Research Statement

Qihong Liu
Professor of Economics
University of Oklahoma
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Much of my early research focuses on the role of information in firms' pricing and product strategies (Section 2). In recent years, I have been drawn toward more industry-relevant research, particularly those involving digital advertising and E-commerce platforms (Section 1). I have also maintained an active research agenda studying the U.S. airline industry (Section 3), where an abundance of public data is available.

Methodologically, I utilize empirical tools from economics with data from industry and firms. I also apply game theory to study various markets when data are unavailable to me.

1 Digital Advertising and E-Commerce Platforms

Business activities continue to evolve with the emergence of digital platforms. The market for advertising, the delivery of content, and the practice of pricing are just a few areas impacted by new internet and mobile technologies. My research contributes to our understanding of this impact.

1.1 Digital Advertising

My most recent research focuses on the digital advertising market ([1, 2, 3, 4, 5]). In [1], we investigate the skippable ad format, which gives a viewer the option to skip part of an advertisement after seeing some limited information. Our results show that skippable ads can be less effective overall in converting existing viewers to advertisers. However, skippable ads bring more viewers to the platform and, in turn, induce more advertisers. This suggests that a switch to the skippable format is a profitable strategy for an emerging and growing platform, but not necessarily for one in a saturated market. In [2], we develop an equilibrium framework to structure informational and non-informational content for ad messages, where individual viewers can choose not to attend or even skip an ad. We then prescribe ad content strategies across various (i) market factors, (ii) advertising goals, and (iii) ad formats (skippable versus non-skippable).

In [3], we find that a lower ad blocking cost may result in fewer consumers blocking ads and higher profit for the advertiser, driven by the signaling function of advertising. In particular, the ad platform reacts to lower ad-blocking cost by lowering the unit ad-distribution cost it charges, forcing the advertiser to spend more on ad production because ad-distribution cost alone is insufficient to signal product quality. In [4], we explore a recent development in a Chinese digital news platform which has the capability to conduct ad auctions upon user arrival, and then customize its content

(news order) for that user depending on auction outcomes. In [5], we consider the impacts of strategic agents, modeled as advertisers who invest in ad quality which in turn affects readers, platforms and themselves.

1.2 E-Commerce Platforms

My research also seeks to better understand the role of E-commerce platforms in various markets ([6, 7, 8, 9, 10, 11]). My interest in platforms started with [6], where we show that perfect price discrimination can raise profits in a two-sided market. [7] is my most publicized work in terms of media exposure and citations (featured in Bloomberg, Forbes, European Competition and Regulatory Law Review, Harvard Business Review, Wall Street Journal etc.). In [7], we investigate the relationship between a dominant platform (Amazon) and its complementors (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. Using data from Amazon.com, we find that the likelihood of Amazon's entry 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. [8] considers a ride hailing market and investigate the welfare implications of multi-homing. [10] studies the effect of product-related user generated contents (UGCs) on product sales. We focus on a particular type of dynamic UGCs platforms, a live streaming platform for video game play, and ask whether such a platform helps or hurts product sales. Using data on weekly sales and high frequency live streaming activities on Twitch.tv, we first document the impact of live streaming activities on product sales using a series of regression analyses. Next, we plan to develop and estimate a structural model product purchase and UGC creation and consumption, and study profit implications of the live streaming platform for video game publishers. Using the model estimates, we evaluate actions by publishers in controlling for content streaming and designing compensation scheme in order to improve profits. [11] considers a setting where the latest technology development (such as AI) enables a retail platform to identify products for consumers better than consumers can themselves. As a result, the platform can decide to offer a ship-then-shop program. In contrast to the common shop-then-ship paradigm, under ship-then-shop, the platform ships the AI-identified products to consumers directly. We derive the optimal product price and subscription fee, and explore how they vary with model primitives such as the level of AI accuracy and search friction.

2 Pricing and Product Strategies

2.1 Pricing and Consumer Information

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 consumer 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 [12] 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 ([13, 14, 15, 16]). In [13], we consider a duopoly vertical differentiation model and show that the low quality (smaller) firm will refrain from engaging in price discrimination. In [14], we allow free entry and find that imperfect price discrimination (facilitated by moderate levels of consumer information) minimizes inefficiency. In [15], we allow rival firms to share information about their customers and find that information sharing will take place if firms are sufficiently asymmetric. [16] shows that more accurate consumer information makes collusion more difficult to sustain. Relatedly, [17] explores a setting where firms invest in product customization technology and then compete in prices. Motivated by coupon trading on eBay, [24] allows some consumers to trade the coupons they receive, and analyzes the welfare impacts of coupon trading.

2.2 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). [20] 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 **[22]** 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 [26] 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").

2.3 Multi-dimensional product differentiation

More recently I have been analyzing competition in multi-dimensional product characteristics spaces ([23, 25, 28]). My research in this area employs multi-dimensional models, and show that they offer new insights relative to one-dimensional models.

In [23], 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.

[25] extends the analysis in [12] 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. In [28], 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.

