Research Statement

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I am an applied microeconomic theorist. My research applies game theory and contract theory to industrial organization, information economics, and organizational economics. My work broadly spans four areas: (1) Optimal pricing for signaling goods; (2) Optimal peer monitoring networks; (3) Monetizing connected products under network effects; (4) Relational contracts in the digital economy.

Optimal Pricing for Signaling Goods

One strand of my research contributes to signaling games. In classic signaling models such as Spence (1973), the cost structure of signaling is exogenously given, and thus, the sender's preference depends only on his intrinsic type. However, in many vertical markets where signaling prevails, the signaling cost—thus the sender's preference—also depends on the choice made by an upstream strategic player. For example, when a student obtains education to signal his ability, the university sets the tuition; when a consumer purchases a luxury good to signal his wealth, the retailer chooses the price; when a firm incurs advertising expenses to signal its product's quality, the media company determines the costs of advertising messages. My paper **"Selling Signals" (R&R at *Journal of Economic Theory*)** develops classic signaling models by allowing a strategic player to affect the signaling cost. Specifically, a seller chooses a price scheme for a good, and a buyer with a hidden type chooses how much to purchase as a signal to receivers. The equilibrium depends critically on whether receivers observe the price scheme. When receivers observe the price scheme, the seller internalizes signaling in screening, causing a downward distortion in quantity. However, such distortion is smaller than in the case where receivers also observe the buyer's type. When receivers do not observe the price scheme, the buyer is more sensitive to price changes than in the observed case. This leads to a more elastic demand for signals and provides the seller with an incentive to cut prices. To refine the set of equilibria, I propose a novel refinement, *quasi-divinity*. In equilibrium, the buyer chooses a higher quantity and obtains higher utility than in the observed case, whereas the seller gains lower profits than in the observed case. The model suggests that price transparency can be socially beneficial and social welfare can be higher in a monopoly market than in a competitive market when the buyer's signaling incentive is relatively strong. The model can be applied to schools choosing tuition, retailers selling luxury goods, media companies selling advertising messages, and to other vertical markets where signaling is prevalent.

In a follow-up paper, **"Competitive Nonlinear Pricing for Signals"**, I further examine how (horizontal) competition affects the seller's pricing strategy and the degree of signaling. In contrast to "Selling Signals", the buyer's preference is two-dimensional: the vertical preference parameter is in conformity with the aforementioned paper; the horizontal preference parameter captures the buyer's outside option; these parameters are independent and both privately known. I apply the advanced technique of optimal control theory to tackle this complicated two-dimensional mechanism design problem. I first consider the monopoly case and show that due to horizontal differentiation, the monopolist charges lower prices for signals than in the above paper. Specifically, when receivers observe the price scheme, the market is partially covered and quantity is downward distorted when there is a slight degree of horizontal differentiation. As the degree increases, market coverage expands, and the downward distortion diminishes. Notably, when horizontal differentiation is relatively high and signaling intensity is moderate, the monopolistic allocation can achieve the first best. This remarkable result emerges from the interplay of signaling, screening and market penetration. In contrast, when receivers do not observe the price scheme, the market is always partially covered and the allocation is more dispersed than in the observed case due to a signal jamming effect, with higher types purchasing more than in the observed case. Then, I turn to the oligopoly case and show that competition leads to greater market coverage and higher quantities than in the monopoly case. In particular, when all vertical types are served, each seller offers a cost-plus-fixed-fee tariff to the buyer. In contrast to the models of competitive nonlinear pricing for non-signaling goods, such as Rochet and Stole (2002), my model derives qualitatively distinct equilibrium and welfare implications.

Optimal Peer Monitoring Networks

Flexibility in task assignment is an outstanding feature of many modern organizations that involve teamwork. It has been increasingly common that the order of completing individual tasks is not predetermined; rather, a substantial part of it is at the discretion of the team designer. Incentivizing team members' efforts in such settings involves two main issues: the first is the classic problem of moral hazard in teams (Holmstrom, 1982); the second, which is more novel and less studied, is to consider peer monitoring among agents (e.g., Winter (2006, 2010)), and to leverage such internal information through designing the team's work sequence. My paper **"Incentive Design under Network-Based Peer Monitoring" (R&R at *Journal of Economic Theory*, with Yangbo Song)** studies a team incentive design problem in which a group of agents are located on a network and work jointly on a risky project. The principal seeks the least expensive mechanism to incentivize full efforts, by choosing the work sequence and the rewards to the agents upon success. Whereas the agents' actions are hidden to the principal, an agent can observe a peer's action if they are linked and the former moves after the latter. We show that under effort complementarity, the transparency of the agents' actions can reduce their incentive costs. However, the effectiveness of transparency decreases as an action becomes more transparent. In the optimal sequence, the agents work sequentially in the order of ascending individual importance to the project. The agents who move later effectively monitor their preceding peers, and have higher incentive costs even if the agents are equally important. When multiple teams collaborate, more important agents also move later in their respective teams, while larger teams are allocated toward either end of the optimal sequence to optimally leverage peer monitoring. Moreover, only a small fraction of the entire group of agents will serve as monitors, since monitors themselves are relatively costly to incentivize. For several typical classes of networks, we provide simple algorithms to explicitly characterize the optimal mechanism.

