Research Statement

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My fields of research include contract theory, industrial organization, and the theory of dynamic games. Two common themes underlie and unify all of my work: players' incentives in dynamic games (interactions) and the presence of asymmetric information. In particular, my research focuses on the following three issues. 1) How repeated interactions between agents help to achieve cooperative behavior. 2) When there is asymmetric information between principals and agents, what can principals do to induce information revelation from agents. 3) When there is asymmetric information among agents, how learning occurs in dynamic settings and how players' strategies are affected by the possibility of learning. I study these issues theoretically by using game theory, and explore the empirical implications for contractual arrangements in markets and industry organization in the real world.

1 Repeated Interactions

A central issue in economics is how to solve the tension between individuals' opportunistic behavior and the common good that arises from cooperation. The theory of repeated games proves that repeated interactions can lead to cooperation by enabling punishment and reward schemes. However, if players have private information regarding some payoff-relevant variables, then designing effective punishment schemes becomes difficult as players cannot tell for sure whether other players have cooperated or defected in previous periods. In "**Collusion, Fluctuating Demand, and Price Rigidity**," with Makoto Hanazono, we study how information asymmetry among firms regarding the demand state, which is fluctuating over time, limits them to achieve the best collusive outcome. We found that when firms' private signals are not accurate (the degree of information asymmetry is high), in the best collusive outcome firms' pricing behavior exhibits price rigidity. That is, firms always charge the same price regardless of the signals they receive about the demand state. On the other hand, when firms' private signals are accurate (the degree of information asymmetry is low), in the best collusive outcome firms' pricing behavior exhibits sorting (prices vary with firms' private signals). These results contribute to the understanding of which industries, and under what conditions, should exhibit rigid prices. We also characterize the optimal punishment scheme to achieve the best collusive outcome under sorting pricing. This contributes to the understanding of "price war" behavior in some collusive industries.

Typically, a repeated interaction or a long-term relationship is not fixed exogenously. Given that there are many potential partners available, players can choose whom to interact with. In this community setting, cooperation becomes difficult to achieve. The main reason is that punishing noncooperative behavior becomes harder, as players can always opt out of their current relationships and seek new partners. In "**Long-Term Relationships as Safeguards**," with Rafael Rob, we introduce heterogeneity of players: "bad" type players always defect, "good" types always cooperate, and "opportunistic" types choose actions based on their incentives. All players choose strategically whether to form long-term relationships: a relationship is continued if and only if both players cooperate. We show that with endogenous formation of long-term relationships, a good equilibrium, with opportunistic types always cooperating exists, if and only if the fraction of the bad type is neither too small nor too large. The logic is that the existence of bad types makes long-term relationships (interacting with non-bad types) valuable. On the other hand, if the fraction of the good type is neither too small nor too large, then the bad equilibrium, in which the opportunistic types always defect, does not exist. This is in contrast to the typical result in repeated games that the equilibrium in which players always defect always exists.

In principal-agent relationships, repeated interactions can make some contractual terms that are not legally enforceable self-enforcing. This is because deviating from agreed upon contractual terms can be punished in repeated relationships. These kind of self-enforcing contracts are called relational contracts. In many situations, contractual terms change as relationships continue. For example, wages usually are increasing with tenure. In "**Nonstationary Relational Contracts**," I try to account for contract dynamics by using a relational contract approach. In particular, workers are of two types: the low type is of low productivity, and the high type is of high productivity but has a moral hazard problem. Learning occurs within each employment relationship as a firm gradually learns the type of its worker. Firms are not able to commit to long-term contracts. To motivate high type workers, wages need to increase with tenure. To reduce the informational rent paid to low type workers, firms try to backload wages. However, firms cannot backload wages too much, since otherwise senior workers are less profitable than new workers and firms have an incentive to renege by firing senior workers and hiring new ones. This tension between incentive provisions and the self-enforcing requirements of contract enforcement pins down the wage dynamics, which is intimately related to the learning effect. One interesting feature in my model is that learning is confined to the current relationship, yet the wage dynamics are tied to the learning effect. This shows that wages being tied to the leaning effect can be generated by internal wage dynamics, while in previous literature this feature is due to competition among firms for workers as workers' performance is publicly observable.

In "**Efficiency Wages and Subjective Performance Pay**," I study two kinds of relational contracts to motivate workers in a market setting. With efficiency wages, employed workers are paid a wage premium, and firing serves as a punishment device. With subjective performance pay, workers are paid an implicit bonus if their performance is good. From the firms' perspective, subjective performance pay is cheaper to motivate workers. However, since the implicit bonus is not legally enforceable, it has to be self-enforcing. The magnitude of the implicit bonus that firms can credibly post is positively related to the turnover costs that firms incur. This implies that labor markets with high turnover costs will use more subjective performance pay and less efficiency wages. Moreover, in those markets the total wage payment is lower and the equilibrium employment level is higher. One interesting result is that, under certain conditions, markets with higher turnover costs will have a higher social welfare.