2.4 Other pricing and product strategies

Behavior-based price discrimination (BBPD): BBPD is often found to create a prisoner's dilemma, under the common assumption that consumer valuations are distributed uniformly. In [27], we consider a wider class of consumer distributions and show that profit and welfare results change qualitatively. When consumers are sufficiently massed at the center of the market (e.g. triangular distribution), BBPD boosts industry profits at the expense of consumers. Otherwise, the usual findings prevail. Our results highlight how assumptions on the density of consumer valuations play a decisive role on pricing and welfare outcomes.

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 [18] we em-

ploy 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 [19] 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 [21] 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.[1]

3 Competition in the Airline Industry

I have maintained an active research agenda studying competition in the U.S. airline industry ([29, 30, 31, 32, 33]). Several features make the industry attractive for marketers. First, it is an important part of the U.S. economy (over $248 billion in total operating revenue in 2019). Second, it has detailed information on its customers, and is known to employ sophisticated pricing and product strategies to improve profitability. Third, airlines are also required to report various data to regulators, which in turn allow us to study a variety of issues important to marketers, such as pricing and segmentation, competitive strategy, advance selling, cancellations etc.

In [29], 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 [29], 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.

[30, 31] are collaboration with a colleague and two former students. [30] considers the impact of a policy change, when Spirit adopted carry-on baggage fee in 2010. Using a vector of route level characteristics, we construct a matched group consisting of routes which best match those served by Spirit (the treated group). We then run a diff-in-diff estimation using the treated and matched group, and examine the impact of Spirit's baggage fee policy on its rivals' ticket prices. Our results that Spirit's rivals reduce their prices by about 5.8% after Spirit charges carry-on baggage fee. We also look into potentially heterogeneous responses across different types of rivals. There is no significant difference in how low-cost carriers and legacy carriers respond to Spirit's policy change. However,

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

relative to non-subcontracting carriers, those which subcontract operations to regional carriers reduce their prices further by more than 10%, including average prices (linear or log) and various other points on the price distribution.

In contrast to the extensive literature on behavior bias by individuals, studies on behavior bias by firms have been relatively scarce. In [31], we explore the possibility of the latter in the context of U.S. airlines, where fuel hedging leads to lump sum gain or loss which is sunk to airlines' pricing decisions. Our results show that the (sunk) hedging gain or loss affects airlines' ticket prices. In particular, a 10% reduction in the reported fuel cost (due to hedging gain) leads to a 2.2% reduction in ticket prices. Hedging gain also leads airlines to use larger aircrafts and reduce airtime of their flights, but has no impacts on the number of routes and flights which airlines operate.

[32, 33] are both based on data which we scraped. [32] is concerned with the impact of competition on quality provision in the airline industry. Most existing studies use on-time performance to measure quality. In [32], 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. Shortly after we scrapped data for [32], we also scrapped pricing and product data about the Chinese airline industry from a dominant online travel platform in China ([33]). One unique feature about the data is product variety, where numerous tickets with different ticket policies (when can the consumer change or return a ticket) are offered simultaneously. We are in the process of studying the endogenous product variety decision, as well as how it is linked with pricing decisions.

4 Other topics

Economics labor market In [34] we manually collected data from the 2007-2008 Ph.D. economist job market, to investigate initial job placement in terms of job location, job type, and job rank. We uncover gender differences in all three dimensions of job placement. Relative to their male counterparts, female candidates are less (more) likely to be placed into academic (government or private sector) jobs and, on average, are placed into worse ranked jobs.[2] We then follow and track the same cohort until Fall 2016, and examine their early career outcomes (i.e., tenure and promotion) in [35]. We find that female economists are less likely (by up to 15.8%) to have received tenure and promotion eight years post-graduation compared to males. The gender gap becomes more pronounced (e.g., 36.5% less likely to receive tenure/promotion) among individuals of foreign origins working in the U.S. In addition, we find a similar gender bias regarding whether an individual remains on tenure-track positions since the initial job placement in 2008. Adding to the literature, our analysis sheds light on the gender gap in the Economics profession from a broad international perspective.

Nutrition: A few years back, I reconnected with Nathalie Lavoie, my supervisor when I was a postdoc at UMass. We noticed a restaurant nutrition labeling policy change, and started collecting data about restaurant menu and nutrition information to study how markets respond to the restaurant calorie

[2]This paper is cited as a further reading in American Economic Association's "Understanding the job market," accessed in May 2018.

labeling rule ([36]). Later on Emily Wang (also from UMass) joined and led the effort for our 3-year USDA funding of over $450,000. I am also working on a Nutrition index project ([37]) with Chen Zhen (University of Georgia) using USDA IRI data. We plan to apply for USDA-NIFA funding in 2023.

Chinese Economy: In [38], we explore the firm quasi-dynamics (entry/exit and growth) in the Chinese manufacturing industries and investigate how these dynamics vary across regions. Our results show that relative to provinces with less developed economies, in provinces with more developed economies: (1) There are higher shares of new firms; (2) New firms are smaller and more labor-intensive; (3) Firms exit at a quicker rate and surviving firms grow faster. These results point toward cross-region differences in market efficiency in terms of how much it costs a firm to enter or exit the market. Our findings shed light on how firms should adapt their strategies across regions and how the government can create sound policies on industrial upgrading and relocation.

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