Monetizing Connected Products under Network Effects

Nowadays, an increasing number of hardware devices are equipped with connectivity features, thus becoming connected products that exhibit significant network effects. An extensive body of empirical work demonstrates that the widespread use of connected products generally follows Metcalfe's law, generating network value and transforming businesses. As a result, business strategies for these connected products must adapt to the proliferation of the network effects. Unlike software, physical connected products incur non-negligible production costs and require distribution through the value chain. My paper **"Leveraging Network Effects for Connected Products: Strategies and Implications for the Value Chain" (R&R at *MIS Quarterly*, with Yifan Dou, D.J. Wu and Jian Chen)** studies how a classic two-tier value chain can leverage network effects for connected products. We consider two typical strategies with network effects: (1) the network expansion strategy (e.g., seeding) and (2) the connection strengthening strategy (e.g., investing to engineer network effect). We show that when the strength of network effect is fixed, the efficient seeding form (i.e., seeding lower value customers) can enhance the efficiency of the value chain by mitigating double marginalization, if the production cost is below some cutoff. In particular, for sufficiently strong network effect and low production cost, the manufacturer charges a lower wholesale price than without seeding and the retailer chooses the same seeding level and market price as the monopolist under vertical integration, and thus, the industry profit is maximized. Then, we consider the combined use of efficient seeding and engineering network effect. We show that if the manufacturer is relatively cost-efficient in engineering network effect, surprisingly, it will choose a higher investment level than the monopolist such that the above retailer-seeding occurs. This is because due to double marginalization, to induce the retailer to seed thereby stimulating market demand, the manufacturer must charge a wholesale price below some price cap which is increasing in the strength of network effect. This provides the manufacturer with an additional benefit of investment than the monopolist. Furthermore, if the engineering cost is relatively low, the value chain can yield higher social welfare than under vertical integration, because the monopolist will underinvest in network strength since there are positive externalities of investment on consumer welfare. The model suggests that the classic double marginalization problem has an unexpected beneficial effect by enhancing productive investments for connected products. Thus, our paper has new policy implications on the value chain regulation.

Relational Contracts in the Digital Economy

A more recent strand of my research explores the role of informal governance structures, specifically self-enforcing relational contracts, in the digital era. In recent years, novel digital technologies such as big data and AI have mushroomed. These new technologies have brought about new opportunities and, at the same time, new challenges for social governance. In the insurance industry, for example, an increasing number of insurance companies and smart car makers are utilizing telematics and smartphones to monitor drivers' behavior in real-time and offering usage-based insurance (UBI). While such a new performance measure (signal) can help mitigate moral hazard and enhance driving safety, it involves a significant level of subjective assessment on the part of the insurer.

Thus, an insurance policy that employs such a subjective signal will have much weaker enforceability than the one that employs an objective signal such as police reports. My paper **"Relational Contracts in Usage-Based Insurance" (with Jiajia Cong)** studies relational contracts under moral hazard in a competitive insurance market. The insurer can employ both an objective and a subjective signal about the insured's behavior as, respectively, the explicit and implicit incentive components of the contract. Once the insured reneges on the implicit part of the contract (e.g., an increase in premium after a bad subjective signal), both parties return permanently to a spot contract that only uses the objective signal. We show that under limited liability the subjective signal may not be used even in a long-term contract when it is relatively noisy. Moreover, the objective and subjective signals can be both complements and substitutes in the contract. Whereas a more precise subjective signal always improves the insurance market efficiency, the welfare implication of the objective signal can be non-monotonic. In particular, if a more precise objective signal makes the spot contract relatively attractive, it may reduce the efficiency of the relational contract, or even render all relational contracts infeasible. This implies that economies with more precise objective signals (e.g., more advanced road monitoring systems) may be less likely to nurture a thriving UBI market. Moreover, the public investment in objective signals may distort the private sector's investment in subjective signals. These results suggest that improving the contractual enforceability of the subjective signals can mitigate the distortion in the design of UBI contracts and the investment in related monitoring technologies.

In our recently finished paper, **"Online Relational Contract and Offline Investment" (with my student Limei Chen)**, we explore the possibility of using relational contracts to remedy the hold-up problems between platforms and online sellers; that is, platforms can utilize proprietary data to create knockoff products to compete against online sellers and appropriate the rents. In the model, in each period a seller decides whether to remain on a platform and, if so, how much to invest in product innovation. Subsequently, the platform decides whether to copy the seller's product. If the platform chooses to copy, both parties then engage in competition; otherwise, they share the monopoly profit. An innovation of our model is that the seller's product will depreciate at some factor in the absence of continuous investment from the seller. Thus, a relational contract here is not modeled by a repeated game as usual, but rather a dynamic game with the seller's latest investment being the state variable. We show that unlike in the static game where both parties interact once, a relational contract can achieve the first best such that the seller invests efficiently and the platform does not copy, under certain conditions. We further examine how some key factors such as the seller's outside option, market competition intensity and the depreciation factor affect the efficiency of the relational contract. We show that the impacts of these factors hinge on whether the platform copies the seller after any breach of the contract. Specifically, these factors impose non-monotonic and discontinuous impacts on the efficiency of the relational contract. Our model thus sheds new light on platform governance and derives empirically testable results about product innovation within seller-marketplace relationships. At a broader level, our paper offers a useful framework to analyze data-driven hold-up problems in the digital economy.

References

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