Research Statement

Qihong Liu

Associate Professor of Economics

University of Oklahoma

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My research lies in the areas of Industrial Organization and Applied Microeconomics. Much of my work focuses on the role of information in firms' pricing and product strategies. More recently, I study platforms and advertising markets, and conduct research on the U.S. airline industry. Accordingly, my research can be grouped by the following topics: (1) the role of information in pricing and product strategies, (2) two-sided markets (platforms, advertising) and (3) U.S. airline industry. My CV lists all of my publications and working papers.[1]

1 The role of information in pricing and product strategies

1.1 Using consumer information to price discriminate

The rapid growth of information technology allows firms to collect and utilize detailed information about consumers. In this area I am interested in understanding how firms interact with each other in the presence of such information, and how the improvement of this information affects the evolution of prices, profits and welfare.

There is an extensive literature on third-degree price discrimination. A common assumption in this literature is that firms have the ability to segment consumers into either two groups or infinitely many groups (perfect price discrimination). In [1] we propose a partition of the consumer preferences space that encompasses the two extremes as special cases. The better the quality of consumer information is, the finer the partition. This approach is more realistic and it uncovers new and interesting equilibrium relationships. In particular, we show that the relationship between equilibrium profits and the quality of information is non-monotonic (U-shaped).

The next step is to extend this analysis in several directions including (i) firm asymmetry, (ii) free entry, (iii) information sharing and (iv) collusion ([2, 3, 4, 5]). In [2], we consider a duopoly vertical differentiation model and show that the low quality (smaller) firm will refrain from engaging in price discrimination. In [3], we allow free entry and find that imperfect price discrimination (facilitated by moderate levels of consumer information) minimizes inefficiency. In [4], we allow rival firms to share information about their customers and find that information sharing will take place if firms are sufficiently asymmetric. [5] shows that more accurate consumer information makes collusion more difficult to sustain. Relatedly, [6] explores a setting where firms invest in product

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customization technology and then compete in prices. Motivated by coupon trading on eBay, [15] allows some consumers to trade the coupons they receive, and analyzes the welfare impacts of coupon trading.

1.2 Low-price guarantees

The advancing of information technology empowers not just the firms, but consumers as well. For example, consumers can visit retailers' web sites or price-comparison sites to conduct comparison shopping. To attract savvy shoppers, many retailers offer low-price guarantees (LPGs). [9] analyzes the impact of most-favored customers (MFC) clause on prices. We collected data on prices and LPG policies at several consumer electronics retailers (including Best Buy). During our sample periods, Best Buy changed its LPG policy by adopting MFC. We find that, after Best Buy adopted MFC, it reduced its prices and its competitors responded by cutting their prices further.

In [11] I employ a dynamic model and show that LPGs robustly facilitate tacit collusion. This is in sharp contrast to existing literature which usually employ static models and the results are sensitive to modeling assumptions such as the types of guarantees (price-matching or beating), the presence of hassle cost and consumer heterogeneity. This contrast is because, in a static model, any equilibrium has to be immune from an incentive for infinitesimal deviation. In a dynamic model, however, one can ignore infinitesimal deviation since it leads to infinitesimal immediate gain but finite loss in ensuing punishments. In [18] I introduce firm asymmetry (duopoly vertical differentiation) and explore the dual roles of price-matching guarantee as a tool for predation and to counter quality free-riding ("showrooming").

1.3 Multi-dimensional product differentiation

More recently I have been analyzing competition in multi-dimensional product characteristics spaces ([12, 16, 19, 20]). My research in this area employs multi-dimensional models, and show that they offer new insights relative to one-dimensional models.

