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STRATEGIC SIGNALING: HOW MISREPRESENTATION AND TRUST INFLUENCE PROFITABILITY IN COMPETITIVE SETTINGS

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Abstract

We analyze the effect of communicating distorted signals by interdependent agents who hold different levels of trust and make repeated decisions, independently and simultaneously, and who learn from each other. We found that in a duopoly model differential levels of misrepresentation and trust of firms have notable and non-trivial effects on profitability. With asymmetric misrepresentation, when the firms have both 1st and 2nd order trust, we find that the firm that misrepresents more gains more, whereas when the firms have 2nd order trust but no 1st order trust, the firm that misrepresents less gains more. We also discuss the effects of firms having different combinations of trust levels. Finally, we conclude with implications and limitations of our findings.

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ABSTRACT

We analyze the effect of communicating distorted signals by interdependent agents who hold different levels of trust and make repeated decisions, independently and simultaneously, and who learn from each other. We found that in a duopoly model differential levels of misrepresentation and trust of firms have notable and non-trivial effects on profitability. With asymmetric misrepresentation, when the firms have both 1st and 2nd order trust, we find that the firm that misrepresents more gains more, whereas when the firms have 2nd order trust but no 1st order trust, the firm that misrepresents less gains more. We also discuss the effects of firms having different combinations of trust levels. Finally, we conclude with implications and limitations of our findings.

INTRODUCTION

Signaling in competitive environments usually involves misrepresentation or deception of some form to gain strategic advantage (Crawford, 2003; Heil & Robertson, 1991). The benefits to misrepresenting strategic variables, such as costs, depend on the extent to which a signal is distorted by the sender and on the type and level of trust formed by the receiver. The level of trust determines the extent to which a distorted, or misrepresented, signal is considered credible. In this study, we analyze the effect of communicating distorted signals by interdependent agents who hold different levels of trust.

This paper aims to answer the question of how misrepresentation and trust jointly influences profitability. To develop new theory, we study scenarios in which agents undertake repeated interdependent actions or decisions. These agents signal *ex ante* about their planned actions, but cannot verify their opponents' misrepresentations of such signals *ex post*. These scenarios arise when the interacting agents' actions depend on their opponents' private information, and there are possible strategic benefits to misrepresenting such information. This problem is quite common as indicated by the study of misrepresentation in contract law.

We study a particular version of this problem that is present in oligopolistic settings. The agents can either trust the communicated signals that their opponents provide, or they can learn from observing the *actual* behavior of their opponents. A common occurrence of such a scenario is when competing firms decide on their planned optimal production quantities by communicating their respective private production costs via cost signals. They can either believe

those signals or learn from each others' observable quantities, which defines their future competitive strategies and hence profitability.

To study the effect of misrepresentation, we first describe a scenario for unverifiable misrepresentation and trust, which involves learning from each other. We then describe a model, representing this scenario, of an industry, in which firms signal their costs, learn and infer their competitors' costs through repeated interactions, and make decisions about their production quantities based on the learned beliefs.

LITERATURE

While the literature on signaling is fairly limited in strategy research (e.g. Balachander and Srinivasan, 1994; Heil & Robertson, 1991; Srinivasan, 1991), there is long line of literature in economics where agents or firms communicate even when they compete against each other, in order to obtain mutual benefits. The most popular topic of these studies deals with Oligopolists sharing private information with their rivals. The information involved in the communication can be either firm specific, such as its costs (Gal-Or, 1986; Li, 1985; Shapiro, 1986), or is common to all firms, such as market demand, but possessed only by a subset of them (Gal-Or, 1985; Kirby, 1988; Novshek & Sonnenschein, 1982; Vives, 1984), or a combination of both (Amir, Jin, & Troege, 2010; Raith, 1996).

Misrepresentation of private information in strategic communication, the main topic of this study, is analyzed in several different strands in literature. Within the realm of general communication models in economics, the classical and prominent study of Crawford and Sobel

(1982) analyzes a model of noisy signaling when the preferences of sender and receiver differ. In game theory, misrepresentation is studied mainly in the context of signaling via cheap talk. Farrell (1993) analyzed private communication in zero-sum games, and a survey of the related theory is provided by Crawford (1998) and Farrell and Rabin (1996). While game theory is mostly filled with studies that deal with equilibrium analysis, studies that undertake non-equilibrium or finite-time analysis which have greater practical implications are relatively few. Farrell (1988) and Rabin (1994) attempted to study non-equilibrium analysis in games with preplay communication via cheap talk and whose players have substantial common interests, while Costa-Gomes (2002) attempted to interpret experimental data in such games. Industrial organization is another strand in which misrepresentation is studied within competitive contexts. Ziv (1993) analyzed truthful information sharing in oligopoly, and showed that if firms have the ability to mislead, they usually do. Milgrom and Roberts (1982a) analyzed misrepresentation via limit pricing, and showed that if an incumbent has private information about costs, then limit pricing can arise in equilibrium. Kreps and Wilson (1982) and Milgrom and Roberts (1982b) studied reputational misrepresentation, though in a weak form. It occurs when firms undertake actions intentionally to form a false reputation to deter entry, only to capitalize on it later on. In terms of competitive strategies, Fudenberg and Tirole (1984) showed that firms under-invest and prefer to look “lean and hungry” with respect to certain capabilities and over-invest in predatory capabilities.

Similar to the mentioned signaling or communication literature, the literature on trust is vast, with several proposed definitions of it. Sztompka (1999) defined trust as the expectation that an opponent will act in ways conducive to our well-being, while Rousseau (1998) defined

trust as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intensions or behavior of another". Here, in this study, we are concerned with cognition-based trust which is based on individual thinking about and trust in the other. In this context, Mayer, Davis, and Schoorman (1995) proposed two dimensions of trust: *benevolence* – an affective component, and *competence* – a cognitive component. For trust in interdependent relationships, Zand (1972) is one of the few who proposed an interactive model.

If competing firms make repeated interdependent decisions, two things happen: firms form belief models of other firms, and they learn from each others' decisions. Stahl and Wilson (1995) analyzed experimentally player's models of other players, and proposed boundedly rational classifications based on these models. Interdependence of competitive decisions is studied by Lenox, Rockart, and Lewin (2006, 2007), while learning behavior, reinforcement or incremental, is formalized by Sutton and Barto (1998), Camerer and Teck-Hua (1999), and Erev and Roth (1998). Levinthal (1997) proposed a model for learning in a setting where policy choices are interdependent.

