Energy Economics 92 (2020) 104950

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Price ceilings as focal points to reach price uniformity: Evidence from a Chinese gasoline market

Xiao-Bing Zhang, Yinxin Fei, Ying Zheng *, Lei Zhang

School of Applied Economics, Renmin University of China, China

ARTICLE INFO

Article history:
Received 18 September 2019
Received in revised form 26 August 2020
Accepted 4 September 2020
Available online 12 September 2020

Keywords:
Retail gasoline market
Price ceilings
Price uniformity

ABSTRACT

This paper studies the price uniformity in the Chinese gasoline market, using station-level data of Hohhot city, Inner Mongolia. We first document that the mode prices of the gasoline stations are consistent with the price ceilings set by the government, implying that the price ceiling regulation in the Chinese gasoline market may serve as a focal point for the gasoline stations to reach price uniformity. We corroborate the focal point hypothesis by providing evidence showing that some stations would "jump" to the ceilings as their prices approach the ceilings. Also, we find that local market structure, distance between stations, station capacity, market characteristics, and past pricing behavior could affect the probability of gas stations to price at the ceilings. Moreover, a higher price ceiling would reduce the probability that stations reach price uniformity. Our results provide another piece of evidence to the literature regarding the unintended effect of price ceiling regulation.

1. Introduction

As an essential input to modern life, gasoline plays an important role in a country's economy. Given the resource endowment in China (i.e., "richness in coal and lack in oil"), the market of oil and its refined products are regulated strictly by the government. In recent years, with the on-going reform and deregulation in the Chinese oil market, more companies are now engaged in the competition of the oil industry. Among the vertical chain of the oil industry, the retail gasoline market faces the lowest level of regulation and can be regarded as the most competitive part of the oil industry. The Chinese retail gasoline market was officially deregulated and open to domestic private companies and foreign oil companies in 2004. Since then, more and more private companies have entered this market and changed the market structure gradually. On the other hand, in spite of relatively more competition in the retail gasoline market, the two major state-owned companies, China National Petroleum Corporation (i.e., PetroChina) and China Petroleum & Chemical Corporation (i.e., Sinopec), still dominate the market, possessing nearly 50% of all gas stations nationwide. This implies that the retail oil market in China is highly concentrated, which highlights the importance of studies on the pricing strategy of the Chinese retail gasoline market.

One should keep in mind that the Chinese retail oil market has its own characteristics in price regulation. Instead of complete marketization of retail oil price, the National Development and Reform Commission (NDRC) has been setting the ceiling prices for refined oil products regularly. According to the "Notification on the Implementation of Retail Oil Price and Taxation Reform" issued by the State Council on December 18th, 2008, NDRC enacts gasoline price ceiling based on crude oil prices in Brent, Dubai and Minas every ten working days, taking into account the reasonable transaction cost, taxation and profit for oil companies. Retailing oil firms are able to set their prices freely under this price regulation (Huang, 2018).

Since price ceilings are publicly announced, they could be easily taken as focal points for pricing by firms, given that the deviations from these (known) focal points can be detected at a low cost (Schelling, 1960; Scherer and Ross, 1990; Knittel and Stango, 2003; Sen et al., 2011).[1] In retail gasoline market, creation of focal point as an effective device for price coordination is discovered and studied in many countries such as the U. S., Norway, Italy and Australia (Lewis, 2012; Foros and Steen, 2013; Andreoli-Versbach and Franck, 2015; Byrne and de Roos, 2019). In our context, this implies that the gasoline price ceilings set by the government can be possibly used as focal points to coordinate the pricing behavior of stations to reach price uniformity. Studies on price regulation in the gasoline market have already raised attention with Barron and Umbeck (1984), Blass and Carlton (2001), Sen et al. (2011), Clark and Houde (2013), Carranza et al. (2015). The Chinese market provides a unique sample to examine the effect of price ceiling in retail oil market. This motivates this study on how the

* Corresponding author.
E-mail addresses: xbzhmail@gmail.com (X.-B. Zhang), feiyinxin@126.com (Y. Fei), yingzheng@ruc.edu.cn (Y. Zheng), zhangleixing27@163.com (L. Zhang).