2 Asymmetric Information

In principal-agent relationships, when the agent has private information the principal usually offers a menu of contracts and lets the agent self-select. This kind of practice is called screening or nonlinear pricing. In previous literature, the attention is restricted to the case where the principal is a monopolist. In the real world, many industries have an oligopolistic market structure. For example, in local markets usually several cell phone service providers compete with each other in attracting consumers. In "**Nonlinear Pricing, Market Coverage, and Competition**," with Lixin Ye, we study how competition among firms affects firms' nonlinear pricing strategies and the menu of contracts offered. For that purpose, we consider a setting in which consumers are both horizontally and vertically differentiated. In the horizontal dimension, consumers have different tastes about firms' products. In the vertical dimension, consumers have different preference intensities about the quality of products. A consumer's horizontal type and vertical type are her own private information. Firms offer a menu of contracts trying to screen consumers in the vertical dimension and compete with other firms for customers in the horizontal dimension. The consumers of low vertical types might be endogenously excluded. The main insight is that competition in the horizontal dimension interacts with the screening condition in the vertical dimension. We found that the effect of increased competition exhibits non-monotonic features. When the initial competition is not too weak, a further increase in competition leads to more types of consumers being covered and a reduction in quality distortions. However, when the initial competition is weak, the results are reversed.

In a follow up project, "**Competitive Nonlinear Pricing and Contract Variety**," a work in progress with Lixin Ye, we study a related setting with consumers' vertical types being discrete and finite. The question we try to address is as follows: when competition becomes more intense, will incumbent firms offer more contracts or fewer contracts? Specifically, we try to identify the conditions under which entry triggers an incumbent monopolist to stop offering an existing low quality good (product pruning), and the conditions under which entry triggers an incumbent monopolist to introduce a new product of low quality (fighting brands).

A situation closely related to nonlinear pricing is optimal income taxation. When workers have private information about their own productivities and working time is not observable, the government has to offer a nonlinear taxation schedule and let workers self-select. In "**Competitive Nonlinear Taxation and Constitutional Choice**," with Massimo Morelli and Lixin Ye, we study the effect of competition on nonlinear tax schedules. Worker-consumers differ in productivity (vertical type) and ability to move across states (horizontal types). We compare two taxation regimes. In the unified regime, one central authority designs the tax schedules for both states. In the competitive regime, two states design tax schedules independently. We found that the overall level of progressivity and redistribution is lower under competitive taxation than under unified taxation; the "rich" are always in favor of competitive authorities and local governments, whereas the "poor" are always in favor of unified taxation. We then endogenize the taxation regime by adding a stage of constitutional choice. It turns out that the constitutional choice between fiscal regimes depends on the preferences of the middle class, which in turn depend on the initial conditions in terms of the distribution of productivities (incomes), and mobility costs. In particular, as mobility increases, it becomes increasingly likely that the unified regime will receive majority support, while an increase in poverty can have the opposite effect. These results shed some light on the European Union's movement toward the unification of fiscal policies.

Related to competitive nonlinear pricing, in "**Group Purchasing, Nonlinear Tariffs, and Oligopoly**," with Howard Marvel, we compare competition under nonlinear tariffs to competition under linear tariffs (each firm charges a single price). Consumers' preferences over two firms products are horizontally differentiated. While nonlinear tariffs are an effective way for a monopolist to extract consumer surplus, when two firms compete using nonlinear tariffs, the results are far more competitive in comparison to competition with linear tariffs. This is because when firms compete with linear tariffs, competition essentially only occurs for "marginal" consumers. However, when firms compete with nonlinear tariffs, competition occurs globally, which leads to more intense competition. We view consumer buying groups, or group purchasing organizations (GPOs), as a device to enable firms to compete with nonlinear tariffs. That is, by forming GPOs, consumers force firms to compete with nonlinear tariffs, which leads to intensified competition and a lower purchasing price. This provides a rationale for the popularity of GPOs.

In many situations, a principal consults an agent or expert for advice, as the agent has more detailed knowledge (or private information) about the state of the world. Communication itself is costless. This kind of situations is studied by the literature of cheap talk. In "**Cheap Talk with Two Senders and Complementary Information**," with Andrew McGee, we study situations in which a principal consults two experts before making a decision (for instance, a CEO consults a marketing manager and a production manager regarding the size of a new plant). The two experts have different expertise and each expert only observes the realized state in the dimension of his own expertise. Moreover, the two experts' private information is complementary: the marginal impact of one expert's private information on the principal's ideal decision depends on the other expert's private information. When two experts communicate with the principal simultaneously, we found that their information transmission exhibits strategic complementarity: more information transmitted by one expert leads to more information transmitted by the other expert. Moreover, when two experts' ideal actions differ from the principal's in the same direction (like biases), compared to simultaneous communication it is better for the principal to delegate the decision rights to the expert with a smaller bias.