While the literature mentioned above analyzes misrepresentation in several different settings, very little has been done to analyze misrepresentation along with trust in competitive scenarios that involve learning. Hence, in this study, we formally model and analyze the effect of communicating misrepresented private information in different trust settings in scenarios where firms make repeated interdependent decisions independently and simultaneously and learn from each other. This approach allows us to add to prior literature by addressing the question of how misrepresentation and trust jointly influences profitability.

A MODEL OF UNVERIFIABLE MISREPRESENTATION AND TRUST

Consider an industry with two firms in an oligopolistic setting. The firms produce non-differentiated products but have access to different production technologies, and as a result, they differ in their production costs; otherwise they are identical. The production cost is private information to the firms and is not readily known to their competitors. Each firm signals or announces its associated production cost to its competitor, who then forms belief of its own depending on its level of trust of the focal firm. Since the signals are unverifiable (by assumption) and there are possible benefits to misrepresentation, firms may or may not reveal their true cost depending on their strategic objectives. It is important to note that the misrepresented behavior and trust attributes of the firms are not common knowledge.

The firms engage in repeated competitive interactions over multiple periods. In each period, the firms compete against each other by deciding upon the quantities to be produced according to the Cournot oligopoly model. We use the Cournot model to capture period-to-period firm-level competitive interactions because it is commonly used for this purpose, both in the literature on industry organization and in models of industry evolution (Postrel, 1991; Knudsen, Levinthal & Winter, 2014). The agents make their decisions or strategies based on their common knowledge of the market demand, their own realized cost of production, and their belief of opponent's cost.

In each interaction in each period, each firm not only makes decisions about its own quantities, but also estimates how much its competitor should produce based on the information

available to it at the time. In order to do that, it needs to take into account its belief of its competitor's belief about its cost – in other words, its competitor's belief of its cost from its perspective. At the end of the period, each of the firms will observe a noisy variation of the quantity produced by its competitor, and updates its belief depending on the level of trust about its competitor. The update can happen to its belief of its competitor's cost (1st order belief) or to its belief of the belief of the competitor about its cost (2nd order belief). The revised beliefs are used to compute new quantities (strategies) in the next period. In this way, the two firms learn from each other and adjust their beliefs about their opponents' apparent costs. These cost estimates are then used to compute their respective output quantities and profits.

A particular feature of this scenario is that, if the estimated competitor's quantity differs from the observed one, a firm can't differentiate whether its competitor has misrepresented its cost signal, or did not believe in the focal firm's signal – we refer to this situation as **unverifiable misrepresentation**.

THE MODEL

We model and analyze the scenario described above with a 2-stage repeated game. As mentioned, the two firms in the industry produce non-differentiated products, i.e. products that are homogenous and perfectly substitutable. The i^{th} firm, $i \in \{1,2\}$, has constant *true* marginal production cost c_i, which is known only to the firm, i.e. it is private information to the firm.

The inverse market demand is defined as

$$p = a - bQ, \tag{1}$$

where p is the market clearing price, $a>0$ and $b>0$ are the intercept and slope, respectively, of the linear demand equation, and Q is the total quantity produced. Note that a and b is known to both firms.

To start with, the firms announce their costs via signals to their opponents, given by s_i and s_j for firm i & j respectively. Unlike some studies in the literature, the signals we deal with are well defined, noiseless, costless, and non-binding. Since the firms tend to act strategically, this can result in the possibility of misrepresenting these signals. They then undertake repetitive competitive interactions, each interaction in two stages.

In the first stage, in each period, the firms make decisions (strategies) independently and simultaneously about the quantities of the product to be produced. The firms compute these quantities according to the Cournot-Nash equilibrium. The decisions are strategic in the sense that they maximize each firm's profit given its opponent's production quantity. Thus the quantity is a function of both a firm's own cost of production as well as its belief of its opponent's (in addition to the market demand parameters). Let the belief of firm i about firm j's cost in period t be $\bar{c}_{jt}^{i}$. Then its quantity decision q_{it} in that period is given by

$$q_{it} = \left(a - 2c_i + \bar{c}_{jt}^{i}\right)/3b, \tag{2}$$

where c_i is the true marginal cost.

In addition to computing its own quantities, firm *i* also estimates that its competitor (firm *j*) should produce a quantity given by

$$\bar{q}_{jt} = \left(a - 2\bar{c}_{jt}^{i} + \bar{c}_{it}^{ij}\right)/3b, \tag{3}$$

where $\bar{c}_{it}^{ij}$ is the firm *j*'s belief of firm *i*'s cost from the perspective of firm *i*.

For brevity, we refer to $\bar{c}_{jt}^{i}$ as firm *i*'s ***1st order belief***, and $\bar{c}_{it}^{ij}$ as its ***2nd order belief***.

In the second stage, in each period, the firms, after trading in the market, learn from each other and update their beliefs, 1st order or 2nd order (since the market demand is common knowledge), again independently and simultaneously. We define a firm's *trust* as its unwillingness or reluctance to learn or update its belief from its opponent's signal. Assume that the firms cannot observe their opponents' quantities accurately, but with a probabilistic deviation given by $e_t \sim N(0, \sigma)$, where σ is the variance of the deviation. Then firm *i* observes its opponent's (firm *j*'s) quantity q_{jt} at the end of period *t* and updates its belief of opponent's cost for the period *t+1* as

$$\bar{c}_{j(t+1)}^{i} = \left[\left(1 + \gamma_j^i \alpha_i\right)\mathbf{1}_{\{(q_{jt}+e_t)<\bar{q}_{jt}\}} + \left(1 - \gamma_j^i \alpha_i\right)\mathbf{1}_{\{(q_{jt}+e_t)>\bar{q}_{jt}\}} + \mathbf{1}_{\{(q_{jt}+e_t)=\bar{q}_{jt}\}}\right]\bar{c}_{jt}^{i}, \tag{4}$$

where $0 < \alpha_i < 1$ is the rate of learning or updating of firm *i*, and γ_j^i is the trust parameter for $\bar{c}_{jt}^i$. γ_j^i indicates whether or not firm *i* blindly trusts firm *j*'s cost signals, i.e. γ_j^i=0 when there is trust (i.e. when beliefs are not updated); else γ_j^i =1 when there is no trust [1]. That is, trust is the situation where a firm believes the cost signal that the opponent provides. In that situation, the belief of the opponent's cost level is held constant, i.e. $\bar{c}_{j(t+1)}^i = \bar{c}_{jt}^i$.

