How Do Market Prices and Cheap Talk Affect Coordination?*

Hong Qu†

ABSTRACT

This paper studies the role of public information in multiple-agent coordination problems underlying a variety of economic scenarios such as banking and debt crises. The impact of information on coordination in such settings rests on the interplay between two types of uncertainty that agents face: fundamental and strategic uncertainty. In a controlled laboratory setting, I study the impact of two key sources of public information on coordination: market prices and cheap talk. I find that although informationally efficient market prices reduce fundamental uncertainty, coordination does not improve because strategic uncertainty intensifies. In contrast, costless nonbinding cheap talk significantly improves coordination as it reduces strategic uncertainty by allowing agents to communicate their intentions. Furthermore, I find that coarsening the cheap talk message space impacts coordination positively.

Key words: coordination game, cheap talk, asset market, experimental economics

JEL classification: C7, C9, D8

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† Ph.D. candidate in accounting, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213. E-mail: hongq@andrew.cmu.edu.
1 Introduction

In this paper, I study the impact of public information in a coordination game, in which agents face both fundamental and strategic uncertainty. *Fundamental uncertainty* is related to agents’ beliefs about exogenous states of nature, and *strategic uncertainty* is related to agents’ beliefs about other agents’ strategic choices. Recent studies suggest that public information that reduces fundamental uncertainty can sometimes exacerbate strategic uncertainty and lead to increased coordination failure (Morris and Shin 2004; Anctil, Dickhaut, Kanodia and Shapiro 2004 [hereinafter referred to as ADKS]; Angeletos and Pavan 2004). In a controlled laboratory setting, I investigate the effect of two important sources of public information on coordination: market price and cheap talk (i.e., non-binding promises). By focusing on the influence of price and cheap talk information on fundamental and strategic uncertainty, this paper sheds light on the effect of public information on coordination and contributes to the debate on the role of accounting information in the recent financial crisis.

The underlying structures of bank runs, currency crises, and debt crises are strategic coordination problems. For example, bank runs (e.g., the recent U.K. Northern Rock crisis) can occur as a consequence of coordination failures (Diamond and Dybvig 1983). Panicking depositors withdraw money based on the expectation that other depositors will withdraw money and leave nothing for them if their bank fails. The beliefs are self-fulfilling, and the bank fails as a result of panic-driven withdrawals. In the recent U.S. financial turmoil, the demise of Bear Stearns can be viewed as a coordination failure. Former Securities and Exchange Commission chairman Christopher Cox comments, “The fate of Bear Stearns was the result of a lack of confidence, not a lack of capital. . . . Bear Stearns’ capital, and its broker-dealers’ capital, exceeded supervisory standards. Counterparty withdrawals and credit denials, resulting in a loss of liquidity—not inadequate capital—caused Bear’s demise” (Cox 2008). Public information, such as market prices, is closely monitored by market participants. For example, the credit default swap (CDS) market on
Bear Stearns’s debt allowed major lenders of Bear Stearns to trade on their private information about the quality of Bear Stearns’s debt. The CDS prices aggregate insider information and become an important source of public information to lenders. Acharya and Johnson (2007) document significant information revelation in a CDS market. In addition, public information is also generated through cheap talk among lenders. For example, right before the debacle of the Bear Stearns Asset Management Fund, its lenders managed to enter into nonbinding agreements not to foreclose on the fund (Cohan 2009). These agreements are cheap talk because of a lack of enforceability. Market prices and cheap talk provide two sources of public information to investors, but their impact on the underlying coordination is not well understood. This paper uses experimental methods to study the influence of market prices and cheap talk on coordination.

This paper studies the coordination problem as an investment game with exogenous fundamentals (Morris and Shin 2004). Similar games have been widely applied to study financial crisis (Goldstein and Pauzner 2004; Goldstein and Pauzner 2005; Marshall 1998; Rochet and Vives 2004; Fehr and Shurchkov 2006). Multiple agents have to decide individually whether to invest in a risky joint project. The success of the project depends on both an exogenous fundamental and agents’ strategic decisions. Each agent has only noisy private information about the project fundamental on which to base his or her investment decision. A project with a sound fundamental can fail if not enough agents invest due to a lack of confidence.

The experimental design consists of three main experimental conditions: the Control Condition, the Market Condition, and the Cheap Talk Condition. In the Control Condition, subjects play the investment game, and they are not allowed to communicate with each other. In the Market Condition, participants trade two state-contingent securities, whose dividend depends on the outcome of the coordination game, before they make their investment decisions. The price of the

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1 A CDS is a swap contract in which the buyer of the contract makes periodic payments and, in return, receives a payment if a credit instrument defaults. For example, the bondholders of Bear Stearns can buy a CDS on Bear Stearns. If Bear Stearns goes bankrupt, the seller of the CDS will pay the bondholders. The prices of CDSs are barometers of the credit quality of a firm.
two securities becomes a source of public information to all agents. In the *Cheap Talk Condition*, agents send nonbinding messages to the experimenter about their investment decisions. The experimenter then announces publicly how many of them intend to invest, which becomes a source of public information to all agents before they make their final investment decisions.

The main results of this paper are threefold. First, in the *Control Condition*, the aggregate investment decreases as the underlying fundamental weakens, and the frequency of investment decreases as the private information indicates weaker fundamentals; moreover, coordination failures occur in the lab as predicted. Second, the frequency of investment is significantly lower in the *Market Condition* than in the *Control Condition*. Price reveals information about the exogenous fundamental and reduces fundamental uncertainty, but the experimental data indicate that strategic uncertainty increases in the *Market Condition*. Third, the frequency of investment is significantly higher in the *Cheap Talk Condition* than in the *Control Condition*. The frequency of project failures is reduced significantly in the *Cheap Talk Condition* compared to the *Control Condition*. Moreover, cheap talk messages convey information about the fundamental. There is also evidence that coarsening cheap talk message spaces has a positive impact on coordination.

The results seem surprising in that competitive markets produce worse outcomes than pure cheap talk. The separate effects of public information on fundamental and strategic uncertainty help explain this seemingly counterintuitive result. Market prices aggregate private information and make more information publicly available, but experimental data indicate that strategic uncertainty increases, and therefore subjects are more reluctant to invest. In contrast, cheap talk allows players to communicate directly their intended choice, which reduces strategic uncertainty; furthermore, information revealed in cheap talk messages reduces fundamental uncertainty. As strategic uncertainty is managed through direct communication about choices, players can further take advantage of the improvements in information about the fundamental.

This paper contributes to our understanding of the role of public information on investor coordination. The importance of coordination problems cannot be overstated. Gorton (2009a)
emphasizes that the banking crises that started from 2007 are essentially “bank runs” in the traditional sense, but in a modern form. For example, the sharp rises in repo haircuts are equivalent to capital withdrawals from the financial institutions that heavily rely on the short-term repo market for funding, such as in the case of Bear Stearns. Moreover Gorton (2009b) argues that common knowledge created by market prices, such as the ABX Index, aggregates information about subprime risks and speeds up the meltdown of the subprime market. Like the CDS on Bear Stearns’s debt, the ABX is a CDS on a basket of subprime home loans, which aggregates information about subprime risk. My experimental results lend support to Gorton’s argument by demonstrating that information from markets similar to the ABX can increase strategic uncertainty and reduce investor confidence in the presence of coordination problems.

Understanding the feedback effect of market information on real investment decisions has implications for accounting. The increasing use of market information in accounting valuation is based on the belief that informationally efficient prices facilitate decision making and improve investment efficiency. As an example, the ABX Index is the preferred input to value subprime mortgage-related assets such as CDOs. During the subprime crisis, however, the ABX Index was driven much lower as the mortgage crisis unraveled and banks were forced to take large write-offs and report depressed financial results. Many argue that such mark-to-market accounting practices have resulted in a loss of market confidence that has further exacerbated the crisis (Joseph-Bell, Joas, and Bukspan 2008). The proponents of mark-to-market accounting believe that providing more transparent information to investors can reduce investor uncertainty and improve investment efficiency. One important factor that has been overlooked in this debate is the role of price information on strategic uncertainty. If coordination underlies the investment problem in a time of financial crisis, as argued by Gorton (2009a), then price information can have unexpected effects on strategic uncertainty, which may diminish investor confidence.

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2 A repo, or repurchase agreement, is a transaction in which one party sells some securities to another party (the repo lender) in exchange for cash and simultaneously agrees to buy those securities back at a predetermined (higher) price at some date in the near future.
The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the model of coordination and discusses how cheap talk or asset markets affect coordination. Section 4 describes the experimental designs and procedures. Section 5 reports and analyzes the experimental results. The last section concludes the paper and discusses limitations and future research directions.

2 Literature Review

Three streams of literature are relevant to my paper: the value of information in multiple-person settings with strategic dependence, the feedback effect of market prices on real investment decisions, and the cheap talk literature.

This paper is closest to the stream of literature studying the role of information in multiple-person settings with strategic dependence. In single-person decision-making settings, the value of additional information is strictly nonnegative, as stated in Blackwell’s theorem. In a multiple-person world, the value of information is no longer so straightforward. Baiman (1975) illustrates that information value can be negative or positive in an exogenously specified two-person noncooperative game. Players’ payoffs are determined not only by exogenous states, but also by their opponents’ decisions. If player A adopts a finer information system, player B may change his decision in anticipation that player A will make decisions based on finer information. Therefore more information can sometimes lead players to play an equilibrium that makes both worse off. In a moral hazard setting, Arya, Glover, and Sivaramakrishnan (1997b) find that the value of information depends on the nature of the strategic interaction between players. In their setting, both the principal and the agent exert effort, and public information arrives after the agent selects effort but before the principal selects effort. This information can help the principal to fine-tune her effort choice, but it can worsen the control problem because the agent will adjust his effort in anticipation that the principal will change effort. In Arya, Glover, and Sivaramakrishnan (1997b), the value of
information depends on whether the principal’s and agent’s efforts are strategic complements or substitutes.