In [12], we analyze the welfare impacts of price discrimination using a two-dimensional Hotelling model. We find that when firms price discriminate on one but different dimensions or when firms price discriminate on both dimensions, profits go down, mimicking the standard results in one-dimensional models with *best-response asymmetry*. However, when firms price discriminate on one and the same dimension, profits go up and uniform price lies in between the discriminatory prices, similar to findings in one-dimensional models with *best-response symmetry*. We identify two effects which price discrimination has in our model. The first effect is the well-understood *intensified competition effect* which exists in both one- and two-dimensional models. The second effect is the *reduced demand elasticity effect* which exists in our two-dimensional model but not in traditional one-dimensional models. We then endogenize firms' price discrimination decisions and show that price discrimination on one and the same dimension can be supported as a subgame perfect Nash equilibrium. Our results suggest that academics and regulators need to use more caution with the

practice of price discrimination, even under best-response asymmetry.

[16] extends the analysis in [1] to a two-dimensional model. We find that as information quality improves, equilibrium prices and profits monotonically increase while consumer surplus and social surplus monotonically decrease. [19] analyzes behavior-based price discrimination (BBPD) in a two-dimensional model and shows that it raises firms' overall profits, relative to uniform pricing. In our framework, two-dimensional uniform distribution is equivalent to one-dimensional triangular distribution. We are now analyzing BBPD in one-dimensional models with classes of non-uniform distribution. In [20], we employ a multi-dimensional model with general consumer distribution. The degree of product differentiation is measured by unit transport costs as well as firms' locations. We first fix firms' locations and show that equilibrium prices can increase or decrease with unit transport cost. We then fix unit transport costs and endogenize firms' location choices. We show that the equilibrium location choice can be qualitatively different from one-dimensional models.

1.4 Other pricing and product strategies

Pricing-to-market: An extensively studied question in the trade literature is whether and how an exporter can adjust destination-specific markups to accommodate changes in exchange rates, a phenomenon called "pricing-to-market" (PTM). Most PTM studies use export unit values as price variables, which are usually obtained by aggregate data from heterogeneous products. In [7] we employ a model with heterogeneous products and show that false evidence of PTM always exists when using unit values. Moreover, the size of the bias increases with the level of product differentiation. Our results suggest that some of the positive PTM results in the literature could be an artifact of product heterogeneity embodied in unit values rather than evidence of market power and imperfect competition.

Consumer sorting: Many agricultural and natural resource goods are divided into a limited number of grades, with each grade encompassing a range of qualities. Quality variability then leads to consumer sorting where buyers expend effort to identify goods of higher quality within a grade of goods. In [8] we find that allowing consumers to sort can increase profit, even when it reduces profit within the category of goods being sorted. This is because sorting within the lower quality category reduces its substitutability with the higher quality category, which in turn allows the firm to extract more surplus from the high quality category.

Loyalty programs: In [10] we study loyalty programs such as frequent-flier programs by airlines and frequent-guest programs by hotels. We show that various types of loyalty programs (with or without commitment to repeat-purchase price or discount) facilitate tacit collusion.[2]

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[2]This paper was featured in "Membership Has Its Punishments," *Kellogg Insight*, January 2010, and reprinted in *Morningstar*, January 4, 2010.

2 Two-sided markets

One of the fastest growing areas in IO economics involves two-sided markets. These are markets where platforms need to sign up two (or multiple) sides for transaction to take place. My work in this area started with [13], where we show that perfect price discrimination can raise profits in a two-sided market. Moreover, the features of the equilibrium are qualitatively very different from those in a one-sided market. In [24] we introduce two modifications to standard models of media markets (with advertisers and viewers). In the first modification, advertisers make strategic choices on the quality of their ads which affect the utility of readers/viewers joining the same platform. In the other modification, we introduce independent retailers between platforms and readers/viewers. We study whether/how each modification affects equilibrium prices and the estimation of the group externality parameters.

My research also touches upon specific platform markets ([17, 23]). In [17], we look at Amazon which, beyond its initial role of an online retailer, has developed into a dominant platform hosting millions of buyers and third-party sellers. Many sellers enjoy success on Amazon.com, but some found their success to be short-lived because Amazon chose to enter into their product space and sell those products itself. Using data from Amazon.com, we find that the likelihood of Amazon's entry into its third-party sellers' product spaces is positively correlated with the popularity and customer ratings of these products. We also find that small third-party sellers affected by Amazon's entry appear to be discouraged from growing their businesses on the platform subsequently.[3] [23] considers a ride hailing market and investigate the welfare implications of multi-homing.