Similarly, firm *i* updates its belief of opponent's (firm *j*'s) belief of its cost for the period *t+1* as

$$\bar{c}_{i(t+1)}^{ij} = \left[\left(1 + \gamma_i^{ij}\alpha_i\right)\mathbf{1}_{\{(q_{jt}+e_t)<\bar{q}_{jt}\}} + \left(1 - \gamma_i^{ij}\alpha_i\right)\mathbf{1}_{\{(q_{jt}+e_t)>\bar{q}_{jt}\}} + \mathbf{1}_{\{(q_{jt}+e_t)=\bar{q}_{jt}\}}\right]\bar{c}_{it}^{ij}, \quad (5)$$

where γ_i^{ij} is the trust parameter for $\bar{c}_{it}^{ij}$. γ_i^{ij} indicates whether or not firm *i* trusts that firm *j* believes its (firm *i*'s) cost signals, i.e. γ_i^{ij}=0 when there is trust (i.e. when beliefs are not updated); else γ_i^{ij}=1 when there is no trust.

Again, for brevity, we refer to γ_j^i as firm *i*'s ***1st order trust***, and γ_i^{ij} as its ***2nd order trust***.

Each of the firms' beliefs are initialized with the respective signals, opponent's as well as its own, in the first period taking into account the existing level of trust. That is, the beliefs of firm *i* in the first period are initialized as

[1] It is unlikely that firm *i* finds out the true cost c_j of firm *j* since it does not know whether or not firm *j* trusts its signal s_i.

$$\bar{c}_{j1}^{i} = \left(1 + \gamma_j^i \alpha_i\right) s_j \text{ and } \bar{c}_{i1}^{ij} = \left(1 + \gamma_i^{ij} \alpha_i\right) s_i. \tag{6}$$

This is based on the premise that firms tend to understate their cost when they misrepresent (Ziv, 1993). We also assume that the 1st and 2nd order beliefs get updated by the same amount, i.e. α_i for firm i.

Since it is a Cournot competition, the quantities jointly produced by the firms determine the market clearing price. This price along with the actual (private) production cost and the quantity produced will determine the profit to a firm in each period. The period t profit π_{it} for firm i is given by

$$\pi_{it} = (p_t - c_i) q_{it}, \tag{7}$$

where p_t is the market clearing price in period t given by the demand equation, and c_i is its true production cost. Note that the profit depends on the values of true costs, (misrepresented) signals, and beliefs.

SIMULATION

A simulation is carried out to analyze the marginal effect of misrepresentation of cost signals issued by firms under different trust settings on their asymptotic profits in repeated competitive environments. We run the simulation with N=500 pairs of firms for T=200 periods. The true marginal production cost of the firms are set at c_1=1.0 (low cost firm) and c_2=2.0 (high

cost firm) respectively. The market demand parameters are fixed at a=10 and b=1. The learning rates of the firms are set at $\alpha_1 = \alpha_2 = 0.2$. The cost signals issued by the firms are varied to analyze their marginal effect, and the outputs measured are the firms' average profits over time.

A *misrepresentation*, denoted by Δ_i for firm i, is considered as the difference between the true cost and the advertised cost. Different combinations of misrepresentations of cost signals for the pair of firms are considered in the simulation. If both firms have the same amount and direction of misrepresentation, then it is considered a *symmetric misrepresentation* case; otherwise it is an *asymmetric misrepresentation* case. A firm is said to *trust*, indicated by the binary variable γ, its opponent if it blindly believes and does not update the respective cost signal. *Mutual trust* on a cost signal is said to prevail if the two firms trust each other with respect to that signal; if one of the firms does not, then *asymmetric trust* is said to prevail.

RESULTS

We present the main findings, in our opinion, in the form of propositions and describe the possible main mechanisms that underlie or lead to those statements. In order to effectively compare and analyze the performance of different combinations of misrepresentations and trust settings, we compare each output to a *base case*, in which the two firms do not misrepresent their cost signals and trust each other.

A feature of the model to be noted is that, *if there is 1st order mutual trust, then 2nd order beliefs don't influence profits*. This follows from eqs. (2) & (3), in which the firms compute their quantities based only on their own costs and on their 1st order beliefs of competitors' costs. Since

it is assumed that the signals firms issue remain constant throughout the simulation, and that the 2nd order beliefs do not influence the signals anytime in the model, these (2nd order) beliefs do not affect the quantity decisions, either directly or indirectly, as long as there is 1st order mutual trust.

Proposition 1. With asymmetric misrepresentation and with 1st and 2nd order mutual trust, the firm which misrepresents more gains more. For the same amount of relative misrepresentation, the gain to the high capable (low cost) firm is more than that of the less capable (high cost) firm.

Insert figure 1 about here

Insert figure 2 about here

In Cournot competition, when a firm sends a cost signal that is lower than its true cost, it tries to persuade its opponent to produce less quantity to gain more market share and make more profit. Therefore, if firms trust each others' signals and also expect the same from their opponents, then the firm which misrepresents more by signaling a much lower cost induces its opponent to produce much less and gains more profit. This is evident in fig. 1 in which firm 1 misrepresents more (Δ_1=0.8) and gains more, and in fig. 2 in which firm 2 misrepresents more (Δ_2=0.8) and gains more, both relative to the base case.

Also, if the high capable (low cost) firm misrepresents its cost signal more, by claiming to be more cost effective than it actually is, then its opponent will trust this signal and, according to eq. 2, will produce even less quantity, which benefits the focal high capable firm more, as depicted in fig. 1 in which the low cost firm, firm 1, misrepresents more. On the other hand, if the low capable (high cost) firm misrepresents more, it will also successfully induce its opponent to produce less, as depicted in fig. 2 in which the low cost firm, firm 2, misrepresents more, but the impact in terms of profit differential (wrt. the opponent) won't be as much as in the case of the high capable firm misrepresenting more. The lower cost signal of the former case is much more effective for generating profit differential than the cost signal of the latter case. Thus for the same asymmetric misrepresentation, the high capable firm gains more by misrepresenting than that of the low capable firm.

Proposition 2. With asymmetric misrepresentation and with no 1st order trust but only with 2nd order mutual trust, the firm which misrepresents less gains and the firm which misrepresents more looses.