[1] A focal point is a selection of outcome that all players can easily identify and assume that all other players will follow without any explicit communication; see Schelling (1980) and Binmore and Samuelson (2006).

https://doi.org/10.1016/j.eneco.2020.104950
0140-9883/

price ceiling regulation in the Chinese retail gasoline market affects the pricing behavior of the gasoline stations in the market.

There are many studies on the competition and coordination of gasoline stations in other countries, e.g., Borenstein and Shepard (1996) and Lewis (2012) on the US market; Eckert and West (2005) on the Canadian (Vancouver) market; Foros and Steen (2013) on Norway market; Byrne and de Roos (2019) on the Australian (Perth) market. However, studies on the effect of price ceilings on gasoline pricing, which can also be seen as a way of coordination, are rare and few studies have been done on the Chinese gasoline market. This paper attempts to fill this gap by investigating the pricing strategies of gasoline stations in the Chinese market and the role of price ceiling regulation in this process, using a unique station-level panel data of Hohhot, Inner Mongolia. We first examine whether the price ceilings could serve as focal points to reach price uniformity in the Chinese retail gasoline market and then try to identify the determinants of gasoline stations' ability to match the price ceilings. Our results document that the mode prices of the gasoline stations are consistent with the price ceilings set by the government, implying that price ceiling regulation in the Chinese gasoline market may serve as a focal point for the gasoline stations to reach price uniformity. We corroborate the focal point hypothesis by providing evidence showing that some stations would "jump" to the ceilings as their prices approach the ceilings. Finally, we find that local market structure, distance between stations, station capacity, market characteristics, and past pricing behavior could affect the probability of gas stations to price at the ceilings. Moreover, a higher price ceiling would reduce the probability that stations reach price uniformity. Our results provide another piece of evidence to the literature regarding the unintended effect of price ceiling regulation.

The rest of this paper is organized as follows. Section 2 provides a brief review of related studies. Section 3 describes the data, documents the price uniformity and then constructs relevant variables. Section 4 construct a preliminary test on the focal point hypothesis. Section 5 presents the econometric methods examining factors influencing stations' probability to match price ceilings and discusses the empirical results. Finally, conclusions and implications are summarized in the last section.

2. Literature review

Competition and market power issues have been studied extensively in the retail gasoline market due to the nature of gasoline as a homogeneous product. Borenstein (1991) shows that the gasoline retailers were able to extract more rents from consumers while the available options are less by studying the trend of leaded gasoline supply in the 1980s; Slade (1987, 1992) studies the interactive behaviors among major and independent retailers using static and dynamic price models and finds that majors are acting as price leaders coordinating price increases, while independent retailers are more inclined to wage price wars. Also, there are evidences that firms in the market can use prices as signals to coordinate and reach price uniformity tacitly (Foros and Steen, 2013; Lewis, 2012; Andreoli-Versbach and Franck, 2015; Byrne and de Roos, 2019) and that location features or geographical distances would affect stations' market power or probability to reach price uniformity (Eckert and West, 2005; Verlinda, 2008). These studies document various strategies implemented by firms to coordinate their pricing behaviors, and show that major companies intend to take leading roles in this process, while fringe companies are inclined to deviate. This implies that collusion could be more difficult to sustain in a market with asymmetric firms.

However, a typical type of price coordination initiated by leadership of major firms is discovered worldwide. Foros and Steen (2013) find that in the Norwegian gasoline market, due to vertical restraints in the large company, retail gasoline prices are raised to the recommended prices set by headquarters of the large company, creating a focal point followed by the other companies. Lewis (2012) finds that price leader in the Midwestern United States gasoline market creates a focal point by simultaneously changing prices of all its stations to a specific price, followed by its competitors raising prices to the same level. Andreoli-Versbach and Franck (2015) find in the Italian gasoline market, price leader unilaterally promised "sticky pricing" policy which facilitates price collusion. Byrne and de Roos (2019) report a long period of "Wednesday price jump" by BP, the dominant firm in the market, followed by "Thursday price jump" by its rivals in Australian gasoline market. This type of price coordination features a focal price set by major firms through raising all their stations' price to the same level. This signal is easily observed with nearly no cost by other firms and they follow the price leader to set their price.