My paper also shows that public information can have an unexpected effect on economic efficiency in the presence of a strategic interdependency, but the underlying economic forces are different. A strategic dependency arises in the coordination game because the outcome of the coordination game depends not only on exogenous states, but also on joint choices of agents. Agents face not only fundamental uncertainty, but also strategic uncertainty. My paper builds closely on the work of Morris and Shin (2004). Morris and Shin (2004) argue that changes in the information environment affect both types of uncertainty, and the effect of the changes on the equilibrium rests on the interplay between the two types of uncertainty. For example, as the precision of private information increases, fundamental uncertainty decreases, but strategic uncertainty may increase. Therefore we have to evaluate the effect of information on both types of uncertainty to measure the value of information on the efficiency of coordination.

The most closely related paper is ADKS, which provides experimental evidence on the impact of changes in the precision of private information on strategic uncertainty and coordination. Multiple creditors individually decide whether to roll over or foreclose a risky project with three possible states (solvent, uncertain, or bankrupt). If the state is solvent (bankrupt), then the project always succeeds (fails) regardless of the creditors’ decisions. However, if the state is uncertain, the project outcome depends on the number of creditors that roll over. If a sufficient number of creditors commit to the project, the project succeeds; otherwise, it fails. Each creditor has a private clue (low, medium, or high) about the true state. ADKS vary the precision of private clues in such a way that as the precision of the private clue increases (fundamental uncertainty decreases), creditors receiving “medium” are more likely to infer that the true state is uncertain, in which state multiple equilibria exist (strategic uncertainty increases). ADKS’s experimental evidence supports the risk dominance principle as the equilibrium selection criterion (Harsanyi and Selten 1988). Sometimes the risk-dominant equilibrium is Pareto inferior, and therefore the increases in private
information fail to improve economic efficiency. My paper also studies the effect of changes in the
information environment on coordination, focusing on interactions between fundamental and
strategic uncertainty. The major difference between this paper and ADKS is that ADKS
exogenously manipulates the information environment by varying the precisions of private
information (see Walther 2004), whereas in this paper, the public information varies across
experimental conditions. Moreover, the public information arises endogenously through players’
communication in the Cheap Talk and Market conditions.

This paper adds to the empirical literature studying the role of information on coordination. For
example, Hertzberg, Liberti, and Paravisini (2009) find that sharing lenders’ private information
about their common borrowers through a public credit registry increases defaults and causes a
permanent decline in debt. Their results are consistent with my experimental findings in that the
credit registry is a similar information channel to a market, through which lenders’ private
information is aggregated and disseminated in public. Brunner and Krahnen (2008) document that
moderate-sized “bank pools” have a positive impact on the success of distressed loan workout in
Germany. Bank pools are cheap talk in that they are formed to allow multiple creditors to
communicate with each other through nonbinding guarantees. Their findings also suggest a positive
impact of cheap talk on coordination. Chen, Goldstein, and Jiang (2009) find that mutual funds that
hold illiquid assets exhibit stronger sensitivity of fund outflows to bad performance than funds that
hold liquid assets. However, such a difference disappears for the sample in which the investor base
comprises large investors. One possibility is that the large investors are able to communicate
through cheap talk. Nagar and Yu (2009) use the quality of public accounting information as a
proxy for public information and provide empirical evidence regarding the impact of public
information on coordination in the currency crisis setting.

My paper is closely related to the literature on feedback effects of prices on real investment
decisions (e.g., Kanodia 1980; Angeletos and Werning 2006; Angeletos, Lorenzoni, and Pavan
2007; Ozdenoren and Yuan 2008; Goldstein and Guembel 2008). The traditional literature on
market efficiency focuses on the information aggregation role of prices (e.g., Grossman 1976; Hellwig 1980; Grossman and Stiglitz 1980). These papers prove that price can be a sufficient statistic for diverse private information, but the role of prices on real production is not considered. Kanodia (1980) incorporates the effects of market prices on firms’ investment decisions and shows that prices play not only an information aggregation role, but also a resource allocation role. My paper also incorporates the resource allocation role of prices beyond its information aggregation role. The underlying coordination game can be regarded as a production problem, and market prices can affect production through its informational role.

Angeletos and Werning (2006) present a theoretical model that is most closely related to the Market Condition in my paper. In their model, dividends of financial assets are determined by outcomes of a coordination game with privately informed agents. In a rational expectation equilibrium framework, they show that price is an endogenous source of public information that aggregates diverse private information. Price information changes the information structure of the coordination game, and sometimes it can increase strategic uncertainty by introducing multiple equilibria to the coordination game; furthermore, price itself can exhibit multiplicity.

In the experimental asset market literature, most studies also focus on the information aggregation role of markets. Securities dividends are usually determined by exogenous state variables. Plott and Sunder (1982) find that information held by traders who are perfectly informed about true states can be disseminated to uniformed traders. Plott and Sunder (1988) show that asset markets with complete sets of state-contingent securities are able to aggregate diverse private information. Lundholm (1991) and O’Brien and Srivastava (1991) find that the ability of markets to aggregate information is weakened as complexity in the information environment increases. O’Brien (1990) suggests that ex post disclosure of public accounting information can help coordinate agents with adaptive expectations on the rational expectations equilibrium. The novelty of my study is that security dividends are determined not only by exogenous states, but also by endogenous investment decisions. In a rational expectation equilibrium, price not only aggregates
information about fundamentals, but also influences investment decisions through its impact on the information environment. This paper is among the first to incorporate real investment decisions in an experimental asset market. Kogan, Kwasnica, and Weber (2008) also conduct experiments studying the impact of the asset market on coordination. They use a coordination game with complete information, and fundamental uncertainty plays no role in their paper.

This paper also adds to the economic literature on cheap talk. Experimental studies on coordination games of complete information have shown that cheap talk can reduce strategic uncertainty and improve efficiency (e.g., Cooper et al. 1992; Blume and Ortmann 2007). In a two-person coordination game with two Pareto-ranked equilibria, Cooper et al. (1990) find that the Pareto-inferior equilibrium is often selected. Allowing subjects to communicate through cheap talk leads them to choose the Pareto-dominant equilibrium more often (Cooper et al. 1992). In Cooper et al.’s studies, agents face only strategic uncertainty. What is new in my paper is the introduction of an exogenous fundamental and fundamental uncertainty. The exogenous fundamental captures the degree of difficulty of the coordination task. Cheap talk not only conveys information about strategic uncertainty, but could also reveal information about the fundamental.

3 Game Setup and Hypotheses

3.1 Coordination Game

The coordination problem is modeled as an investment game with an exogenous fundamental. There are multiple agents indexed by $i$, each of whom has to make a binary investment decision on a project, $a_i \in \{\text{invest, not invest}\}$. The project outcome depends on the aggregate investment $A$, which is the proportion of agents who choose to invest, and a state variable $\theta$, related to the project fundamental. The project succeeds if $A \geq \theta$, and fails otherwise. If an agent chooses not to invest, his payoff is $\lambda$ ($\lambda > 0$), irrespective of the project outcome, which can be regarded as the opportunity cost of investment. If the agent chooses to invest, his payoff depends on the project
outcome: $R (R > \lambda)$ if the project succeeds, and 0 if it fails. The payoffs are summarized in the following table.

<table>
<thead>
<tr>
<th>Investment Game Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A \geq \theta$ (Success)</td>
</tr>
<tr>
<td>$A &lt; \theta$ (Failure)</td>
</tr>
<tr>
<td>$a_i = \text{invest}$</td>
</tr>
<tr>
<td>$a_i = \text{not invest}$</td>
</tr>
</tbody>
</table>

This game captures the coordination problem among agents in the range $0 < \theta \leq 1$. The best outcome is achieved if everyone invests ($A = 1$), the project succeeds, and each agent gets a payoff of $R$. However, agents have to weigh the possibility that other agents may not invest. The variable $\theta$ is the hurdle of aggregate investment for the project to succeed. If the aggregate investment is less than the hurdle, the project fails, and those who chose to invest are penalized with zero payoffs. Such beliefs can be self-fulfilling and lead more agents to refrain from investing, which leads to the failure of the project even if it is fundamentally sound. In the case of bank runs, an interpretation of the model is the following: a bank failure is triggered if the total funding to the bank ($A$) is not enough to meet the bank’s liquidity needs ($\theta$). As $\theta$ increases, the amount of total investment that is required for the bank to survive increases. Large $\theta$ represents weak economic fundamental. If $\theta > 1$, the hurdle is insurmountable, and there is no chance for the project to succeed. If $\theta \leq 0$, the project is guaranteed to succeed.

Agents’ decisions are influenced by their knowledge of $\theta$. Consider for a moment the case in which $\theta$ is common knowledge. The equilibrium of this game is the following. If $\theta \leq 0$, the dominant strategy is for all to invest; if $\theta > 1$, the dominant strategy is for all not to invest; if $0 < \theta \leq 1$, there are two pure-strategy symmetric Nash equilibria: either everyone invests or no one invests. In my setup, $\theta$ is not common knowledge. Instead, agents have heterogeneous information about it. They have a common prior that $\theta$ is drawn from a normal distribution, $\theta \sim N(\mu, 1/\alpha)$,
where $\alpha$ is the precision of the prior information and $y$ is the expected value of $\theta$. In addition, each agent receives a private clue $S_i = \theta + \varepsilon_i$, where $\varepsilon_i \sim N(0, \frac{1}{\beta})$ is independently and identically distributed (i.i.d.) across agents and independent of $\theta$ and $y$, where $\beta$ is the precision of the private clues. I further assume that $\beta \geq \alpha^2 / 2\pi$, which is a standard condition that guarantees equilibrium uniqueness.\(^3\)

### 3.2 Information Conditions

To study the impact of public information on coordination, my research design consists of three main conditions: the Control Condition, the Market Condition, and the Cheap Talk Condition. In the Control Condition, agents are not allowed to communicate with each other, and they only have the common prior and private clue about the fundamental. In the Market Condition, agents have access to a market and can trade two state-contingent securities: “Success” and “Failure.” The “Success” stock pays a dividend if the project succeeds and pays no dividend if the project fails; the “Failure” stock pays a dividend if the project fails and pays no dividend if the project succeeds. Price information is publicly available as the market is organized as a double-auction market with an open order book. Agents play the coordination game after trading in this market. Their total earnings consist of trading profits and game payoffs. In the Cheap Talk Condition, agents are asked to send a message to the experimenter about their intended choices: invest or not invest. The experimenter then announces publicly how many intend to invest, and agents play the coordination game afterward. Agents’ messages are nonbinding; that is, they can make a choice different from their stated intentions. There is no cost for agents to send messages, and the messages have no effect on their payoffs.

