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Consumer search costs, geographical concentration, and retail gasoline pricing: Evidence from inland Japan

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ABSTRACT

We examine determinants of retail transaction and list prices for gasoline using cross-sectional data for gas stations in inland Japan. The study makes two original contributions: it examines inland Japan where gasoline prices at proximate stations theoretically should be identical, and it analyzes retail transaction and list prices for gasoline. Empirical analysis yields three results. First, the concentration of stations correlates negatively with gasoline prices, but its effects are attenuated by increased numbers of uninformed consumers. Second, stations should set retail prices that include markups based on location, their service features, and brand affiliation. Third, they should charge different markups for different grades of gasoline based on concentration of stations and location. Our findings suggest that consumers' search for stations that set lower price could significantly influence pricing and that providing price information could reduce search costs and gasoline prices, thereby raising social welfare.

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1. Introduction

Different sellers often set different prices of homogeneous goods, and the same seller sometimes set different prices of homogeneous goods to different consumers. Although traditional economic theory regards gasoline as a homogeneous good subject to the law of one price, empirical studies show gasoline prices are dispersed (Yilmazkuday and Yilmazkuday, 2016; Eckert, 2013; Chandra and Tappata, 2011; Lewis, 2008; Barron et al., 2004; Shepard 1991). These considerations imply each gas station should set individually strategic prices.

Using cross-sectional data of gas stations in inland Japan, we examine determinants of retail transactions and list prices across stations. Our empirical analysis produces three results. First, geographical concentration of gas stations correlates negatively with gasoline prices, but its effect attenuates as numbers of uninformed consumers rise. Second, stations should set prices that include markups determined by their location, station characteristics, and brand affiliation. Third, they should charge different markups for different grades of gasoline based on geographical concentration and location. Further, our findings suggest that consumers' search for lesser-cost gasoline could significantly

influence pricing and that providing price information could reduce search costs and gasoline prices, thereby raising social welfare.

Retail gasoline markets in inland Japan suffice for our analysis.¹ Lacking significant domestic reserves, Japan imports substantial quantities of crude oil. Japan has no oil pipelines; imported crude is transported by ship, rendered into gasoline at coastal refineries, and trucked inland to each station.

Our paper extends the literature on gasoline pricing and price dispersion in three ways. First, we use Japanese station-level retail price data. Several empirical studies examine retail gasoline pricing in assorted locales, including Eastern Massachusetts (Shepard, 1991), California and Arizona (Barron et al., 2004), Vancouver and Ottawa (Eckert and West, 2004), Lexington (Cooper and Jones, 2007), Lower Austria (Pennerstorfer, 2009), and the United States nationwide (Yilmazkuday and Yilmazkuday, 2016). Tsuruta's (2008) study of Japan's gasoline market examines intra-national price dispersion at the prefectural, not station, level. No study analyzes Japanese retail gasoline pricing at the station level. Further, we examine inland Japan where gasoline is trucked to

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¹ The Japan Fair Trade Commission (2016) reports practices in the gasoline industry, and the Petroleum Association of Japan (2015) oversees Japan's gasoline industry. For industry details see Japan Fair Trade Commission (2016) and Petroleum Association of Japan (2015).

individual stations from refineries via terminals. Therefore each station encounters roughly identical transportation costs, providing an appropriate area to analyze retail pricing.

Second, we collect data for list and transaction prices and analyze both. Earlier studies use only list prices (Eckert and West, 2004, 2005; Cooper and Jones, 2007) or transaction prices (Hosken et al., 2008; Chandra and Tappata, 2011). We analyze differences between transaction and list prices to identify the basis for strategic price markups.

Third, we investigate relations between market segmentation and pricing. Although Shepard (1993) and Chandra and Tappata (2011) analyze pricing for different grades of gasoline, they disregard differences in market segments that are reflected in pricing strategies.

The paper proceeds as follows. Section 2 reviews gasoline distribution in inland Japan. Section 3 is theoretical background. Section 4 provides results for transaction pricing. Section 5 examines list pricing for regular gasoline, differences between transaction and list price, high-octane list pricing, and differences between regular and high-octane prices. Section 6 concludes.

2. Overview of gasoline distribution in inland Japan

2.1. Nakadōri region in Fukushima Prefecture

We study the Nakadōri region in Fukushima Prefecture. An inland area, Nakadōri covers 5400 km² and has 1.2 million persons in its 8 cities and 21 towns or villages. Its two principal cities (Kōriyama and Fukushima) are mid-sized with concentrated populations and employment opportunities.² Its population collapsed after the 2011 Tōhoku earthquake but is recovering.