Price ceilings, commonly used to stabilize the market price, may unintentionally serve as focal points to facilitate price coordination in many markets, including the gasoline markets. Using data from the US credit card market during the 1980s, Knittel and Stango (2003) find that card issuers could use the ceiling rate as the focal point for tacit collusion, in spite of the initial intention of the regulator to curb market power and to benefit consumers via lower prices. Also, they find that firms are more likely to match the price ceiling when the ceiling becomes lower (Knittel and Stango, 2003). Evidence has also been found in other areas such as the Nasdaq dealers market (Christie and Schultz, 1994), and debit card interchange fees (Shy, 2014). Genakos et al. (2014) make use of the repeal of maximum wholesale and retail markup regulation in the Greek market for fresh fruits and vegetables and find that abolishing the regulation led to a significant decrease in both retail and wholesale prices, which provide indirect evidence that markup ceilings provided a focal point for coordination among wholesalers.

In particular to the gasoline retailing market, Clark and Houde (2013) discuss the effect of the price floor regulation, i.e., the minimum price allowed to set, in Canada. They find that higher price floors can weaken collusion by crippling punitive undercutting from other firms. Barron and Umbeck (1984) and Blass and Carlton (2001) find that the restrictions on vertical integration of major oil refiners in the retail sector led to higher prices. Sen et al. (2011) evaluate the efficacy of price ceiling legislation by employing weekly data on retail gasoline prices for eight cities in Eastern Canada and find that such regulation is significantly correlated with higher prices. Carranza et al. (2015) study the impact of a price floor introduced in Quebec in 1997 and find the long-term effect of the regulation was to lower margins and station productivity. Due to the lack of station-level data, there are few studies on how gasoline stations set prices under the price ceiling regulation. Our unique data set of daily station prices allows us to examine this question comprehensively.

This paper first contributes to a growing literature studying market power in the retail gasoline market. By studying the asymmetric gasoline market structure in China, where competition/coordination is not only between the two state-owned companies but also among the state-owned and independent companies, this paper adds a new typical sample on the pricing behaviors and market power in the gasoline retailing market. Previous empirical research concerning high-frequency micro-level data in China is especially rare, with most of existing literature, to our knowledge, analyzing from qualitative perspective or basing on aggregate data. For example, Zhang (2014) argues qualitatively and theoretically that China's market structure and price regulation could promote firms to reach uniform prices. Zhang and Peng (2018) employ a vector autoregression (VAR) model to analyze the monthly gasoline prices in China and find that international crude oil price is the main driving force of gasoline price. Using gasoline prices in 35 major cities in China, Ma et al. (2009) argue that energy reserve and transportation cost could explain a large proportion of price dispersion in China. Ma and Oxley (2012) further find that gasoline prices in China converge in the regional level instead of across the country, suggesting gasoline market segmentation in China.

Specially, we make contributions to the studies of regulations on firm behavior and competition. The Chinese gasoline market is a typical

and unique example for price regulation. Specifically, the price regulation process follows a certain formula and adjustment cycle, which is commonly known by the public. As shown by many studies on gasoline pricing, e.g., Byrne and de Roos (2019), that public price information may facilitate the pricing coordination. However, there are few empirical studies on the gasoline stations' pricing strategy under the price ceiling regulation in China. This paper fills a gap in this direction by investigating the pricing strategies of gasoline stations in the Chinese market and the role of price ceiling regulation in this process, using a unique daily station-level panel data of Hohhot, Inner Mongolia.

Finally, we contribute to a small but growing empirical IO literature on studying firms' behavior in other Chinese industries where both state-owned and independent companies are present; e.g., automobile and airline markets. Deng and Ma (2010) find that large automobile manufacturers were capable of setting high markups, indicating their strong market power in China's automobile market. Hu et al. (2014) explore the ownership structure of the Chines automobile market, where big corporate groups centered around state-owned enterprises, and find no evidence of within or cross-group price collusion. Zhang and Round (2011) find that both price war and collusion existed but short-lived in China's airline market during the period of 2002–2004. Our paper contributes to empirical IO research regarding Chinese industries by investigating the pricing strategy of stations affiliated to the two major oil companies and independent stations respectively. And we find different roles of the three types of stations when using price ceilings as focal points.