Insert figure 3 about here

Insert figure 4 about here

When firms' don't trust each others' cost signals, they form beliefs and modify them based on the difference between the estimated and observed production quantities. So, when

firms don't trust each other but expect their opponents to trust them, then the firm which misrepresents more causes its opponent to modify its (1st order) belief of the focal firm's cost more, i.e. increase its cost estimate more, in the subsequent period. This pattern gets repeated in later periods and results in the opponent producing more and more quantities, and hence more profits, relative to the base case. The focal firm also modifies its belief of opponent's cost initially, but because the opponent's misrepresentation is less, and combined with the fact that the opponent produces more quantities in later periods due to the focal firm's greater misrepresentation, the focal firm ends up producing less quantities subsequently, and hence less profits, until stability is reached. This is evident in fig. 3 in which greater misrepresentation of firm 1 decreases its profits while improving profits for firm 2, and in fig. 4 in which greater misrepresentation of firm 2 decreases its profits while improving profits for firm 1, both relative to the base case.

Proposition 3. With symmetric misrepresentation and with 1st order asymmetric trust and 2nd order mutual trust, the firm which does not trust its opponent gains more by misrepresenting than the firm which does.

Insert figure 5 about here

Insert figure 6 about here

In cases where there is 1st order asymmetric trust and 2nd order mutual trust, the firm which trusts its opponent will not modify its beliefs, both 1st and 2nd order, and will keep its quantity decision constant throughout. Whereas the firm which does not trust its opponent modifies (increases) its 1st order belief based on the feedback, and increases its quantity decision in subsequent periods, thereby reducing the market price. If competing firms misrepresent to each other by the same amount, then for the trusting firm the price reduction combined with constant quantity will reduce its profits, whereas for the non-trusting firm, the price reduction is more than compensated by the increase in its quantities, and hence its profit will increase and remain more or less constant. This is depicted in fig. 5 in which firm 1 trusts its opponent and reduces its profit over time whereas firm 2 does not trust and improves its profits over the base case, and in fig. 6 in which firm 2 trusts its opponent and has its profit level close to the base case whereas firm 1 does not trust and improves its profits over the base case.

Inline with proposition 1, the gain to the high capable firm which does not trust its opponent, firm 2 in fig. 6, is more than that of a less capable firm which does not trust, firm 1 in fig. 5.

Proposition 4. With symmetric misrepresentation and with 1st order asymmetric trust, not having 2nd order mutual trust is better for the firm which trusts its opponent than having 2nd order mutual trust.

Insert figure 7 about here

Insert figure 8 about here

A firm does not change its quantity decision if it has 1st order trust, whether or not it has 2nd order trust. However, its opponent who does not have 1st and 2nd order trust will modify both beliefs, revising them downward. This results in the opponent producing less and less quantities subsequently, thereby decreasing the total market output and increasing the market price. Hence, a firm that trusts gains more in profit due to this price increase by not having 2nd order mutual trust. Whereas for the firm which does not trust, the net effect of price increase and less quantity is a slight decrease in its profit. This is evident in fig. 7 in which firm 1 has trust and gains more in profit, and in fig. 8 in which firm 2 has trust and gains more in profit, both relative to the base case.

DISCUSSION & CONCLUSIONS

We developed a duopoly model to study the effect of misrepresentation and trust in a competitive setting. We found that differential levels of misrepresentation and trust have notable and non-trivial effects on performance. When one firm misrepresents its true cost value more than another firm, we say that firms have asymmetric levels of misrepresentation. With asymmetric levels of misrepresentation, trust is a fundamental determinant of profitability. Here it is important to make a distinction between first and second order trust. 1st order trust is the condition that I believe the cost value you report is true. 2nd order trust is the condition that I believe, that you believe, the cost value that I report is true. When two firms have asymmetric levels of misrepresentation and both have 1st and 2nd order trust, we find that the firm that

misrepresents *more* gains more. This is because the firm that (untruthfully) claims that its cost value is lower captures a larger share of the profits. In contrast, when the firms have 2nd order trust but no 1st order trust, the firm that misrepresents *less* gains more. This is because the firm that misrepresents less causes its *opponent* to decrease its estimate of the focal firm's cost. The opponent will consequently capture a smaller share of the profits. To complete the analysis, we then looked at the corresponding cases where misrepresentation is symmetric and trust is asymmetric. Here we found that when there is 1st order asymmetric trust and 2nd order mutual trust, the firm that does not trust its opponent gains more. The explanation is that the firm that trusts its opponent will not modify its beliefs (about its opponents costs), and therefore will keep its output constant throughout, whereas the firm that does not trust will adjust its opponent's cost upward and captures a larger share of the profits. Finally, when there is 1st order asymmetric trust, the firm that trusts the other gains when there is no 2nd order mutual trust. With 2nd order mutual trust, the firm that has 1st order trust will never adjust its estimate, whereas the opponent gains by adjusting its cost estimate downwards. However, with no 2nd order mutual trust, the opponent's adjustment will be more aggressive, i.e. revise both its 1st and 2nd order beliefs, and results in a price increase if it does not have 2nd order trust. This in turn benefits the trusting firm.

We have sketched four cases that provide a fairly complete picture of possible scenarios. Our theory is new and the predictions that follow from it may be tested in empirical research. The caveat here is that it is difficult to obtain direct measures of trust and misrepresentation. Perhaps a more immediate benefit of our analysis is that it provides useful heuristics to think of the value of trust and misrepresentation in a competitive setting. In this regard, our contribution

adds to the fairly scant work in strategy and management on signaling (notable exceptions include Srinivasan, 1991, and Balachander and Srinivasan, 1994). Our approach also admits some limitations. The most important is the simplification that we analyze a duopoly setting. The extension to an oligopoly setting with more than two firms is straightforward as regards to the extraction of results, but the configuration space obviously increases in the number of firms. Even so, our results will hold if considered as statements regarding the firm that has the highest levels of misrepresentation or trust relative to the other firms in the industry. Another limitation is behavioral plausibility. As Knudsen et al. (2014), we believe that the Cournot setting provides a fairly realistic picture of short-term equilibration, with the long run being a sequence of such short run states. That is, we find our model to be a fair compromise between tractability and behavioral plausibility.

To conclude, we find that misrepresentation and trust in a competitive setting is an exciting and important topic in the study of firm strategies. We have taken a first step towards a deeper understanding of how trust and misrepresentation influences profitability. We hope others will follow and provide many more.

REFERENCES

Amir, R., Jin, J., & Troege, M. 2010. Robust Results on the Sharing of Firm-Specific Information: Incentives and Welfare Effects. ***Journal of Mathematical Economics,*** 46: 855-566.