In recent years, the average grades in higher education have been rising substantially. This phenomenon is known as grade inflation. In "**An Economic Theory of Grade Inflation**," with Chun Seng Yip, we try to account for how grade inflation came about and its economic consequence. We argue that grade inflation is caused by the information asymmetry between universities and firms, and by each university's incentive to help its students to secure "good" jobs. Given that all the students employed at the "good" jobs are paid the same wage, each school tends to assign good grades to as many students as possible, ignoring its negative impact on efficient job assignment and wages. This leads to a free rider problem: "bad" grades drive out "good." Furthermore, schools with a better reputation will grade inflate more, and the bigger the productivity difference between "good" and "bad" jobs, the higher the grade inflation. Our welfare analysis suggests that universities, firms and students are all worse off with grade inflation.

3 Learning in Dynamic Games

In many retail markets, prices rise faster than they fall. In "**Search with Learning: Understanding Asymmetric Price Adjustments,**" with Lixin Ye, we construct a dynamic model of search with learning to explain the phenomenon of asymmetric price adjustment. The wholesale price (cost) evolves according to a Markov chain with positive persistence. Consumers do not observe the cost. Instead, they have to infer it from the prices they encountered in the last period. Based on his own belief about the cost state, a consumer decides whether to search in the current period. In general, consumers have a stronger incentive to search when the cost is low, since the price dispersion and the gains from search are higher. The key insight is that whether to search or not leads to different speeds of learning. When a consumer searches, by observing all the prices he immediately learns the cost state. On the other hand, a non-searcher learns the cost state slowly since he only observes one price. Now the interaction between search and learning naturally leads to asymmetric price adjustments. When a positive cost shock occurs, all the searchers immediately learn the true state; the search intensity, and hence the prices, fully adjust in the next period. When a negative shock occurs, it takes longer for non-searchers to learn the true state, and the search intensity increases gradually, leading to slow falling prices. We also found that when the cost shocks become more persistent, the pattern of asymmetric price adjustment becomes more prominent.

Players often learn by observing other players' actions, as other players' actions might reveal their private information. Ironically, learning from others might lead later players to ignore their own private information and take the same action as previous players', resulting in information cascades or herding. Usually, players can also choose when to act in order to learn from others. In "**Investment Cycles, Strategic Delay, and Self-reversing Cascades,**" with James Peck, we study how the possibility of delaying investment decisions affects information cascades and the pattern of investment cycles. Specifically, the common investment return evolves according to a Markov process, and players in each period observe a private signal regarding the investment return. In the No-waiting Game, after observing the history of aggregate investment, all agents in the current period make investment decisions simultaneously. In the Waiting Game, each period is divided into two rounds and players can delay their investment decisions until the second round. Comparing the two games, we show that the possibility of delay reduces the average length of boom cascades (everyone invests regardless of her own signal) and increases the average length of recession cascades (everyone does not invest), leading to shorter booms and longer recessions. The possibility of delay also leads to more underinvestment (lack of investment when the investment return is high) and less overinvestment (investment when the return is low).

In a related paper, "**Information Aggregation and Investment Cycles with Strategic Complementarity**," I study the interaction between information aggregation and firms' investment behavior, and explore its implications about investment cycles. I adopt an overlapping generations (OLG) model. Firms differ in investment costs, and investments within the same period exhibit positive externalities. The mass of each cost type is uncertain, and the existence and the cost type of each active firm is its own private information. Firms learn the distribution of the masses of the old generation by observing the history of aggregate investment. Different investment costs imply that different cost types might make different investment decisions, which means that the composition of information aggregation varies across different phases of cycles. Now the interaction between information aggregation and investment cycles naturally emerges. The information aggregated in the last period depends on the phase of cycles in that period, which in turn affects the investment behavior in the current period through the OLG structure. I found that investment cycles depend on the growth rate of aggregate investment: a slowdown in growth is interpreted as bad news and might trigger an economic downturn, while a slowdown in downturn is considered as good news and might trigger a recovery. Moreover, a small structural change in lower cost investments can have a large impact on the pattern of cycles.

In many industries, entry occurs gradually and in waves, and then a shakeout stage follows in which a big fraction of existing firms exit. In "**Dynamic Entry and Exit with Uncertain Cost Positions**," with Makoto Hanazono, we try to account for this dynamic pattern of entry and exit based on firms' learning about their relative cost positions. Each firm's marginal cost of production is its own private information; thereby a firm is facing ex ante uncertainty about its cost position. The (inelastic) market demand can accommodate only a fraction of firms to operate, and thus only firms with relatively lower costs are viable in the long run. Some firms in the market will exit if excessive entry (or overshooting) occurs. Firms face a tradeoff by entering late: they give up the profit in earlier periods in case they are among the lower cost firms, while they gain by learning other firms' costs and avoiding paying the sunk cost in case they have relatively higher costs. The equilibrium properties are consistent with empirical observations: (i) entry occurs gradually overtime with lower cost firms entering earlier than higher cost firms, (ii) exiting firms are among the ones that entered later. Moreover, the equilibrium overshooting probability is shown to be always positive and decreasing over time.