The three conditions differ in the information environment. Compared with the benchmark Control Condition, prices are additional public information in the Market Condition, and cheap talk

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\(^3\) See Morris and Shin (1998, 2004) for proofs. A brief derivation of the equilibrium is provided in Appendix A.
messages are additional public information in the *Cheap Talk Condition*. Information affects agents’ decisions through its impact on fundamental uncertainty (agents’ beliefs about $\theta$) and strategic uncertainty (agents’ beliefs about aggregate investment $A$). In the rest of the paper, I focus my discussion and analysis on the two types of uncertainty separately. The following chart summarizes the effect of information on decisions.

### Information and Investment Decisions

**Information:***
- Private clues
- Market price
- Cheap talk

**Decision Process**

- **Fundamental Uncertainty**
  - Belief about $\theta$
  - Conjecture about game outcome
  - Investment decision

- **Strategic Uncertainty**
  - Belief about $A$

**3.3 Hypotheses**

This section establishes hypotheses for the three conditions. For the *Control Condition*, the unique Bayesian Nash equilibrium is that agents adopt a symmetric monotone threshold strategy; that is, they invest if and only if their clues are less than a cutoff $S^*$, and do not invest otherwise. Under this strategy, the project succeeds if and only if $\theta$ is less than a cutoff $\theta^*$, and it fails otherwise. Appendix A provides details about the derivation of the equilibrium and predicted equilibrium given by my experimental parameters. The theoretical solution depends on the assumption of homogenous preferences. In the experiments, subjects may have different risk preferences, and therefore the investment cutoffs may vary across individuals. If an individual adopts different cutoff strategies, we will observe that the probability of choosing to invest at the individual level is decreasing in the private clues. This is my first hypothesis.

*Hypothesis 1:* In the *Control Condition*, the likelihood of choosing to invest decreases as the private clues increase.
To compare the outcome of the Market Condition with the outcome of the Control Condition, we have to analyze the impact of prices on fundamental and strategic uncertainty, respectively. I expect that price information can reduce fundamental uncertainty. Previous experiments show that markets with state-contingent securities can aggregate dispersed private information (Plott and Sunder 1988). Field studies also provide evidence that such markets can aggregate private information and predict future uncertain events (Berg et al. 2008). Therefore I expect that prices of the stocks can predict the game outcomes and aggregate private information about the fundamental. If prices aggregate information about \( \theta \), we should be able to find a correlation between the prices of stocks and \( \theta \). As success is more likely if the fundamental is strong (\( \theta \) is small), I hypothesize the following:

**Hypothesis 2:** The prices of “Success” stocks are decreasing in \( \theta \); the prices of “Failure” stocks are increasing in \( \theta \).

Price, although it reduces uncertainty about \( \theta \), can possibly increase strategic uncertainty. Previous research has shown that information that reduces fundamental uncertainty can sometimes increase strategic uncertainty (Morris and Shin 2004; ADKS). Angeletos and Werning (2006) derive the equilibrium of a two-stage game with an asset market that settles on the outcomes of the coordination game. They show that prices can sometimes increase strategic uncertainty by reintroducing multiple equilibria. Prices change the structure of the information environment by increasing the precision of public information \( \alpha \), and the condition for the existence of a unique equilibrium \( \beta \geq \alpha^2 / 2 \pi \) can be violated because prices increase the precision of the public information \( \alpha \). If strategic uncertainty increases, it is possible that price information can have no impact or even a negative impact on coordination.

The impact of cheap talk on coordination also depends on its effect on fundamental and strategic uncertainty. I expect that cheap talk can reduce strategic uncertainty. Previous experiments on coordination games with complete information found that cheap talk can reduce strategic uncertainty and improve coordination efficiency (Copper et al. 1992; Blume and Ortmann
Crawford (1998, p294) summarizes literature on cheap talk and comments, 

“Communication appears to play an important reassurance role, allowing subjects to coordinate on more efficient equilibria by reducing their uncertainty about each other’s decision.” The impact of cheap talk on fundamental uncertainty is less clear. One equilibrium in the game under the Cheap Talk Condition is a babbling equilibrium: agents send random messages and ignore other agents’ messages. In this equilibrium, the aggregate message conveys no information. I analyze the experimental data to determine whether subjects play this uninformative equilibrium, or instead engage in informative cheap talk. Cheap talk will not increase fundamental uncertainty. As cheap talk can reduce strategic uncertainty, I expect that cheap talk has a positive effect on coordination.

Hypothesis 3: The efficiency of coordination is higher in the Cheap Talk Condition than in the Control Condition.

4 Experimental Details

4.1 Experimental Procedure

Thirteen sessions of computerized experiments were run at a computer lab at Carnegie Mellon University in fall 2008 and spring 2009. Each session had 12 subjects. No subject could participate in more than one session. In total, 156 undergraduate students recruited from the Tepper Research Participation Pool participated. The experiment was conducted using the Financial Trading System (FTS). The coordination game was run by FTS sender/receiver software, and the security market was run by FTS market software.

The Market Sessions lasted 2 hours, and other sessions lasted 1 hour. In the experiments, participants were individually seated, and their desks were separated by dividers. Prior to the experiment, they received written instructions, including the relevant payoff tables. Subjects read the instructions by themselves and then completed a short quiz testing whether they understood the experimental instructions. The answers to the quiz were then announced publicly by the instructor. Throughout the experiment, subjects were not allowed to communicate with each other. After the experiment, the subjects filled out a questionnaire about their game strategy and provided
comments on the experiment. Afterward, they were paid in cash. Their total experimental points were converted into dollars at a predetermined exchange rate of 1000 points = 50¢. The average payment for the 2-hour sessions was $24, and the average payment for the 1-hour sessions was $12. In addition, subjects were also rewarded 1 credit for each hour of participation, which could be converted into course credits, according to the rules of the Tepper Research Participation Pool.

4.2 Parameterization and Session Design

The parameters are chosen under the guidance of the theory. The payoff for investing in a successful project is 1000 points, and the payoff for investing in a failed project is 0. The payoff is 500 points if a subject chooses not to invest. This payoff scheme is chosen for its simplicity for the theory and for the ease of the experimental participants. The prior is that θ is normally distributed with mean 0.5 and standard deviation 1 (precision parameter α is 1). The private clues are drawn from a normal distribution with mean θ and standard deviation 0.2 (precision parameter β is 25). The equilibrium uniqueness condition $\beta \geq \alpha^2 / 2\pi$ is satisfied under this parameterization. The experimental parameters are summarized in the following table.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R$</td>
<td>Payoff if invest and project succeeds</td>
<td>1000</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>Payoff if not invest</td>
<td>500</td>
</tr>
<tr>
<td>$y$</td>
<td>Expected value of θ</td>
<td>0.5</td>
</tr>
<tr>
<td>$1/\alpha$</td>
<td>SD of θ (prior)</td>
<td>1</td>
</tr>
<tr>
<td>$1/\beta$</td>
<td>SD of private clues</td>
<td>0.2</td>
</tr>
</tbody>
</table>

To avoid the complexity of dealing with fractions in the experiment, the values of θ and private clues $S_i$ are rescaled by a factor of 100. In the remainder of the paper, both θ and $S_i$ are referred to by their rescaled values.
I conducted four types of experimental session: the Control Session, the Cheap Talk Session, the Market Session, and the Modified Cheap Talk Session. In the Control Sessions, subjects first play the first 20 rounds of coordination games under the Control Condition and then play 20 rounds of games in the Cheap Talk Condition. In the Cheap Talk Sessions, the order is reversed. Such a design allowed me to study the history effect on coordination. Previous experiments showed that the history of plays has a significant impact on equilibrium play in coordination games (Brandts and Cooper 2006). In the Market Sessions, subjects only play 20 rounds of games in the Market Condition. The Modified Cheap Talk Sessions are similar to the Cheap Talk Sessions, except that message spaces are different (details will be provided in the following section). Following is a summary of the experimental sessions.

<table>
<thead>
<tr>
<th>Sessions</th>
<th>First 20 Rounds</th>
<th>Last 20 Rounds</th>
<th># of Sessions</th>
<th># of Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Control Condition</td>
<td>Cheap Talk Condition&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4</td>
<td>48</td>
</tr>
<tr>
<td>Cheap Talk</td>
<td>Cheap Talk Condition</td>
<td>Control Condition&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4</td>
<td>48</td>
</tr>
<tr>
<td>Market</td>
<td>Market Condition</td>
<td></td>
<td>4</td>
<td>48</td>
</tr>
<tr>
<td>Modified Cheap Talk</td>
<td>Modified Cheap Talk</td>
<td>Control Condition</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

<sup>a</sup>This is referred to as the Cheap Talk (with History) Condition in the rest of the paper<br>
<sup>b</sup>This is referred to as the Control (with History) Condition in the rest of the paper

4.3 Timeline of Events in Experiments

Each experimental session consists of multiple rounds. The following schematic illustrates the timeline of events in one round. At the beginning of each round, the server computer generates a random θ and a set of clues $S_i$. It then transmits the private clues to subjects. After the communication stage, subjects enter their game decisions: 1 (invest) or 0 (not invest). Subjects’

<sup>4</sup>In one Market Session, only 15 rounds are run due to time constraints.
inputs are gathered and processed by the server computer. At the end of each round, subjects receive feedback, which includes the realization of $\theta$, the game outcome, and their payoffs. Each round $\theta$ is freshly drawn, and the draw is independent of other rounds.