3. Data and variables

3.1. Data description

We obtain the station-specific daily data on gasoline prices from Hohhot, the capital of Inner Mongolia, from the survey company owned by the PetroChina Planning and Engineering Institute. The data includes daily gasoline (#92)[2] prices posted by all gas stations, i.e., stations owned by PetroChina, Sinopec and other companies, operated in Hohhot for the period from January 1 to August 29, 2018. In addition, we collect data on geographical features and specific characteristics of these gas stations such as addresses, longitudes and latitudes, numbers of gas guns owned, numbers of carports for gas filing. In total, there are 170 gas stations, of which PetroChina owns 104, Sinopec owns 39 and the other independent gas stations or retail chains (denoted as "other" hereinafter) own the remaining 27. The market share shows a typical gasoline retailing market structure in a Chinese city, i.e., the two largest oil companies, PetroChina and Sinopec, dominate the market. Our sample consists of 29, 695 unique prices from the 170 gas stations in Hohhot. On average, each gas station is observed 175 of 241 days.

Fig. 1 shows the spatial distribution of these gas stations, where red spots represent PetroChina stations, blue spots SinoPec stations, and yellow spot other stations. It is clear that the stations are highly concentrated in the downtown area and that most of the stations locate alongside main roads.

As a first glance, we depict the average daily prices of stations owned by different companies and the ceiling prices in Fig. 2(a). First, an adjustment cycle for price ceilings is observed: every ten working days, the Inner Mongolia Development and Reform Commissions would decide the ceiling prices for the next 10 days.[3] Second, PetroChina persistently sets prices slightly lower than the ceilings on average, followed by Sinopec and then other stations.

Fig. 2(b) plots the daily mode prices, i.e., the most frequently adopted prices, set by different companies. It shows that the majority of PetroChina and Sinopec stations are setting exactly the ceiling prices every day in our sample period and that the majority of "other" stations follow the same pricing strategies with only a few exceptional days.

Fig. 3 further illustrates the distribution of prices for each company via different price percentiles for each day. It can be seen that for all brand types of stations, their daily prices are capped by the government's price ceilings and the maximum prices for each brand are actually coinciding with the ceilings, while the minimum prices are notably below the ceilings and differ by companies. The minimum prices for PetroChina stations are generally higher than those of Sinopec and other stations. In more details, more than 75% of PetroChina stations set their daily prices at the ceilings; meanwhile, only around half of Sinopec stations and less than 25% of "other" stations set their prices at the ceilings. This observation shows that PetroChina and Sinopec stations seem to reach some extent of price uniformity at the price ceilings set by the government, while the other independent stations tend to undercut in the market.

3.2. Construction of variables

Following the literature on retail gasoline pricing, e.g., Eckert and West (2005), we construct a series of variables to investigate the underlying mechanism of the observed price uniformity.

3.2.1. Pricing at the ceilings

As illustrated above, a large proportion of stations actually set their prices at the ceilings, i.e., matching the ceilings. To characterize such a pricing behavior, we construct a dummy variable $pricing\_at\_ceiling_{it}$, with $pricing\_at\_ceiling_{it} = 1$ if station i sets its price at the ceiling price in period t and $pricing\_at\_ceiling_{it} = 0$ otherwise.

3.2.2. Dominating companies

As two leading companies in Hohhot, PetroChina and Sinopec stations' pricing decisions are expected to affect other stations. Therefore, we construct two dummies to indicate whether the station is operated by either PetroChina or Sinopec or neither. These dummies can also capture the brand effect that is found important in the literature.

3.2.3. Market competition

Clearly, the pricing behavior is affected by the competition environment faced by each station. Therefore, we include two variables, $no\_station\_near_{it}$ and $Nstations\_rival_{it}$ to measure the spatial competition and the market concentration level. In particular, $no\_station\_near_{it}$ is equal to one if there is no other station within a 10 km radius of a station; and $Nstations\_rival_{it}$ counts the total number of stations within a 3 km radius excluding the stations of the same brand.

