could be introduced. Incorporating these variations will provide new evidence on the hold-up problem and its remedies under more “realistic” environments.

References