**Timeline of Events in an Experimental Round**

- **Control Condition**: No action
- **Market Condition**: Trading
- **Cheap Talk Condition**: Send message

**Communication stage**

The communication stage represents the major difference among the various experimental conditions. In the **Control Condition**, there is no activity at the communication stage. In the **Market Condition**, subjects trade two stocks: “Success” and “Failure”. The market lasts for 2 minutes. If the game outcome is success, the “Success” stock pays 1 point of dividend per share and the “Failure” stocks pay nothing; if the game outcome is failure, the “Failure” stock pays 1 point of dividend per share and the “Success” stock pays nothing. In each round, subjects are endowed with 300 points cash loan and 10 shares of each stock. Subjects can both make market and take market, and short selling is allowed. In the **Cheap Talk Condition**, subjects send a message to the experimenter about their intent: 1 (invest) or 0 (not invest). The experimenter announces the number of subjects who intend to invest. In the **Modified Cheap Talk Condition**, subjects are asked to send to the experimenter a message about their estimated probability (a number between 0 and 1) that the game outcome will be success. The experimenter announces the average messages.
5 Experimental Results

This section reports the experimental results in three parts. Section 5.1 focuses on three main experimental conditions: the Control Condition in the Control Sessions and the Market Condition and the Cheap Talk Condition in the Cheap Talk Sessions. Section 5.2 evaluates and compares the efficiency of coordination in various experimental conditions. Section 5.3 discusses the relation between public information and investment decisions.

In the following analysis, the main dependent variables are the investment decisions, either at the individual decision $a_i$ or at the aggregate level $A$. The stock prices in the Market Condition and cheap talk messages in the Cheap Talk Condition are additional variables of interest. The main explanatory variables are $\theta$ and private clue $S$. Table 1 provides the descriptive statistics for the variables. The average of $\theta$ in all experimental conditions is around 50, which is the prior mean of $\theta$. The average private clue $S$ is also around 50.

5.1 Analysis of Individual Condition

5.1.1 Control Condition

The Control Condition in the Control Sessions is the benchmark for the rest of the analysis. Figure 1A shows that the aggregate investment $A$ is decreasing in $\theta$. This indicates that the percentage of subjects who choose to invest decreases as the fundamental weakens. This relationship is confirmed by the result of a linear regression with $\theta$ as the explanatory variable and $A$ as the dependent variable. The regression coefficient on $\theta$ is $-0.66$ ($p < 0.0001$). Figure 1A also plots the predicted aggregate investment under the assumption of risk neutrality. We can see that the observed aggregate investment is close to the theory prediction. Project failure does occur when $\theta$ is less than 100. For example, when $\theta$ is 70, only about 30% of subjects choose to invest, and the game outcome is failure. Had all subjects chosen to invest, the project would have succeeded and all players would have been better off. Therefore coordination failure occurs in the lab (see
Heinemann, Nagel, and Ockenfels 2004; Fehr and Shurchkov 2006; Duffy and Ochs 2009). They fail to do so as they face strong strategic uncertainty: if other people do not invest, their payoff is 0.

Figure 1B shows the investment decisions at the individual level. We can see that the frequency of “invest” is decreasing with private clues. The results of a linear regression of each individual’s choice on the private clues confirm the negative relationship between choices and clues. The coefficient on private clues is −0.00695 (p < 0.0001). Hypothesis 1 is supported. Moreover, most subjects follow a cutoff strategy, as predicted by the theory; that is, they invest if $S \leq S^*$, and do not invest otherwise. To estimate $S^*$, I run logistic regressions with the individual choices as the dependent variable and the private clues as the explanatory variables. The regression model is as follows:

$$\Pr(a_i = 1) = \Pr(S_i \leq S^*) = \frac{1}{1 + e^{-(\alpha - \beta S_i)}}.$$  

The fitted model gives the estimated probability of “Invest” for a given private clue $S$. The estimated threshold $S^*$ is $\hat{\alpha} / \hat{\beta}$, and the dispersion of the estimated threshold is $\pi / \sqrt{3\hat{\beta}}$. Table 2 reports the average estimated thresholds for each experimental condition. The average estimated threshold for the Control Condition in the Control Sessions is 55.49, which is not significantly different from the theory prediction of $S^* = 50$ under the assumption of risk neutrality (two-sided $t$-test, $p = 0.35$). Table 3 provides detailed logistic regression results for each experimental condition in each session.

5.1.2 **Market Condition**

The analysis begins with the comparison of the investment choices in the Market Condition with those in the benchmark condition. Figure 2 shows that the frequency of “invest” in the Market Condition is lower than in the benchmark condition. Table 4A reports the results of logistic regressions with the individual choice as the dependent variable. The explanatory variables include private clues and a dummy variable Market, where Market equals 1 for the Market Condition and 0
for the benchmark Control Condition. The coefficient on this dummy variable is negative and significant, which confirms that subjects are less likely to invest in the Market Condition than in the benchmark condition after controlling for the private clues.

I also estimate the investment threshold $S^*$ for the Market Condition. Table 2 reports that the average estimated investment threshold for the Market Condition is 45.37, which is significantly smaller than that of the Control Condition (one-sided $p = 0.05$, nonparametric Wilcoxon-Mann-Whitney test). This confirms that subjects are less likely to invest in the Market Condition.

Moreover, the dispersion of the estimated threshold is very large in the Market Condition. Table 2 shows that the average dispersion of the estimated threshold of the Market Condition is the largest (31.41). This suggests that individuals are less able to coordinate with each other in the Market Condition.

I use the last five trades in each period as my measure of market prices. There is a significant negative (positive) relation between prices of the “Success” (“Failure”) stock and $\theta$. The linear regression with the price of “Success” stock as the dependent variable and $\theta$ as the explanatory variable has the coefficient $-0.01$ ($p = 0.0007$). The linear regression with the price of “Failure” stock as the dependent variable and $\theta$ as the explanatory variable has the coefficient $0.009$ ($p = 0.0063$). Hypothesis 2 is supported. In the following analysis, I use the rescaled prices of “Success” stock as the measure of the information from stock prices. The variable $\text{price\_Success}$ is the price of “Success” stock divided by the sum of the prices of the two stocks. Figure 3 shows that there is a negative relationship between $\text{price\_Success}$ and $\theta$. Table 5 reports the results of linear regressions with $\text{price\_Success}$ as the dependent variable. It confirms the significant negative relation between prices and $\theta$. In addition, prices are also positively related to the aggregated investment $A$. After controlling for information in $\theta$, the coefficient on the aggregated investment is still significant.

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5 Similar results are obtained if I use the last prices.
6 In these regressions, $\theta$ is adjusted in the following way: $\theta$ is set to 0 if it is less than 0, and $\theta$ is set to 100 if it is more than 100.
This suggests that prices provide information not only about \( \theta \), but also about investment choices in the game.

We can also use prices to predict game outcomes with a high degree of accuracy. One simple rule to predict the game outcome based on prices is to predict success (failure) if the price of “Success” stock is higher (lower) than “Failure” stock. This forecast rule based on prices generates correct predictions in 90.7% of rounds. In sum, stock prices provide additional information to subjects about \( \theta \), and fundamental uncertainty is reduced.

Table 6 shows the results of linear regressions with the net changes in the holdings of each stock as the dependent variable. The explanatory variables include the investment choices, private clues, and \textit{price\_Success}. We can see that trading decisions and investment decisions are consistent with each other. Subjects who choose “invest” are more likely to buy “Success” and sell “Failure” stock, whereas subjects who choose “not invest” are more likely to buy “Failure” and sell “Success” stock. On average, subjects who chose to invest sold 3.29 shares of “Failure” stock and bought 4.24 shares of “Success” stock. Similarly, subjects who chose not to invest sold 3.67 shares of “Success” stock and bought 2.85 shares of “Failure” stock. Subjects also use their private information in trading the stocks. There is a significant negative (positive) relation between the holdings of “Success” (“Failure”) stock and private clues. In addition, Table 6 shows that subjects also use information from stock prices. There is a significant positive (negative) relation between the net changes in the holdings of “Success” (“Failure”) stock and \textit{price\_Success}, even after controlling for the private clues. This suggests that price information affects trading decisions.

5.1.3 Cheap Talk Condition

The analysis also begins with a comparison of the investment decisions in the \textit{Cheap Talk Condition} with those in the benchmark condition. Figure 4 shows that the frequency of “invest” is much higher in the \textit{Cheap Talk Condition} than in the \textit{Control Condition}, which suggests that subjects are more likely to invest under the \textit{Cheap Talk Condition}. Table 4B reports the results of a
logistic regression with the individual choices as the dependent variable. The explanatory variables include private clues and a dummy variable \textit{CheapTalk}, where \textit{CheapTalk} equals 1 for the \textit{Cheap Talk Condition} and 0 for the benchmark \textit{Control Condition}. The coefficient on this dummy variable is positive and significant. This confirms that subjects are more likely to invest in the \textit{Cheap Talk Condition} than in the benchmark condition after controlling for the private clue. The average estimated investment threshold $S^*$ reported in Table 2 for the \textit{Cheap Talk Condition} is 72.97, which is significantly higher than that of the \textit{Control Condition} (one-sided $p = 0.03$ for nonparametric Wilcoxon-Mann-Whitney test). This also confirms that the subjects are more likely to invest in the \textit{Cheap Talk Condition}.