3.2.4. Distances

Distances and the associating transport cost make the essentially homogenous gasoline products of different gas stations perceived as differentiated products by consumers. To capture the heterogenous effects from being near a major or other firms, we define two variables, $Dist\_Major_{it}$, which measures the distance of station i to the nearest rival major company (PetroChina or Sinopec) station, and $Dist\_Other_{it}$, which measures the distance to the nearest rival (other) independent station. Meanwhile, to investigate heterogeneous effect of distance on different type of station brand, we include cross terms illustrating brand and geographic distance: $PetroChina_{it} \times Dist\_Major_{it}$,$Sinopec_{it} \times Dist\_Major_{it}$, $PetroChina_{it} \times Dist\_Other_{it}$ and $Sinopec_{it} \times Dist\_Other_{it}$.

[2] 92# gasoline price is the price of 92# gasoline, the most frequently used type of gasoline by consumers in China. Other types of gasoline include 89# gasoline, 95# gasoline, etc. The larger the number (Octane Number), the higher the quality of gasoline.

[3] There are irregular changes in ceiling prices due to the change of added-value tax rate (in May 2018) and the change of ton-liter converting coefficient by Inner Mongolia Development and Reform Commissions (in April 2018).

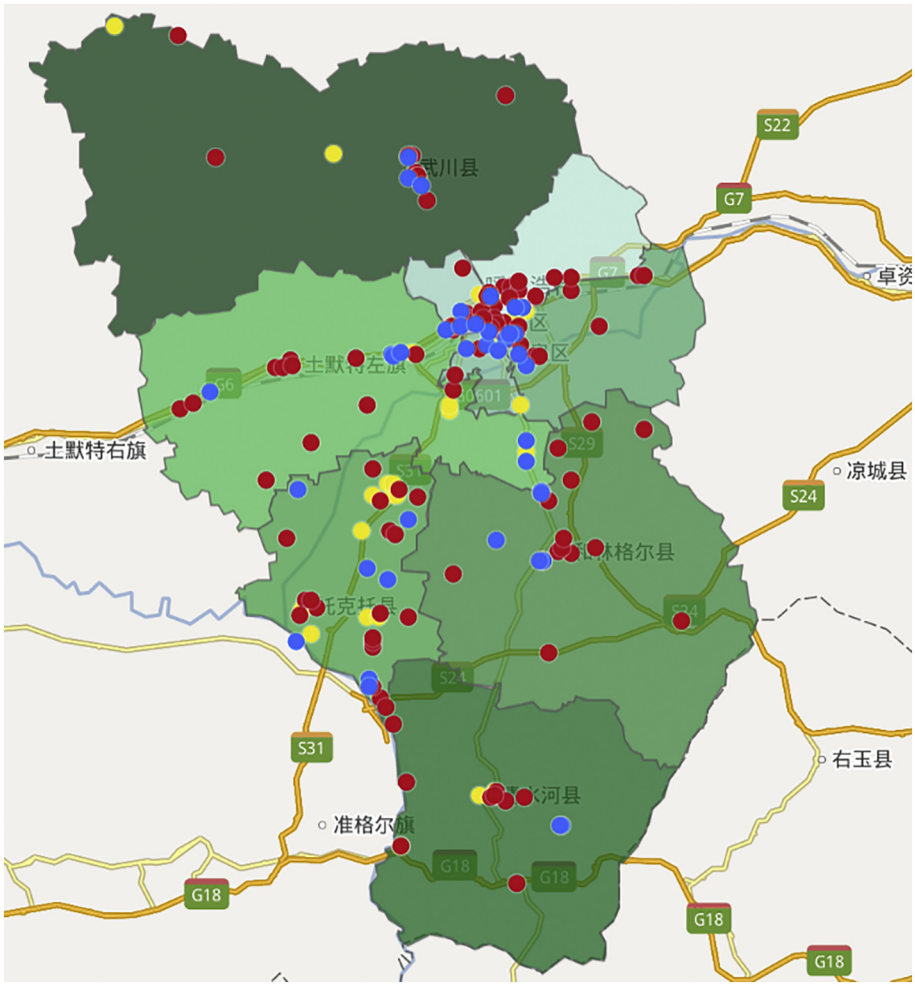

Fig. 1. Spatial distribution of gasoline stations in Hohhot. Note: The red spots are PetroChina stations, the blue spots are Sinopec stations and the yellow spots are other stations.