Balachander, S., & Srinivasan, K. 1994. Selection of Product Line Qualities and Prices to Signal Competitive Advantage. ***Management Science,*** 40(7): 824–41.

Camerer, C., & Teck-Hua, H. 1999. Experience-weighted attraction learning in normal form games. ***Econometrica,*** 67(4): 827.

Costa-Gomes, M. 2002. A Suggested Interpretation of Some Experimental Results on Pre-play Communication. ***Journal of Economic Theory,*** 104(1): 104-136.

Crawford, V., & Sobel, J. 1982. Strategic Information Transmission. ***Econometrica,*** 50: 1431-1451.

Crawford, P. 1998. A Survey of Experiments on Communication via Cheap Talk. ***Journal of Economic Theory,*** 78(2): 286-298.

Crawford, P. 2003. Lying for Strategic Advantage: Rational and Boundedly Rational Misrepresentation of Intensions. ***The American Economic Review,*** 93(1): 133-149.

Erev, I., & Roth, A. 1998. Predicting how people play: Reinforcement learning in experimental games with unique mixed strategy equilibria. ***American Economic Review,*** 88(4): 848-881.

Farrell, J. 1988. Communication, Coordination and Nash Equilibrium. ***Economics Letters,*** 27(3): 209-214. Erratum. 1990. 33(3): 299.

Farrell, J. 1993. Meaning and Credibility in Cheap-Talk Games. ***Games and Economic Behavior,*** 5(4): 1214-1223.

Farrell, J., & Matthew, R. 1996. Cheap Talk, ***Journal of Economic Perspectives,*** 10(3): 103-118.

Fudenberg, D., & Tirole, J. 1984. The Fat-Cat Effect, they Puppy-Dog Ploy, and the Lean and Hungry Look. ***The American Economic Review,*** 74(2): 361-366.

Heil, O., & Robertson, T. S. 1991. Toward a Theory of Competitive Market Signaling: A Research Agenda. ***Strategic Management Journal,*** 12: 403-318.

Gal-Or, E. 1985. Information Sharing in Oligopoly. ***Econometrica,*** 53: 329-343.

Gal-Or, E. 1986. Information Transmission – Cournot and Bertrand Equilibria. ***Review of Economic Studies,*** 53: 138-146.

Kirby, A. 1988. Trade Associations as Information Exchange Mechanisms. ***The RAND Journal of Economics,*** 19: 138-146.

Knudsen, T., Levinthal, D. A., & Winter, S. G. 2014. Hidden but in Plain Sight: The Role of Scale Adjustment in Industry Dynamics. ***Strategic Management Journal***, Forthcoming.

Kreps, D. M., & Wilson, R. 1982. Reputation and Imperfect Information. ***Journal of Economic Theory,*** 27: 253-279.

Lenox, M., Rockart, S., & Lewin, A. 2006. Interdependency, competition and the distribution of firm and industry profits. ***Management Science,*** 52: 757-772.

Lenox, M., Rockart, S., & Lewin, A. 2007. Interdependency, competition, and industry dynamics. ***Management Science,*** 53(4): 599-615.

Levinthal, D. A. 1997. Adaptation on rugged landscapes. ***Management Science,*** 43: 934-950.

Li, L. 1985. Cournot Oligopoly with Information Sharing. ***The RAND Journal of Economics,*** 16: 521-536.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. 1995. An Integrative Model of Organizational Trust, ***Academy of Management Review,*** 20(3): 709-734.

Milgrom, P., & Roberts, J. 1982a. Limit Pricing and Entry under Incomplete Information: An Equilibrium Analysis. ***Econometrica,*** 50(2): 443-459.

Milgrom, P., & Roberts, J. 1982b. Predation, Reputation, and Entry Deterrence. ***Journal of Economic Theory,*** 27: 280-312.

Novshek, W., & Sonnenschein, H. 1982. Fulfilled Expectations Cournot Duopoly with Information Acquisition and Release. ***Bell Journal of Economics,*** 13: 214-218.

Postrel, S. 1991. Burning Your Britches Behind You: Can Policy Scholars Bank on Game Theory? ***Strategic Management Journal,*** 12: 153–55.

Rabin, M. 1994. A Model of Pre-game Communication. ***Journal of Economic Theory,*** 63(2): 370-391.

Raith, M. 1996. A General Model of Information Sharing in Oligopoly. ***Journal of Economic Theory,*** 71: 260-288.

Rousseau. D. M., Sitkin, S. B., Burt, R. S., & Camerer, C. 1998. Not so different after all: A cross-discipline view of trust. ***Academy of Management Review*****,** 23(3): 393-404.

Shapiro, C. 1986. Exchange of Cost Information in Oligopoly. ***Review of Economic Studies,*** 53: 433-336.

Srinivasan, K. 1991. Multiple Market Entry, Cost Signalling and Entry Deterrence. ***Management Science,*** 37(12): 1539–55.

Sutton, R. S., & Barto, A. G. 1998. ***Reinforcement Learning.*** Cambridge, Massachusetts: The MIT Press.

Sztompka, P. 1999. ***Trust: A Sociological Theory.*** Cambridge: Cambridge University Press.