In the \textit{Cheap Talk Condition}, individuals send messages about their intended choices to the experimenter, and the experimenter announces how many of them decide to invest, which becomes a source of public information. To measure public information in the \textit{Cheap Talk Condition} in a comparable scale with prices, public information in the \textit{Cheap Talk Condition} is defined as the percentage of subjects who intend to invest, which is between 0 and 1. Figure 5 compares the frequency of choosing to invest with the frequency of sending messages that a subject intends to invest. We can see that both frequencies are decreasing with private clues. This suggests that subjects are less likely to invest and also less likely to announce that they intend to invest as their private clue increases. In cases in which private clues are larger than 60, the actual percentage of subjects who invest is much lower than the percentage of subjects who intend to invest.

At the individual level, most choices are consistent with the messages about intentions. Overall, actual investment choices are consistent with intentions in 77% of cases. Among the observations that the intention is “invest,” 80% of actual choices are “invest.” Among the observations that the intention is to “not invest,” 72% of the actual choices are “not invest.” For the cases in which actual choices differ from intentions, the cause is likely to be that subjects take into account the public information. One simple way to use this information is to form a conjecture about the game outcome: success if the total percentage of subjects who intend to invest is equal to or larger than a
subject’s private clue, and failure otherwise. Indeed, in 84% of the cases in which subjects announce “invest” but choose “not invest,” the conjectured outcome is failure. Similarly, in 71% of the cases in which subjects announce “not invest” but choose “invest,” the conjectured outcome is “Success.” This indicates that a majority of subjects did not follow their intentions because they took into account the announced public information.

The analysis of the messages sent by subjects reveals three types of strategy in the communication stage. The first is a signaling type of strategy, in which a majority of subjects announce they will invest as long as their private clues are less than 100. Because they can succeed and get the highest payoff if all invest as long as \( \theta \leq 100 \), they try to signal to others that they will invest. The second strategy is a truth-telling type, in which a small percentage of subjects announce they will invest if their clues are below a cutoff around 70. They try to reveal their cutoff strategy truthfully. The third is a babbling type of strategy, in which one or two subjects’ messages are random in each session. The public information is the aggregate messages resulting from the three types of behavior. Therefore the aggregated cheap talk messages are informative about the fundamental, as shown in Figure 5. To summarize, cheap talk messages convey information, and subjects take into account this additional piece of information.

5.2 Coordination Efficiency

In the following analysis, I compare the efficiency of coordination under various experimental conditions. Three measures are considered: the frequency of project failures, the frequency of miscoordination, and the average game payoffs.

5.2.1 Frequency of Project Failures

Table 7 reports the frequency of project failures for various ranges of \( \theta \). In all experimental conditions, there is no project failure for \( \theta \leq 40 \), and the failure frequency is 100% for \( \theta \geq 70 \). In

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7 E.g., suppose that 6 out of 12 subjects intend to invest; then \( E(A) = 50 \). A subject who receives a signal 30 estimates that \( E(\theta) = 30 \). This subject would conjecture that the outcome will be success because \( E(A) = 50 > E(\theta) = 30 \).
the intermediate range, the failure frequencies are nonzero and increase with $\theta$. The frequencies of failure in the *Cheap Talk Condition* are significantly smaller than in the *Control Condition*. For example, the failure rate for $\theta \in [40, 50]$ is 67% in the *Control Condition*, and it drops to 0 in the *Cheap Talk Condition*. The failure rate for $\theta \in [60, 70]$ is 91% in the *Control Condition*, and it reduces to 37.5% in the *Cheap Talk Condition*. Hypothesis 3 is supported. The difference in failure rates between the *Market Condition* and the *Control Condition* is not significant. The failure rates for $\theta \in [50, 70]$ are slightly higher in the *Market Condition* than in the *Control Condition*. There is also strong evidence of a history effect. The failure rates in the *Cheap Talk (with History) Condition* are much higher than in the *Cheap Talk Condition*. This suggests that cheap talk is less effective at improving coordination if a group has played under the *Control Condition*.

5.2.2 Frequency of Miscoordination

The other source of inefficiency in a coordination game is that players’ choices are not perfectly coordinated. For example, suppose that 50% of the players choose to invest and the project succeeds; then the rest of the players, who have not chosen to invest, lose the opportunity to profit from the successful project. I define a dummy variable *Miscoordination* to measure the ex post inefficient decisions. *Miscoordination* equals 1 if the game outcome is success but the choice is “not invest” or the game outcome is failure and the choice is “invest.” Figure 6 compares the frequency of miscoordination in the three main conditions. In the *Control Condition*, the frequency of miscoordination has an inverse $U$–shaped pattern. The frequency of miscoordination is the largest for state realizations around 50. Miscoordination can arise as the result of either fundamental or strategic uncertainty. Hence it can be used as a proxy for total uncertainty. As the fundamental uncertainty is kept constant in the *Control Condition*, the graph of miscoordination indicates the intensity of strategic uncertainty. We can see that subjects face very large strategic uncertainty for $\theta$ around 50.
Figure 6A shows that the frequency of miscoordination is much higher in the Market Condition than in the Control Condition. This indicates that total uncertainty is higher in the Market Condition than in the Control Condition. Because we have found that price reduces fundamental uncertainty, this implies that strategic uncertainty in the Market Condition is higher than in the Control Condition. Figure 6B compares the frequency of miscoordination in the Cheap Talk Condition with that in the Control Condition. We can see that the frequency of miscoordination is much lower in the Cheap Talk Condition, which suggests that the change in information environment caused by cheap talk reduces total uncertainty. In addition to affecting the amount of uncertainty, prices or cheap talk also shift the distribution of uncertainty. Compared to the Control Condition, the peak of uncertainty in the Market Condition is shifted to the left (better fundamental), whereas the peak of uncertainty in the Cheap Talk Condition is shifted to the right (weak fundamental).

5.2.3 Game Payoffs

Table 8 summarizes the average game payoff per subject per round for each experimental condition. The average payoff is the highest in the Cheap Talk Condition, significantly higher than the average payoff in the Control Condition ($p < 0.001$, two-tailed t-test). This also supports hypothesis 3. The average payoff in the Market Condition is significantly lower than the average payoff in the Control Condition ($p < 0.001$, two-tailed t-test). Moreover, the average payoff in the Cheap Talk (with History) Condition is significantly lower than the average payoff in the Cheap Talk Condition ($p < 0.001$, two-tailed t-test), which also confirms the history effect. Table 8 also reports the efficiency ratios, which are calculated as the ratio between the total payoffs and the highest payoffs that subjects can earn under the first best solution. The average efficiency ratio is 67.54% in the Control Condition; it increases to 76.7% in the Cheap Talk Condition and decreases to 64.57% in the Market Condition.

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Under the first best, subjects will invest if $\theta \leq 100$ and their payoffs will be 1000 points. Subjects will not invest if $\theta > 100$ and their payoffs will be 500 points.
5.3 Public Information and Investment Decisions

To explore the link between public information and investment decisions, I run a linear regression with the estimated $S^*$ as the dependent variable and public information as the explanatory variable. The regression results show that there is a strong positive relation between the level of public information and estimated $S^*$ ($p < 0.0001$, $R^2 = 0.83$). The estimated investment thresholds are largely explained by the variations in the public information. The more optimistic is the public signal, the higher is the estimated investment threshold.

The history effect can be explained by the difference in the public information. The messages in the Cheap Talk Condition are much more optimistic than the messages in the Cheap Talk (with History) Condition. Subjects are less likely to announce that they intend to invest in the Cheap Talk (with History) Condition. As a result, they are less likely to achieve successful coordination.

This difference in public information can also explain the different investment decisions in the Modified Cheap Talk Condition compared to the Cheap Talk Condition. Subjects are less likely to choose “invest” in the Modified Cheap Talk Condition compared to the Cheap Talk Condition. The estimated investment threshold $S^*$ in the Modified Cheap Talk Condition is 62.79, lower than the average of the Cheap Talk Condition (72.12). Figure 7 shows that the messages in the Modified Cheap Talk Condition are less optimistic than the messages in the Cheap Talk Condition. The only difference between the two conditions is the message space. In the Cheap Talk Condition, the message space is restricted to either “invest” or “not invest”. In the Modified Cheap Talk Condition, the message is a continuous number between 0 and 1. Restricting agents to reporting “invest” or “not invest” has the effect of generating optimistic public information. An agent who has decided to invest with at least 50% probability will report that he intends to invest. If the agent is allowed to

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9 In the Cheap Talk Condition, the public information is percentage of subjects that intend to invest. In the Market Condition, the public information is the prices of “Success” stocks. In the Modified Cheap Talk Condition, the public information is the average estimated probability of success.

10 In the post experiment questionnaires, subjects indicate that they are less likely to say they intend to invest in the Cheap Talk (with History) Condition because they have experienced the game in the Control Condition and they expected others will not cooperate.
report the probability, then the average message will be lower than if he were restricted to report “invest” or “not invest.” The experimental results suggest that there is a benefit to restricting message spaces of communication.

Previous literature also finds benefits to restricting message spaces in communication. In a capital budgeting setting, Arya, Glover, and Sivaramakrishnan (1997a) and Arya et al. (2000) illustrate that restricting message spaces of informed managers can serve as the commitment device for the uninformed principal. In my setting, coarsening communication by restricting message space exogenously seems to be able to reduce strategic uncertainty. Moreover, endogenous coarse communication—most players reporting “invest” more often than a player would if he or she were trying to best convey information—also reduces strategic uncertainty.