Much of my ongoing research effort is directed toward advertising markets. [21] is motivated by YouTube's TrueView ads where a viewer can skip an ad and proceed directly to desired content after 5 seconds into the ad. We develop a dynamic model of a viewer receiving incremental information from the advertiser. This model identifies conditions under which the viewer (i) skips the ad and (ii) engages with the advertiser. We then incorporate the advertising market and assess implications of skippable ads on platform's profit and advertisers' surplus. Relative to the traditional ad format, we find that there are unambiguously more advertisements and viewers on the platform with skippable ads. Under reasonable conditions, the skippable ad format is a strict Pareto improvement, which raises the surplus of advertisers and the profit of the platform. The source of the additional surplus is that skippable ads allow the viewers to use incremental information about the advertiser to make more efficient decisions about their ad viewing choices. In [22], we consider a setting where firms can advertise to signal quality. The novelty is that consumers can block ads at a cost. We analyze how ad blocking affects ad signaling. Our results show that when ad blocking cost goes down, it is possible that fewer consumers block ads and the advertising firm's profit increases.

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[3]This paper was featured in "When Platforms Attack," *Harvard Business Review*, October 2015.

3   Competition in the airline industry

In [14], we explore the relationship between market structure and price dispersion in the U.S. airline industry. Most of the empirical literature investigating this relationship has imposed a monotonic relationship. In [14], we develop a theoretical model and uncover a non-monotonic relationship. This non-monotonic relationship is then confirmed using panel data in the U.S. airline industry. In [25], we examine the impact of competition on quality provision in the airline industry. Most existing studies use on-time performance to measure quality. In [25], we scrap data on inflight amenities instead and find significantly higher product quality (Wi-Fi, entertainment, and in-seat power) on more competitive routes. We also find that carriers have lower posted base ticket prices on flights with Wi-Fi and entertainment.

After receiving tenure in 2013, I started advising Ph.D. students on a regular basis. Almost all of our Ph.D. students focus on empirical research, and airline industry emerges as a suitable topic with publicly available data. I have written 3 airline papers ([26, 27, 28]) with my students and colleagues. [26] considers the impact of a policy change, when Spirit adopted carry-on baggage fee in 2010. Using generalized difference-in-difference (diff-in-diff) estimation, we find that Spirit's rivals reduce their prices by about 5% after Spirit's baggage fee policy, and the price reduction is larger for prices at the 50th-percentile relative to the 80th-percentile and 20th-percentile. We also explore the role of subcontracting status, i.e., whether a major airline operates its own flights on a route, or subcontracts the operations to a regional airline. Our results show that subcontracting carriers reduce their ticket prices significantly more than carriers which do not subcontract. [27] estimates the impact of merger between US Airways and America West in 2005. Existing studies run standard diff-in-diff estimation, using routes where merging airlines operate as treated group, and using routes where merging airlines do not operate as control group. The problem is there may be systematic difference between the treated and control group. Our paper's contribution is to implement a genetic matching algorithm and construct a matched group (out of the control group), which better resembles the treated group. [28] investigates how airline fuel cost pass-through rate varies with market structure. Drastic relative changes in airline specific fuel costs also allow us to test for sunk cost fallacy. This occurs when an airline gains or loses a significant lump sup amount from its fuel hedging contracts, which affects its reported fuel cost but not its true economic cost of using fuels.

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[26] **"The Impact of Carry-On Baggage Fee and the Differential Burden on Regional Airlines," (with Lei He and Myongjin Kim), manuscript.**

[27] "The Impact of Merger on Product Differentiation: An Application of Genetic Matching Method," with Pallab Ghosh and Zexuan Liu, work in progress.

[28] "Airline Fuel Costs: Hedging and Pass-Through," with Myongjin Kim and Long Shi, work in progress.