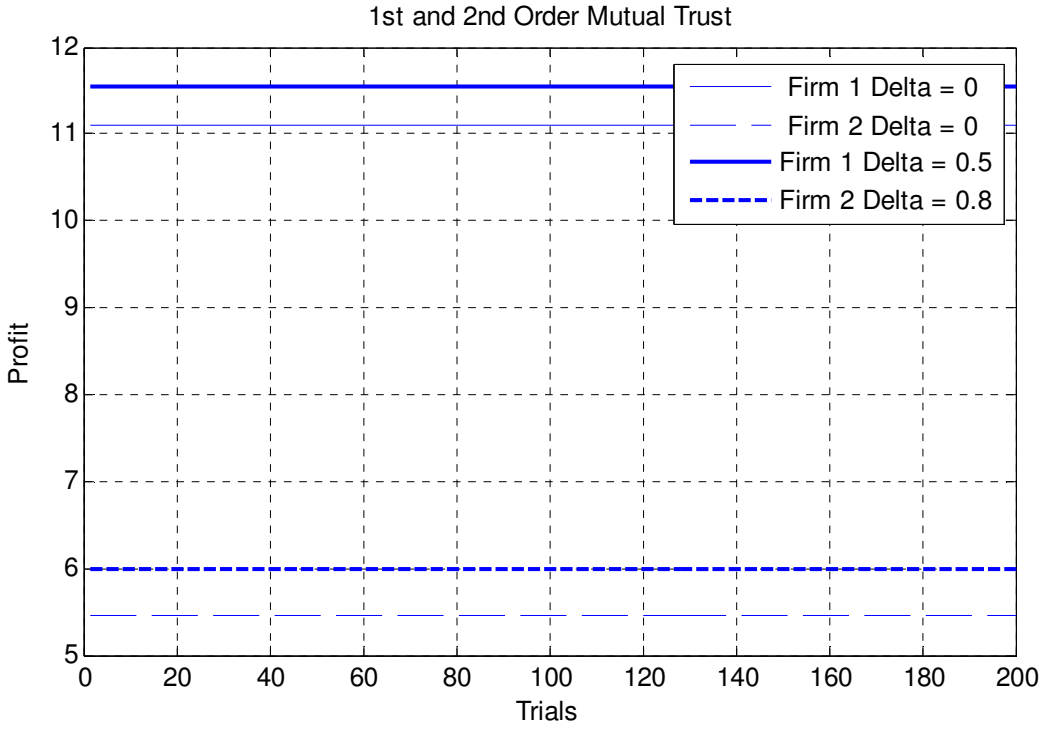
Vives, X. 1984. Duopoly Information Equilibrium: Cournot and Bertrand. ***Journal of Economic Theory,*** 34: 71-94.

Zand, D. E. 1972. Trust and Managerial Problem Solving. ***Administrative Science Quarterly,*** 17(2): 229-239.

Ziv, A. 1993. Information Sharing in Oligopoly: The Truth-Telling Problem. ***The RAND Journal of Economics,*** 24(3): 455-465.


1st and 2nd Order Mutual Trust
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.8
Firm 2 Delta = 0.5
Profit
Trials
12
11
10
9
8
7
6
5
0
20
40
60
80
100
120
140
160
180
200

Fig. 1


1st and 2nd Order Mutual Trust
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.5
Firm 2 Delta = 0.8
Profit
Trials
12
11
10
9
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6
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0
20
40
60
80
100
120
140
160
180
200

Fig. 2

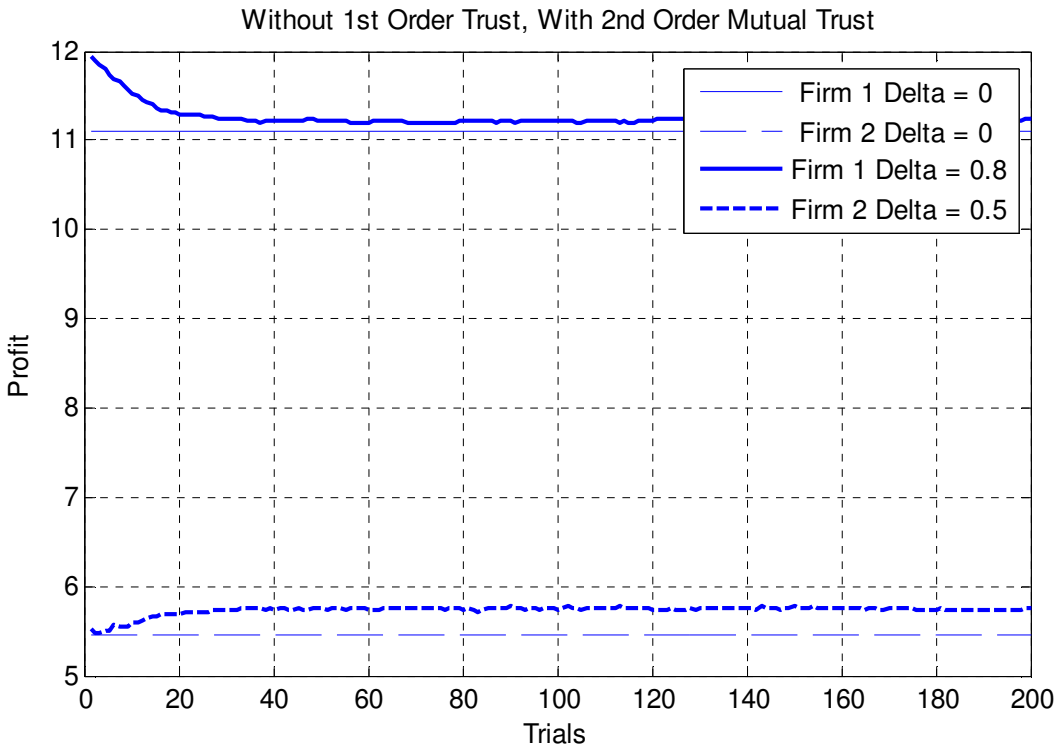

Without 1st Order Trust, With 2nd Order Mutual Trust
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.8
Firm 2 Delta = 0.5
Profit
Trials
12
11
10
9
8
7
6
5
0
20
40
60
80
100
120
140
160
180
200