6 Discussion and Conclusion

The role of information on fundamental uncertainty is well understood, but the role of information on strategic uncertainty is rather new to the accounting literature. This paper provides empirical evidence of the importance of strategic uncertainty on investment decisions in a coordination game. I study the impact of two important sources of public information on coordination: market price and cheap talk. The experimental results suggest that market price reduces investments, whereas cheap talk increases investments and improves efficiency. Experimental data indicate that price reduces fundamental uncertainty but increases strategic uncertainty, whereas cheap talk allows players to communicate their intentions and reduces strategic uncertainty. Furthermore, there is evidence that coarsening communication by restricting message space exogenously can increase investments.

The results in this paper suggest that information aggregation properties of a market can sometimes lead to unexpected consequences on resource allocation (Goldstein and Guembel 2008). Price can increase strategic uncertainty by aggregating information about a fundamental and making it publicly available. The anecdotal evidence of the failure of Bear Stearns seems to be
consistent with this argument. The CDS spreads measuring the default risk on Bear Stearns debt rocketed from 246 to 792 basis points in a single day on March 13, 2008. All market participants observing the spike knew that other participants were also observing the spike. This may have caused the confidence of lenders to evaporate suddenly, and the resulting panic-driven withdrawals triggered the failure of Bear Stearns.

Understanding the role of strategic uncertainty has implications for the debate on mark-to-market accounting. Under mark-to-market accounting, banks are required to value their subprime mortgage securities using the ABX Index; at the same time, banks are also the major traders in this market as they hedge their exposure to the subprime risk through the ABX market. Their hedging activities drive down prices, but ironically, they have to use the depressed prices to value their subprime-related assets, which forces banks to take large write-offs. If there is hedging activity in the market, market prices will be even more depressed, and investment may be further reduced. In addition to the information effect on strategic uncertainty, marking-to-market assets using the ABX may further exacerbate the underlying coordination problem by introducing an additional feedback effect. For example, banks may be forced to withdraw their investments prematurely due to the deterioration of capital (Allen and Carletti 2008). Future research can introduce financial reporting to the coordination game to study this effect. Ryan (2008) discusses about the potential feedback effect of mark-to-market accounting using the ABX Index on the index itself and he calls for behavioral-experimental type of research on this topic.

Coordination problems also exist within decentralized organizations, and this study also has implications for managerial accounting. For example, suppose a firm undertakes a project that requires the input of multiple divisions. Each division must decide whether to commit scarce resources to the project. A division may hold back its investments because of a lack of confidence about other divisions’ commitment. Participative budgeting, which is widely applied in decentralized organizations, shares common attributes with cheap talk. In the participative budgeting process, each division submits its future plan, and the head office aggregates and
publishes the plan. My paper suggests that participative budgeting may play a role in facilitating coordination among divisions in decentralized firms. In the accounting literature, Kachelmeier, Smith, and Yancey (1994) interpret budgets as cheap talk messages sent by central management. Luft and Shields (2007, p35) show that organizational size, diversification, and decentralization increase participative budgeting.

Recently, internal markets called “prediction markets” have been explored as an innovative way of aggregating information within organizations (Wolfers and Zitzewitz 2004). For example, Microsoft opened a prediction market to predict an internal product ship date. In this market, software developers and testers traded state-contingent securities such as NOV, DEC, JAN, and so on. If the actual ship date was in January, then the JAN share had a $1 payoff, and the others had a $0 payoff. Such prediction market generates useful information for project management as prices aggregate diverse information. My paper cautions companies against the potential negative effect of prediction markets relative to more traditional mechanism for coordination such as participative budgeting.

There are limitations of the current study, and several related extensions may be helpful in addressing those limitations. First, only insiders who play the coordination game participate in the trading in the current market experiment. Future experiments can allow outsiders to trade. Future studies can also vary the relative payoffs from the market and the game. Second, future experiments can study other cheap talk procedures such as committee meetings or repeated cheap talk. Third, the experimental task is framed as an abstract game with neutral labeling. It would be interesting to see if labeling could serve as a focal point for coordination (Mehta, Starmer, and Sugden 1994). In addition, the payoff structure is exogenously specified in this paper. Future experiments can vary the payoffs and study how changes in the payoff parameters affect coordination and whether such changes affect the impact of price and cheap talk on coordination. Last, it may also be interesting to study the combined effect of cheap talk and an asset market on
coordination. If strategic uncertainty can be managed through cheap talk, can investors take advantage of the information revealed in the market?

In this paper, public information is generated through communication among investors. In practice, there are other exogenous channels of public information, such as public accounting reports, credit ratings, public news, and media announcements. Future research can study the impact of such information channels on coordination. Also, these public disclosures may contain biases such as the conservative bias of accounting or an optimistic bias in managerial disclosure. How such biased information affects coordination is also an important and interesting question.

The strategic interdependence among agents in a coordination setting can make the role of public information counterintuitive. As public information plays a significant role in coordinating beliefs, it is rational for agents to overweight public information relative to private information. As a result, the noise in the public information can be amplified, and social efficiency can be adversely affected by public information disclosure (Morris and Shin 2002). Accounting information is the most important source of public information to play a significant role in coordination. Understanding the role of public information on coordination is necessary and useful for both accounting theory and policy design.
Appendix A: Theory Predictions for the Control Condition

Assuming that there is a continuum of agents, we can derive the equilibrium of the coordination game under the Control Condition. Agents have a common prior about the state variable \( \theta \sim N(y, 1/\alpha) \), where \( \alpha \) is the precision of the prior information and \( y \) is the expected value of the state variable. In addition, each agent has a private signal about the state, \( S_i = \theta + \varepsilon_i \), where \( \varepsilon_i \sim N(0, 1/\beta) \) and \( \beta \) is the precision of private signals. Furthermore, \( \varepsilon_i \) are i.i.d. across agents and independent of \( \theta \) and \( y \). Given the prior and their private signal, agents update their beliefs about \( \theta \). Their posterior is \( \varphi = \frac{\alpha y + \beta S_i}{\alpha + \beta} \). The strategy of an agent maps his private clue onto one of the two actions. Because it is strictly dominant to invest for sufficient low signals and not to invest for sufficient high signals, one possible strategy is a monotone threshold strategy: invest if the private signal is smaller than \( S^* \) and do not invest otherwise. Given this strategy, the measure of agents who invest is given by \( A(\theta) = \Pr(S < S^*|\theta) = \Phi(\sqrt{\beta}(S^* - \theta)) \), where \( \Phi \) is the cumulative distribution function of the standard normal distribution. If agents adopt this threshold strategy, the outcome of the project is deterministic. The project succeeds if and only if \( \theta \leq \theta^* \), where \( \theta^* \) solves \( \theta^* = A(\theta^*) \). This gives us the first equilibrium condition:

\[
\theta^* = \Phi(\sqrt{\beta}(S^* - \theta^*)) = \Phi\left(\sqrt{\beta} \left( \frac{\alpha + \beta}{\beta} \varphi^* - \frac{\alpha}{\beta} y - \theta^* \right) \right)
\]  

(1)

In equilibrium, agents are indifferent between “invest” and “not invest”, which gives us the second equilibrium condition:

\[
R\Phi(\sqrt{\alpha + \beta}(\theta^* - \varphi^*)) = \lambda
\]

(2)

The left-hand side is the expected payoff if an agent chooses to invest.\(^{11}\) The right-hand side is the payoff if an agent chooses not to invest. The posterior probability of project success given a signal

\(^{11}\)It is assumed here that agents are risk-neutral.
\[ S \) is \( \Pr(\theta \leq \theta^*|S) \), which equals \( \Phi(\sqrt{\alpha + \beta}(\theta^* - \varphi)) \). Combining equations (1) and (2), we can derive the equilibrium pair \((S^*, \theta^*)\), where \( \theta^* \) is the implicit solution of equation (3):

\[
\theta^* = \Phi \left( \frac{\alpha}{\sqrt{\beta}} \left( \theta^* - \frac{\sqrt{\alpha + \beta} \Phi^{-1}(\frac{\lambda}{\beta})}{\alpha} - y \right) \right)
\]

(3)

The threshold state \( \theta^* \) is obtained as the intersection between the 45° line and a cumulative normal distribution with mean \( \frac{\sqrt{\alpha + \beta} \Phi^{-1}(\frac{\lambda}{\beta})}{\alpha} + y \) and variance \( \beta \frac{\alpha^2}{\alpha^2} \). To ensure the existence of a unique solution to equation (3), the slope of the right-hand side of equation (3) must be smaller than 45°. Differentiating the right-hand side with respect to \( \theta \), we derive the slope of the CDF function:

\[
\phi(\cdot) \frac{\alpha}{\sqrt{\beta}}, \text{ where } \phi(\cdot) = \Phi' \left( \frac{\alpha}{\sqrt{\beta}} \left( \theta_p - \frac{\sqrt{\alpha + \beta} \Phi^{-1}(\frac{\lambda}{\beta})}{\alpha} - y \right) \right).
\]

The slope must be smaller than 1 to ensure a unique solution for equation (3) because \( \phi(\cdot) \) is bounded by \( \frac{1}{\sqrt{2\pi}} \). Therefore, the condition \( \frac{\alpha}{\sqrt{\beta}} < \sqrt{2\pi} \) is needed, or equivalently, \( \beta \geq \frac{\alpha^2}{2\pi} \). This condition requires that the precision of the private signal must be sufficiently larger than the precision of the public signal. The iterated deletion of strictly dominated strategies ensures that when the monotone equilibrium is unique, there is no other equilibrium.\(^\text{12}\) The equilibrium investment strategy \( S^* \) can be expressed as a function of \( \theta^* \).