3.2.5. Station locations

Dummies are constructed to categorize the locations of gas stations into four types: 1) in the city area; 2) on a highway or orbital road; 3) in a county center or on a national/provincial trunk road; 4) on a township road or in the countryside.

3.2.6. Wholesale prices

Wholesale price is usually considered as a proxy of the marginal cost for the gas station in the literature. This study uses the daily volume-weighted average wholesale gasoline prices for each company (brand) to indicate the wholesale prices for their gasoline

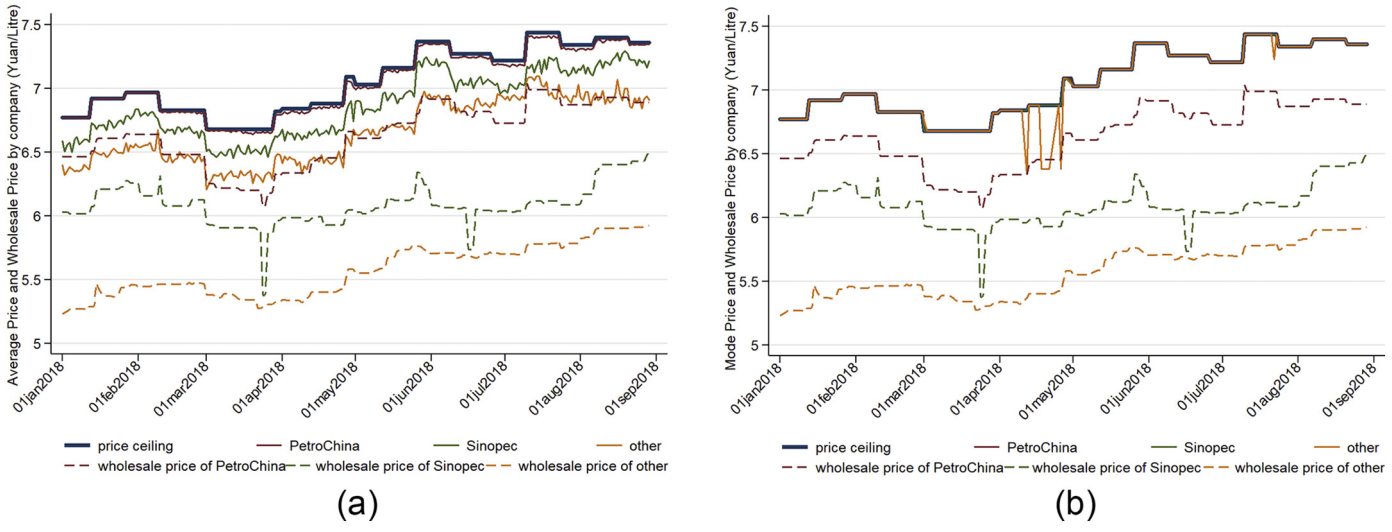

Fig. 2. (a) Price ceilings and daily average prices. (b) Price ceilings and daily mode prices.