Fig. 3

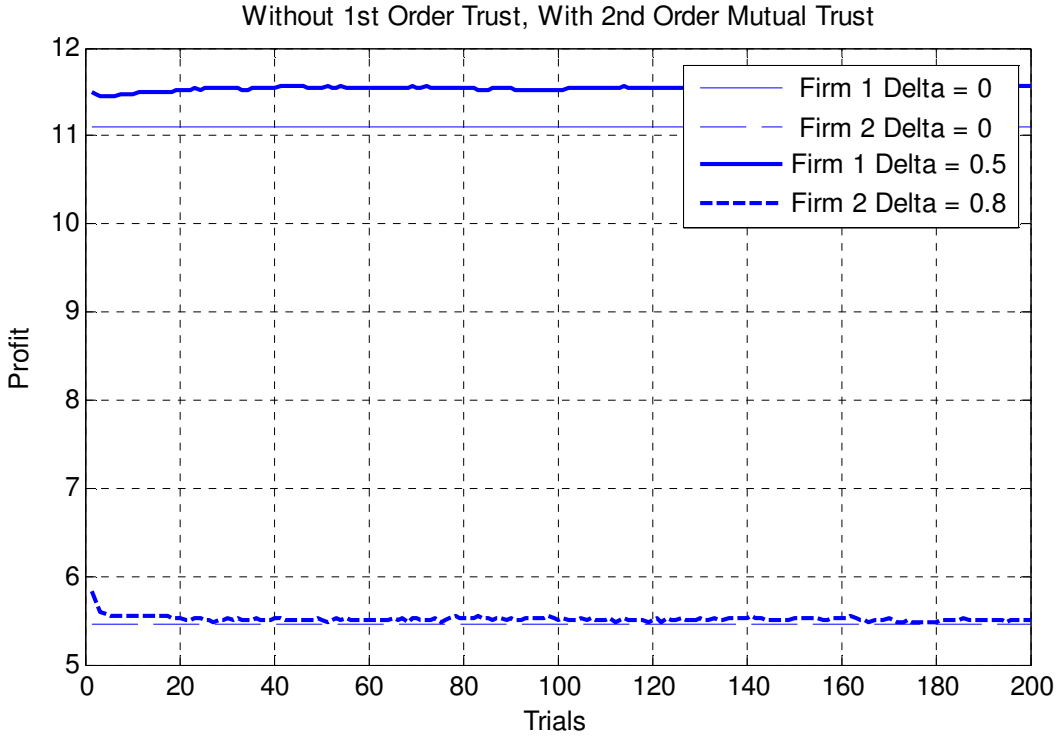

Without 1st Order Trust, With 2nd Order Mutual Trust
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.5
Firm 2 Delta = 0.8
Profit
Trials
12
11
10
9
8
7
6
5
0
20
40
60
80
100
120
140
160
180
200

Fig. 4

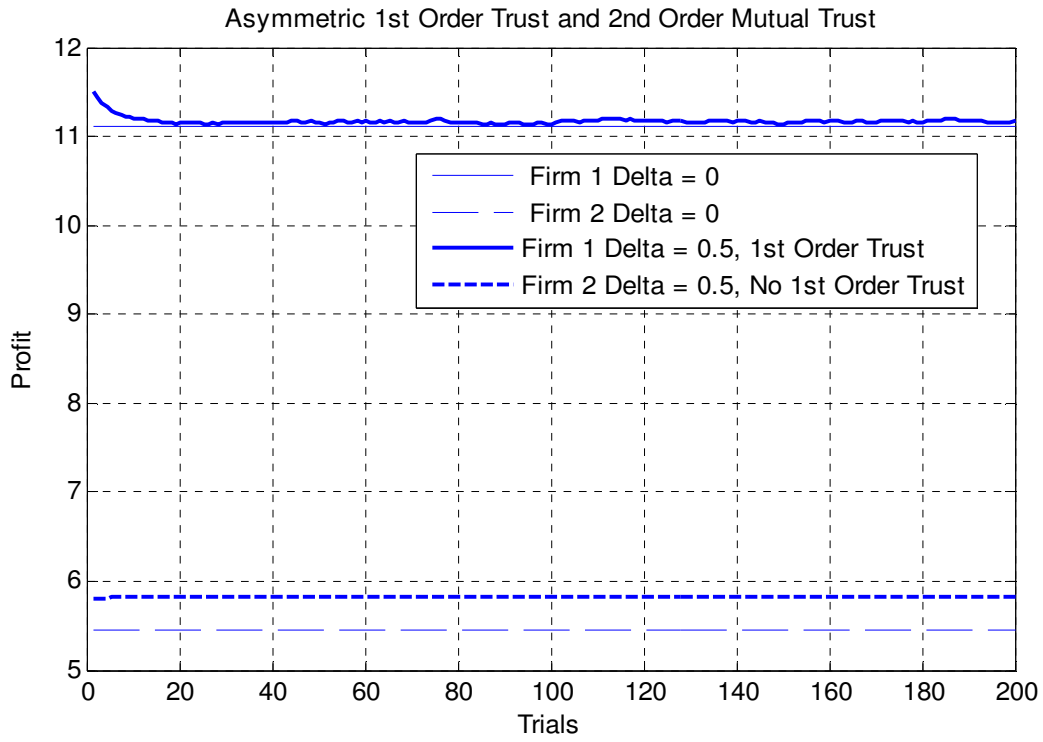
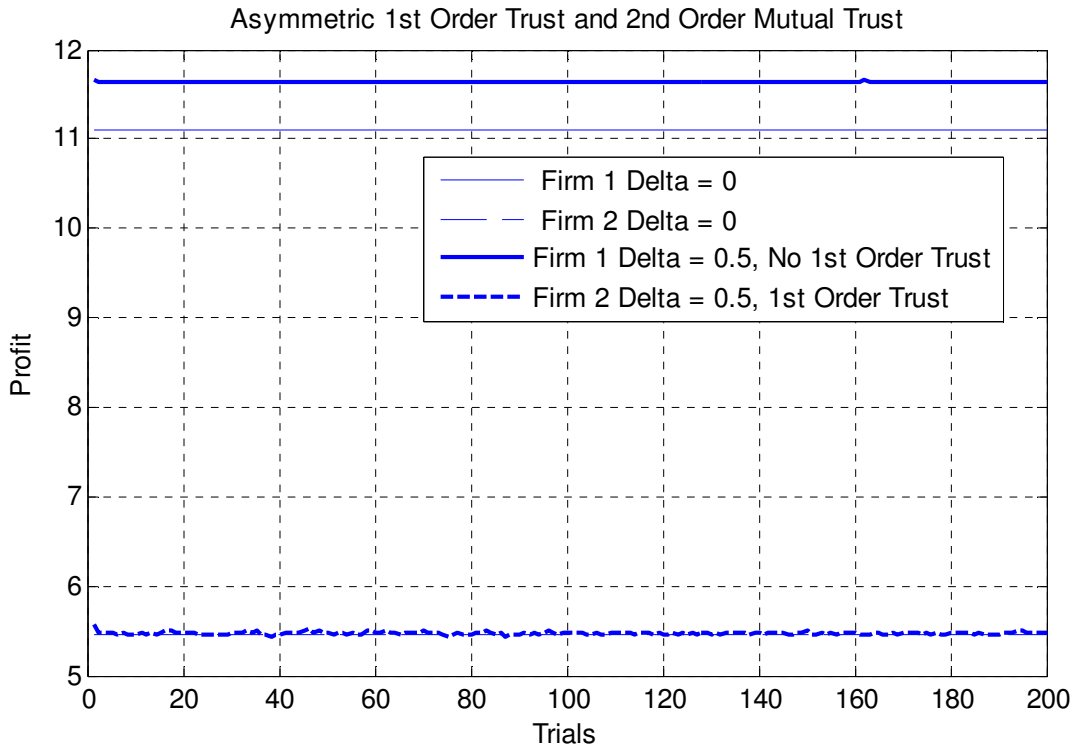