The experimental parameters are \( y=0.5, R=1000, \lambda =500, \beta=25, \) and \( \alpha=1 \). Assuming that agents are risk-neutral, the predicted equilibrium is \( S^* = 0.5 \) and \( \theta^* = 0.5 \). Assuming that agents are risk-averse (negative exponential utility with risk aversion coefficient 0.001), the predicted equilibrium is \( S^* = 0.693 \) and \( \theta^* = 0.628 \). Assuming that agents are risk-loving (negative exponential utility with risk aversion coefficient -0.001), the predicted equilibrium is \( S^* = 0.307 \) and \( \theta^* = 0.372 \). Figure A1 plots the predicted aggregated investment \( A \) for the three cases respectively.

References


Figure 1: Investment Choices in the *Control Condition*

The left panel depicts the actual and predicted aggregate investment for different realizations of \( \theta \). The actual aggregate investment is the percentage of subjects that choose to invest in the experiments. The predicted aggregate investment is the proportion of investment predicted by the theory under the assumption that there is a continuum of risk-neutral agents. The right panel depicts the frequency of subjects choosing to invest for different clue bins. The data in this figure includes the *Control Condition* in the Control Sessions.

Figure 2: Investment Choices in the *Market Condition* Compared with the *Control Condition*

Depicts the frequency of choosing “Invest” for various clue ranges. The data in this figure include the *Market Condition* in the four Market Sessions and the *Control Condition* in the four Control Sessions.
Figure 3: Information from the Stock Prices

Depicts the rescaled prices of the “Success” stock. I use the last five trades in each period as the measure of market prices. “Price_Success” is the prices of “Success” stocks rescaled by the sum of the “Success” and “Failure” prices.

Figure 4: Investment Choices in the *Cheap Talk Condition* Compared with the *Control Condition*

Depicts the frequency of choosing “Invest” for various clue ranges. The data in this figure include the *Cheap Talk Condition* in the four Cheap Talk Sessions and the *Control Condition* in the four Control Sessions.
Figure 5: Messages Compared with Actual Choices in the *Cheap Talk Condition*

![Graph depicting messages compared with actual choices.](image)

Depicts the frequency of choosing to invest (Choice) and the frequency of sending cheap talk message that a subject intends to invest (Cheap Talk). The data in the figure includes the *Cheap Talk Condition* in the four Cheap Talk Sessions.

Figure 6: Frequency of Miscoordination

**Panel A:** Miscoordination in the *Market Condition* Compared to the *Control Condition*

**Panel B:** Miscoordination in the *Cheap Talk Condition* Compared to the *Control Condition*

![Graphs showing miscoordination frequency.](image)

Depicts average frequency of miscoordination. Miscoordination is defined to be 1 if game outcome is success and subjects’ choices are “Not Invest” or if game outcome is failure and subjects’ choices are “Invest.” Otherwise, miscoordination is defined to be 0.
Figure 7: Average Messages in the *Cheap Talk* and Modified *Cheap Talk Conditions*

![Average Messages Graph]

Depicts the average messages in the *Cheap Talk Condition* in the Cheap Talk Sessions and in the Modified *Cheap Talk Condition*. In the *Cheap Talk Condition*, the message is percentage of subjects who intend to invest. In the Modified *Cheap Talk Condition*, the message is the average estimated probability of success.

Figure A1: Predicted Aggregate Investments

![Aggregate Investment Graph]

Depicts the predicted aggregate investment for the experimental parameters: \( y = 0.5, R = 1000, \lambda = 500, \beta = 25, \alpha = 1 \), under the assumption that there is a continuum of agents. The aggregate investment \( A \) is the percentage of subjects who invest. The solid line is the predicted aggregate investment under the assumption that agents are risk-neutral. The dashed line is the predicted aggregate investment under the assumption that agents are risk-loving (negative exponential utility with risk aversion coefficient \(-0.001\)). The dotted line is the predicted aggregate investment under the assumption that agents are risk-averse (negative exponential utility with risk aversion coefficient 0.001).
Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th>Cheap Talk (with History)</th>
<th>Cheap Talk</th>
<th>Control (with History)</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min θ</td>
<td>−58.6</td>
<td>−51.9</td>
<td>−51.9</td>
<td>−58.6</td>
<td>−58.6</td>
</tr>
<tr>
<td>Max θ</td>
<td>144.5</td>
<td>143.4</td>
<td>143.4</td>
<td>144.5</td>
<td>144.5</td>
</tr>
<tr>
<td>Mean θ</td>
<td>51.5</td>
<td>51.6</td>
<td>50.7</td>
<td>51.5</td>
<td>50</td>
</tr>
<tr>
<td>Min S</td>
<td>−87.2</td>
<td>−102.6</td>
<td>−102.6</td>
<td>−74.3</td>
<td>−74.3</td>
</tr>
<tr>
<td>Max S</td>
<td>179.9</td>
<td>163.9</td>
<td>163.9</td>
<td>179.9</td>
<td>179.9</td>
</tr>
<tr>
<td>Mean S</td>
<td>50.44</td>
<td>51.51</td>
<td>51.14</td>
<td>50.5</td>
<td>49.5</td>
</tr>
<tr>
<td>Mean choice</td>
<td>0.54</td>
<td>0.6</td>
<td>0.65</td>
<td>0.55</td>
<td>0.46</td>
</tr>
<tr>
<td>% of success</td>
<td>0.49</td>
<td>0.53</td>
<td>0.59</td>
<td>0.51</td>
<td>0.45</td>
</tr>
<tr>
<td>Average game payoff</td>
<td>641.67</td>
<td>690.63</td>
<td>728.65</td>
<td>659.90</td>
<td>615.56</td>
</tr>
<tr>
<td># of subjects</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
</tbody>
</table>

Variable θ is the exogenous state variable. The prior about θ is that it is normally distributed with mean 50 and standard deviation 100. S is the private clue received by the individual, which is drawn from a normal distribution with mean θ and standard deviation 20. Choices a are either 0 or 1. In the experiment, subjects are asked to choose between 0 (not invest) and 1 (invest). If the percentage of subjects choosing 1 is equal to or greater than θ, the outcome is success. Otherwise, the outcome is failure. The average payoffs are payoffs per round measured in game points.
Table 2: Estimated Investment Threshold $S^*$

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Condition</th>
<th>Average Estimated Threshold</th>
<th>SD of Estimated Threshold</th>
<th>Average Dispersion of Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Control</td>
<td>55.49</td>
<td>10.05</td>
<td>26.62</td>
</tr>
<tr>
<td>Cheap Talk (with History)</td>
<td><strong>66.46</strong>*(0.09)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheap Talk</td>
<td>Cheap Talk</td>
<td>72.97*(0.03)</td>
<td>9.38</td>
<td>25.97</td>
</tr>
<tr>
<td>Control (with History)</td>
<td>55.68*(0.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market</td>
<td>Market</td>
<td>45.37*(0.05)</td>
<td>5.48</td>
<td>31.41</td>
</tr>
</tbody>
</table>

*Significant at 5% level. **Significant at 10% level.

For each experimental session, I run logistic regression $\Pr(\text{Choice} = \text{Invest}) = 1/[1+e^{-(\alpha + \beta \cdot I)}]$ to estimate the investment threshold. The estimated threshold is $\hat{\alpha}/\hat{\beta}$ and the dispersion of the estimated threshold is $(\pi^2/3)\hat{\beta}$. This table gives the summary statistics for the estimated threshold (Table 3 reports the estimates for each session.) The average estimated threshold is the average of the estimated threshold over the four replicating sessions. The standard deviation of the estimated threshold is the standard deviation of the four estimated thresholds. The average dispersion of the threshold is the average of the dispersions of the estimated threshold over the four replicating sessions. Numbers in parentheses are one-tail $p$-values comparing the mean with that under the Control Condition in the Control Sessions based on the Wilcoxon-Mann-Whitney test.
### Table 3: Results of Logistic Regressions