2.2. Distribution network

Given the previously noted lack of domestic oil reserves, import reliance, and absence of pipelines, transportation costs govern retail gas prices throughout inland Japan.³ Gasoline is transported to individual gas stations in tank trucks. It may be trucked directly from refineries or from refineries to individual stations through a gas terminal. This second course is most common.

Gasoline distribution in Nakadōri is typical of inland Japan. Almost all gasoline sold there is from the Sendai refinery and is trucked to each station via the Kōriyama oil terminal. Most branded refiners share the Sendai and Kōriyama facilities, suggesting that all stations incur roughly identical transportation costs. Fig. 1 shows locations for the Nakadōri region, Sendai refinery, and Kōriyama terminal.

3. Theoretical background

Theoretical and empirical studies routinely observe price dispersion of homogeneous goods and argue they should adhere to the law of one price. As a somewhat homogeneous good, gasoline prices should be identical. In fact, they are dispersed by local, as empirical studies reveal.⁴

Barron et al. (2004) highlight two theoretical approaches to price dispersion: as an extension of monopolistic competition and through consumer search models. In standard monopolistic competition models, prices charged by different stations are

known to all consumers. Generally, consumer searches for gasoline might be easier than for other goods, but in Japan searching for lower-cost gas incurs significant costs (Tsuruta, 2008), and the assumption of perfect price awareness is unrealistic. Therefore, consumer search models better describe Japan's retail gasoline market and illuminate predictions of retail pricing.

Although consumer search models predict prices should change when the concentration of gas stations is more intense, directionality depends on model specifications.⁵ For example, Rosenthal (1980) assumes each firm has price-insensitive "loyal" consumers. Under this assumption, firm entry attracts more price-insensitive consumers, creating progressively smaller fractions of price-sensitive consumers. This attenuates providers' incentives to compete for price-sensitive consumers, and prices rise. This result indicates that increases in numbers of stations should boost retail gasoline prices. However, Morgan et al. (2006) assume firm entry leads to an increasingly larger fraction of price-sensitive consumers, strengthening incentives to compete for their business by reducing prices. This result indicates that increased numbers of stations should reduce retail gasoline prices. The relation between the intensity of concentration and prices becomes an empirical question.

4. Empirical analysis

4.1. Data

We surveyed 213 stations in the Nakadōri region of Fukushima Prefecture from August 29, 2016, to September 3, 2016.⁶ These 213 account for 44% of all stations in region and operate mainly along heavily trafficked national highways.⁷ We investigated maximum list prices of regular and high-octane unleaded gasoline at each station. Also, we bought 1 liter of regular unleaded gasoline at 160 surveyed stations, paying with cash, and recorded their prices.

We supplemented survey data with population data for each municipality on September 1, 2015 and 2016, from *Estimated population* in Fukushima Prefecture and calculated population growth rates. We consulted the Japanese telephone directory *Townpage*, which lists telephone numbers and addresses of gas stations by municipality, to count numbers of stations in each. We measured distances between stations, distances to the nearest expressway interchange for each station, and distances to the nearest oil terminal for each station using Google Maps. Table 1 summarizes the variables, including their definitions.

4.2. Specification

We employ the following estimation specification to consider prices for regular grade gasoline:

$$\ln Tp_i = \alpha_0 + \alpha_1 \ln Num2.0r_i + \alpha_2 \ln Num2.0r_i \cdot Growth_i + \alpha_3 \ln Dens_i + \alpha_4 \ln DistE_i + \alpha_5 \ln DistT_i + \alpha_6 Expressway_i + \alpha_7 Full_i + \alpha_8 \ln NumAR_i + \alpha_9 Single_i + \delta_i + u_i. \quad (1)$$

In Tp is the logarithm of transaction prices for regular gasoline. Several studies use list prices as explained variables—e.g., Eckert and West (2004, 2005) and Cooper and Jones (2007). Hosken et al.

⁵ Baye et al. (2006) comprehensively review the literature on theoretical consumer search models.

⁶ We implicitly assume gasoline prices do not change with day of the week. As in many countries Japan Agency for Natural Resources and Energy (Ministry of Economy, Trade, and Industry) reports weekly data every Monday. Therefore, our implicit assumption is plausible.

⁷ There are 405 stations in the 8 cities and 8 towns or villages which are Kōriyama, Fukushima, and surrounding municipalities.

² Kōriyama's population was 335,800 and Fukushima's 293,500 on September 1, 2016 (*Estimated population* in Fukushima Prefecture).

³ See Japan Fair Trade Commission (2016) and Petroleum Association of Japan (2015).

⁴ Eckert (2013) surveys empirical studies of gasoline retailing.

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