Asymmetric 1st Order Trust and 2nd Order Mutual Trust
Profit
Trials
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.5, 1st Order Trust
Firm 2 Delta = 0.5, No 1st Order Trust
12
11
10
9
8
7
6
5
0
20
40
60
80
100
120
140
160
180
200

Fig. 5


Asymmetric 1st Order Trust and 2nd Order Mutual Trust
Profit
Trials
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.5, No 1st Order Trust
Firm 2 Delta = 0.5, 1st Order Trust
12
11
10
9
8
7
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0
20
40
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80
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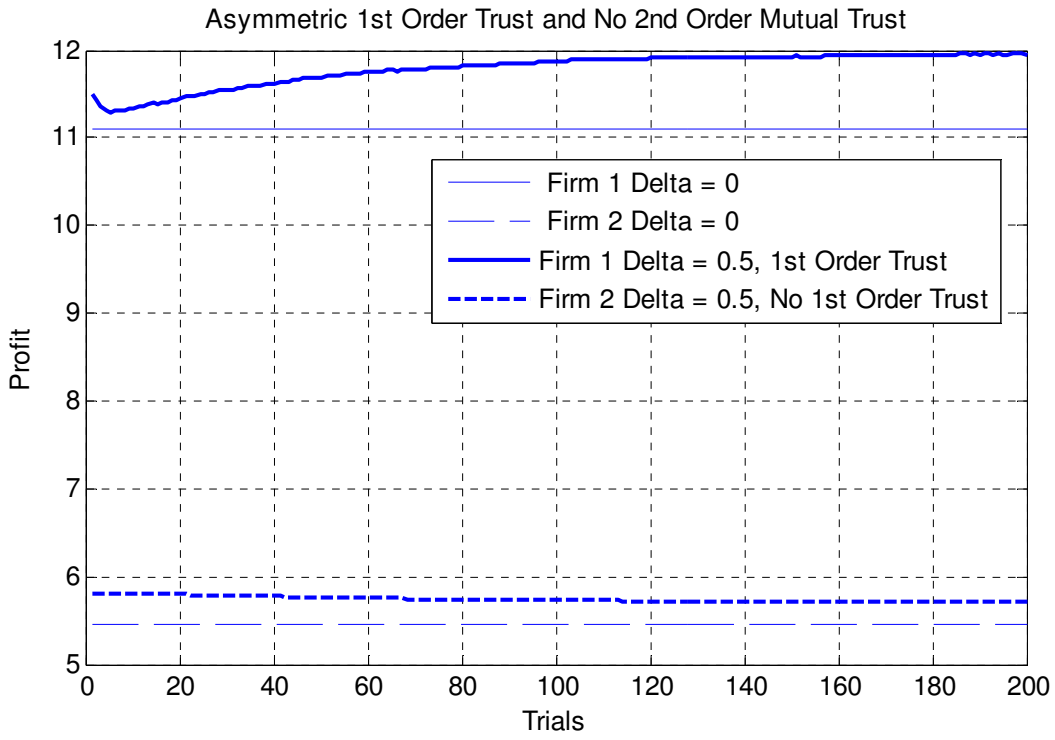
120
140
160
180
200

Fig. 6


Asymmetric 1st Order Trust and No 2nd Order Mutual Trust
Profit
Trials
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.5, 1st Order Trust
Firm 2 Delta = 0.5, No 1st Order Trust
12
11
10
9
8
7
6
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0
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80
100
120
140
160
180
200

Fig. 7

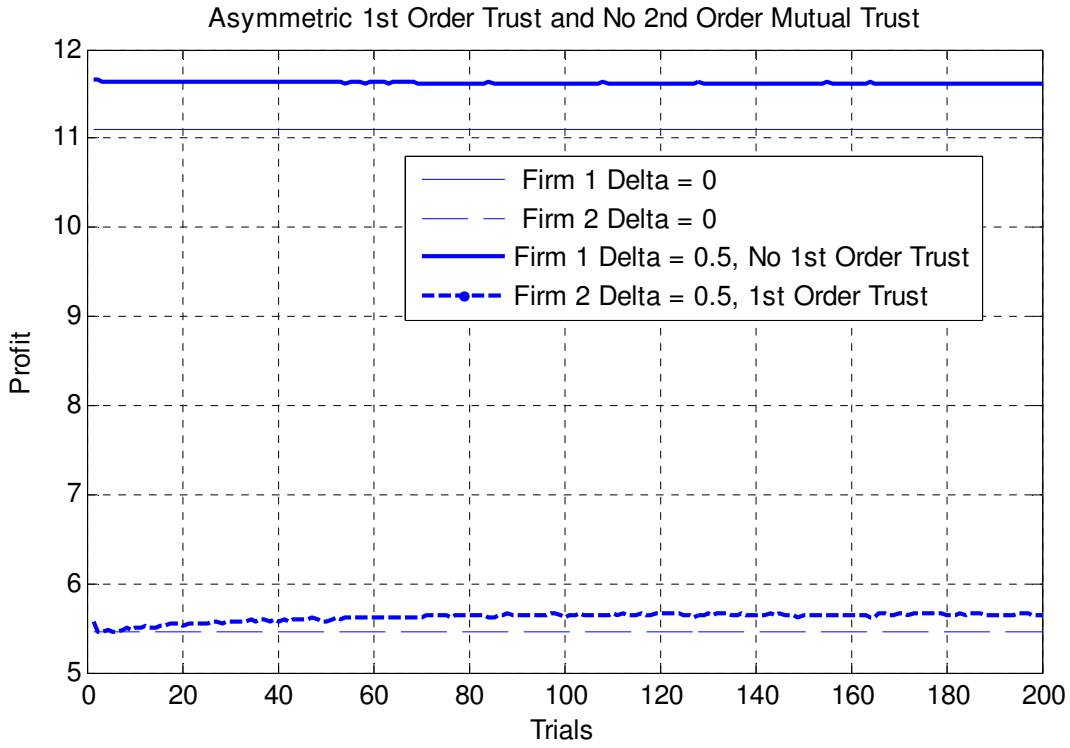
Asymmetric 1st Order Trust and No 2nd Order Mutual Trust
Profit
Trials
Firm 1 Delta = 0
Firm 2 Delta = 0
Firm 1 Delta = 0.5, No 1st Order Trust
Firm 2 Delta = 0.5, 1st Order Trust
12
11
10
9
8
7
6
5
0
20
40
60
80
100
120
140
160
180
200

Fig. 8