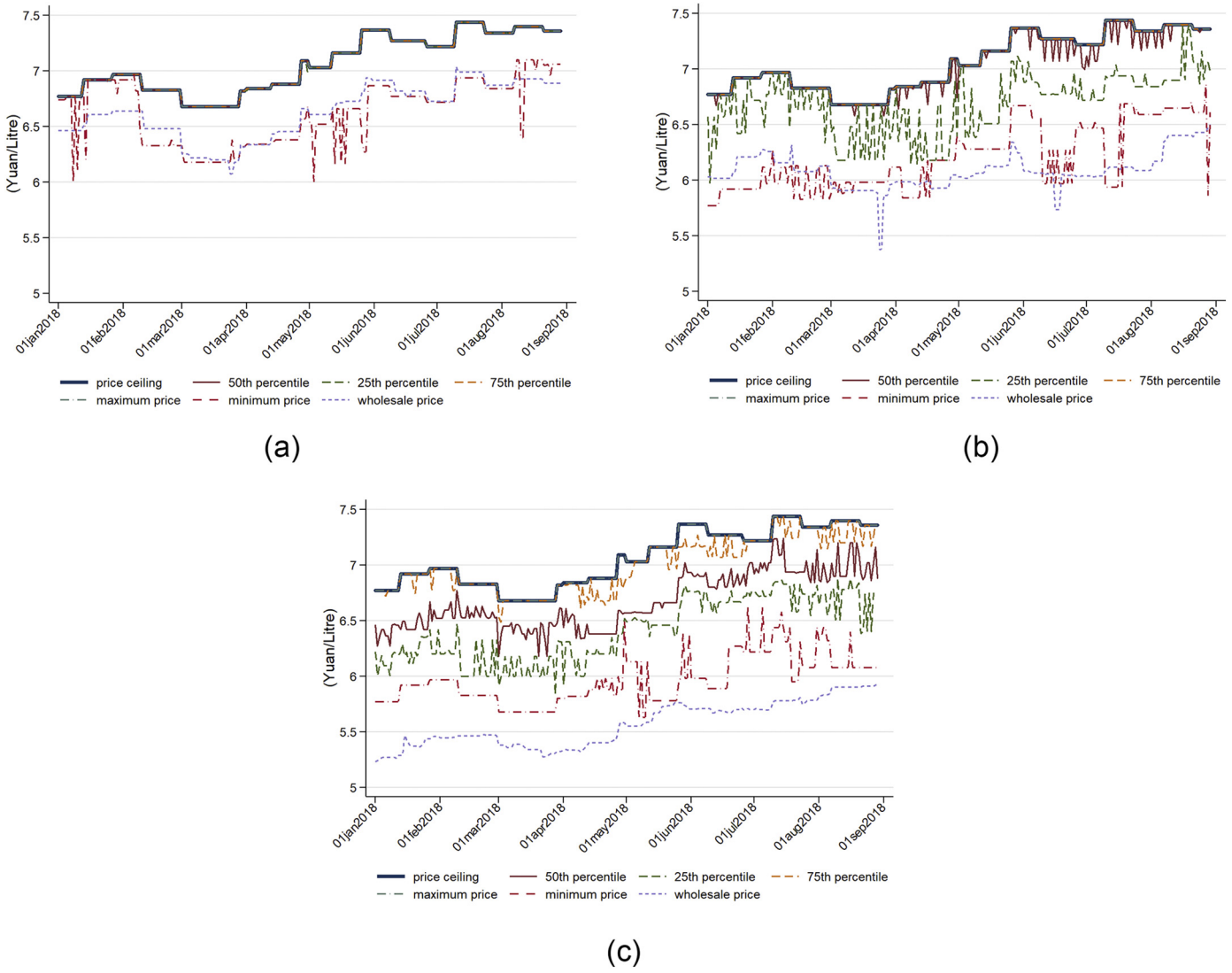

Fig. 3. (a) Price distribution of PetroChina stations. (b) Price distribution of Sinopec stations. (c) Price distribution of other stations.

stations to somehow capture the common trend in matching the price ceilings.

3.2.7. Price ceilings

As mentioned above, the retail oil price in China has been regulated by the government and has been operating under the price ceilings. The National Development and Reform Commission (NDRC) publishes the price ceilings approximately every 2 weeks. Following the NDRC, each provincial Development and Reform Commissions (DRC) will also release their respective price ceilings on their websites. Therefore, this paper derives the price ceiling data from the website of Inner Mongolia DRC.[4]

3.2.8. Changes in price ceilings

To control for the effect of the changes in price ceilings, we construct two variables to indicate how much the price ceiling increases or decreases compared to the previous day, similar to the entire-sample specification in Eckert and West (2005).[5] In particular, we construct two variables, $\Delta price\_ceiling_t^+ = abs(\max\{\Delta price\_ceiling_t, 0\})$ and $\Delta price\_ceiling_t^- = abs(\min\{\Delta price\_ceiling_t, 0\})$, to denote the increase or decrease (in absolute value) in price ceiling on day t compared to the previous day. That is, we would have ($\Delta price\_ceiling_t^+ > 0$, $\Delta price\_ceiling_t^- = 0$) if the price ceiling increases on day t, and ($\Delta price\_ceiling_t^- > 0$, $\Delta price\_ceiling_t^+ = 0$) if the price ceiling decreases on day t. For a large proportion of observations in our data, both variables are equal to zero, which indicates that the price ceiling remains unchanged (compared to the previous day).