<table>
<thead>
<tr>
<th>Session Code</th>
<th>Treatment</th>
<th>Condition</th>
<th>$\hat{\alpha}$</th>
<th>$\hat{\beta}$</th>
<th>$\hat{\alpha} / \hat{\beta}$</th>
<th>Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Control</td>
<td>Control</td>
<td>2.45</td>
<td>0.06</td>
<td>43.09</td>
<td>31.93</td>
</tr>
<tr>
<td>C2</td>
<td>Control</td>
<td>Control</td>
<td>4.14</td>
<td>0.08</td>
<td>53.92</td>
<td>23.61</td>
</tr>
<tr>
<td>C3</td>
<td>Control</td>
<td>Control</td>
<td>4.60</td>
<td>0.07</td>
<td>67.44</td>
<td>26.56</td>
</tr>
<tr>
<td>C4</td>
<td>Control</td>
<td>Control</td>
<td>4.28</td>
<td>0.07</td>
<td>57.53</td>
<td>24.39</td>
</tr>
<tr>
<td>C1</td>
<td>Control</td>
<td>Cheap Talk</td>
<td>6.05</td>
<td>0.10</td>
<td>60.30</td>
<td>18.08</td>
</tr>
<tr>
<td>C2</td>
<td>Control</td>
<td>Cheap Talk</td>
<td>3.75</td>
<td>0.06</td>
<td>62.21</td>
<td>30.06</td>
</tr>
<tr>
<td>C3</td>
<td>Control</td>
<td>Cheap Talk</td>
<td>7.21</td>
<td>0.09</td>
<td>81.95</td>
<td>20.60</td>
</tr>
<tr>
<td>C4</td>
<td>Control</td>
<td>Cheap Talk</td>
<td>4.13</td>
<td>0.07</td>
<td>61.39</td>
<td>26.93</td>
</tr>
<tr>
<td>T1</td>
<td>Cheap Talk</td>
<td>Cheap Talk</td>
<td>5.22</td>
<td>0.07</td>
<td>77.22</td>
<td>26.80</td>
</tr>
<tr>
<td>T2</td>
<td>Cheap Talk</td>
<td>Cheap Talk</td>
<td>5.98</td>
<td>0.08</td>
<td>74.74</td>
<td>22.64</td>
</tr>
<tr>
<td>T3</td>
<td>Cheap Talk</td>
<td>Cheap Talk</td>
<td>5.72</td>
<td>0.07</td>
<td>80.56</td>
<td>25.53</td>
</tr>
<tr>
<td>T4</td>
<td>Cheap Talk</td>
<td>Cheap Talk</td>
<td>3.72</td>
<td>0.06</td>
<td>59.36</td>
<td>28.92</td>
</tr>
<tr>
<td>T1</td>
<td>Cheap Talk</td>
<td>Control</td>
<td>7.07</td>
<td>0.11</td>
<td>62.78</td>
<td>16.09</td>
</tr>
<tr>
<td>T2</td>
<td>Cheap Talk</td>
<td>Control</td>
<td>8.73</td>
<td>0.16</td>
<td>54.29</td>
<td>11.28</td>
</tr>
<tr>
<td>T3</td>
<td>Cheap Talk</td>
<td>Control</td>
<td>4.68</td>
<td>0.08</td>
<td>56.33</td>
<td>21.82</td>
</tr>
<tr>
<td>T4</td>
<td>Cheap Talk</td>
<td>Control</td>
<td>5.35</td>
<td>0.11</td>
<td>49.34</td>
<td>16.73</td>
</tr>
<tr>
<td>M1</td>
<td>Market</td>
<td>Market</td>
<td>3.01</td>
<td>0.06</td>
<td>50.32</td>
<td>30.33</td>
</tr>
<tr>
<td>M2</td>
<td>Market</td>
<td>Market</td>
<td>2.36</td>
<td>0.06</td>
<td>41.07</td>
<td>31.60</td>
</tr>
<tr>
<td>M3</td>
<td>Market</td>
<td>Market</td>
<td>3.74</td>
<td>0.07</td>
<td>49.89</td>
<td>24.21</td>
</tr>
<tr>
<td>M4</td>
<td>Market</td>
<td>Market</td>
<td>1.85</td>
<td>0.05</td>
<td>40.20</td>
<td>39.49</td>
</tr>
<tr>
<td>MT</td>
<td>Modified Talk</td>
<td>Cheap Talk</td>
<td>3.75</td>
<td>0.06</td>
<td>62.79</td>
<td>30.21</td>
</tr>
<tr>
<td>MT</td>
<td>Modified Talk</td>
<td>Control</td>
<td>7.61</td>
<td>0.14</td>
<td>54.34</td>
<td>12.95</td>
</tr>
</tbody>
</table>
Table 4: Investment Choices Compared with the Control Condition

Panel A: Investment Choices in the Market Condition

<table>
<thead>
<tr>
<th></th>
<th>Dependent Variable: Choice a_i</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S</strong></td>
<td>−0.06*</td>
</tr>
<tr>
<td></td>
<td>(&lt;=0.0001)</td>
</tr>
<tr>
<td><strong>Market</strong></td>
<td>−0.63*</td>
</tr>
<tr>
<td></td>
<td>(&lt;0.0001)</td>
</tr>
<tr>
<td><strong>Market * S</strong></td>
<td>−1.05*</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td># of observations</td>
<td>1860</td>
</tr>
</tbody>
</table>

Panel B: Investment Choices in the Cheap Talk Condition

<table>
<thead>
<tr>
<th></th>
<th>Dependent Variable: Choice a_i</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S</strong></td>
<td>−0.06*</td>
</tr>
<tr>
<td></td>
<td>(&lt;=0.0001)</td>
</tr>
<tr>
<td><strong>CheapTalk</strong></td>
<td>1.14*</td>
</tr>
<tr>
<td></td>
<td>(&lt;0.0001)</td>
</tr>
<tr>
<td><strong>CheapTalk * S</strong></td>
<td>1.17**</td>
</tr>
<tr>
<td></td>
<td>(&lt;0.0001)</td>
</tr>
<tr>
<td># of observations</td>
<td>1920</td>
</tr>
</tbody>
</table>

*Significant at 1% level. **Significant at 5% level.

Reports results of logistic regressions with individual choices as the dependent variable. Choice equals 1 if “Invest” and choice equals 0 if “Not Invest.” Panel A includes data in the Control Condition of the Control Sessions and Market Condition. Panel B includes data in the Control Condition of Control Sessions and the Cheap Talk Condition of the Cheap Talk Sessions. The explanatory variables include private clue S, two dummy variables, and the interaction between private clues and dummy variables. “Market” is a dummy variable that equals 1 if data are from the Market Condition. “CheapTalk” is a dummy variable that equals 1 if data are from the Cheap Talk Condition. Numbers in parentheses are p-values. Standard errors are clustered at the experimental session level.
Table 5: Information Content of Prices

<table>
<thead>
<tr>
<th>Dependent Variable: Price_Success</th>
<th>Intercept</th>
<th>State 0</th>
<th>Aggregated investment A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.93* (0.0001)</td>
<td>-0.86* (&lt;0.0001)</td>
<td>0.81* (&lt;0.0001)</td>
<td></td>
</tr>
<tr>
<td>0.10* (0.0012)</td>
<td>-0.42** (0.018)</td>
<td>0.44* (0.0096)</td>
<td></td>
</tr>
<tr>
<td>0.49* (0.0034)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R²: 0.73  0.73  0.75  # of observations: 75  75  75

*Significant at 1% level. **Significant at 5% level.

Reports results of a linear regression with “price_Success” (the price of the “Success” stock divided by the sum of the prices of “Success” and “Failure” stocks) as the dependent variable. The explanatory variables include θ and the aggregated investment A (the percentage of subjects who choose to invest).

Table 6: Factors That Explain the Stock Holdings

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Net Change in Holdings of “Success” Stock</th>
<th>Net Change in Holdings of “Failure” Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-3.67** (0.031)</td>
<td>2.85*** (0.078)</td>
</tr>
<tr>
<td></td>
<td>1.75** (0.020)</td>
<td>-1.09** (0.018)</td>
</tr>
<tr>
<td></td>
<td>7.909* (0.007)</td>
<td>-4.93* (0.006)</td>
</tr>
<tr>
<td>Choice a_i</td>
<td>7.915** (0.041)</td>
<td>-6.142*** (0.083)</td>
</tr>
<tr>
<td></td>
<td>-0.035** (0.017)</td>
<td>0.022** (0.02)</td>
</tr>
<tr>
<td></td>
<td>-0.075** (0.012)</td>
<td>0.047* (0.008)</td>
</tr>
<tr>
<td>Clue S</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.858** (0.013)</td>
<td>5.353* (0.005)</td>
</tr>
<tr>
<td>Price_Success</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-8.58** (0.013)</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.045</td>
<td>0.024</td>
</tr>
<tr>
<td># of observations</td>
<td>900</td>
<td>900</td>
</tr>
</tbody>
</table>

*Significant at 1% level. **Significant at 5% level. ***Significant at 10% level.

Reports results of a linear regression with the net change in the holdings of two stocks as the dependent variable. Each individual has 10 units of initial endowment of each stock. The net change in stock holdings is the final position minus the initial holdings. “Success” stock pays a dividend if and only if the game outcome is success; “Failure” stock pays a dividend if and only if the game outcome is failure. The explanatory variables include individual investment choice, stock prices, and private clues S. Choice equals 1 if subjects choose to invest and 0 if subjects choose not to invest. “Price_Success” is the price of “Success” stock divided by the sum of the prices of “Success” and “Failure” stocks. Numbers in parentheses are p-values. Standard errors are clustered at the experimental session level.
Table 7: Frequency of Project Failures

<table>
<thead>
<tr>
<th>State θ</th>
<th>Control Sessions</th>
<th>Cheap Talk Sessions</th>
<th>Market Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Cheap Talk (with History)</td>
<td>Control (with History)</td>
</tr>
<tr>
<td>0–40</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>40–50</td>
<td>0.67</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50–60</td>
<td>0.5</td>
<td>0.56</td>
<td>0.25</td>
</tr>
<tr>
<td>60–70</td>
<td>0.91</td>
<td>0.71</td>
<td>0.375</td>
</tr>
<tr>
<td>70–100</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Reports the frequency at which project failures occur under each experimental condition. Project failure occurs if the percentage of subjects who invest is less than θ.

Table 8: Average Game Payoffs per Round

| Session | Condition             | N  | Mean | Max  | Min  | SD  | Efficiency%
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Control</td>
<td>48</td>
<td>642</td>
<td>800</td>
<td>450</td>
<td>84</td>
<td>67.54%</td>
</tr>
<tr>
<td></td>
<td>Cheap Talk (with History)</td>
<td>48</td>
<td>691</td>
<td>775</td>
<td>600</td>
<td>43</td>
<td>72.70%</td>
</tr>
<tr>
<td></td>
<td>Cheap Talk</td>
<td>48</td>
<td>729</td>
<td>825</td>
<td>600</td>
<td>44</td>
<td>76.70%</td>
</tr>
<tr>
<td></td>
<td>Control (with History)</td>
<td>48</td>
<td>660</td>
<td>750</td>
<td>550</td>
<td>54</td>
<td>69.46%</td>
</tr>
<tr>
<td></td>
<td>Market (with History)</td>
<td>48</td>
<td>616</td>
<td>750</td>
<td>425</td>
<td>64</td>
<td>64.57%</td>
</tr>
</tbody>
</table>

*Efficiency is measured as the ratio between the total payoffs earned by all subjects divided by the payoffs in the first solution. Under the first best, all subjects choose to invest as long as θ ≤ 100. The payoff is 1000 if θ ≤ 100 and 500 if θ > 100. The ratio is calculated for each experimental condition in each experimental session. The reported ratio is the average ratio over the four replications of each condition.

Reports the summary statistics for the average game payoffs per round. The game payoffs are measured in game points. For each condition in each experimental session, I calculate average game payoffs per round for each subject.