3.2.9. Market characteristics

We include the population size (*population*) and per-capita income (*income*) for each of the 9 districts/counties of Hohhot to capture the market characteristics such as market size and consumer preference.

[4] Specifically, we derive the price ceiling data from the website of Inner Mongolia DRC: http://fgw.nmg.gov.cn/. Note that the published price ceilings are only for 89# gasoline and 0# diesel. It is stipulated that multiplying the prices for 89# gasoline by 1.06 would be the price ceilings for 92# gasoline. Besides, the price (ceiling) unit is yuan/ton and the ton-to-liter conversion coefficient for 92# gasoline in Hohhot is 1329.8 before April 2018 and 1325.1 after, according to the documents by Inner Mongolia DRC.

[5] Two dummy variables were added in the entire-sample specification in Eckert and West (2005) to indicate whether the price ceiling increases or decreases compared to the previous day so as to allow for asymmetric responses to increases or decreases in the price ceiling. In this paper, we further allow continuous responses for upward changes and downward changes in the price ceiling. We appreciate an anonymous reviewer for pointing this out and inspiring us to do such an improvement.

The annual measurement of these two variables is obtained from the Inner Mongolia Statistical Yearbook 2018, which is the newest yearbook available while completing this study.

3.2.10. Station capacity

Capacity limits could also affect the outcome of firms' competition. For instance, a station with a small capacity may have limited incentive to undercut its rivals since the demand it faces is constrained by its capacity. To control for the possible effect of capacity on the likelihood of matching the price ceilings, we use variables: one is the number of gasoline (#92) pump guns at the station, $gasgun_{it}$, and the other one is the number of carports (for gas filling) at the station, $carport_{it}$.

3.2.11. Day-of-week effect

We also include the day-of-week dummies to control for the day-of-the-week effect and a holiday dummy to capture the holiday effect. The commuting pattern varies over the whole week and on holidays, which may change the pricing strategies of the gasoline stations. This variations, known as weekend effect and holiday effect, are well documented in the literature.

3.2.12. Past behavior

As in Eckert and West (2005), we construct two variables, $lag1\_ceiling\_share_{it}$ and dur_days_{it}, to measure the pricing inertia and ceiling persistency. $lag1\_ceiling\_share_{it}$ is the proportion of stations in the same district as station i matching the price ceilings 1 day before; and $dur_days_{it}$is the number of days that the current price ceiling has been in effect.

Table 1 below is a descriptive summary of the variables we used in the regression analysis that follows.

4. Focal point effect: a preliminary investigation

From the descriptive analysis in Section 3, we observe a persistent pattern of price uniformity among the gasoline stations in Hohhot city.

Table 1
Summary statistics of variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
pricing_at_ceiling	29,695	0.772	0.420	0	1
PetroChina	29,695	0.645	0.479	0	1
Sinopec	29,695	0.215	0.411	0	1
no_station_near	29,695	0.074	0.261	0	1
Nstations_rival	29,695	1.398	1.639	0	9
Dist_Major	29,695	6.215	7.209	0.000	53.770
Dist_Other	29,695	9.704	9.869	0.213	52.178
location_type1	27,759	0.284	0.451	0	1
location_ type2	27,759	0.186	0.389	0	1
location_ type3	27,759	0.454	0.498	0	1
location_ type4	27,759	0.076	0.265	0	1
wholesale_price	29,603	6.363	0.434	5.23	7.04
price_ceiling	29,695	7.057	0.254	6.68	7.44
$\Delta price\_ceiling^{+}$	29,695	0.005	0.029	0	0.22
$\Delta price\_ceiling^{-}$	29,695	0.003	0.017	0	0.15
gasgun	27,759	3.905	2.696	0	12
carport	27,525	8.180	5.728	0	40
population	29,695	34.241	20.303	11	70.66
income	29,695	27,782.720	11,057.170	16,263	49,080
lag1_ceiling_share	29,568	0.772	0.141	0	1
dur_days	29,695	8.352	5.368	1	28
Sunday	29,695	0.142	0.349	0	1
Monday	29,695	0.142	0.349	0	1
Tuesday	29,695	0.146	0.353	0	1
Wednesday	29,695	0.146	0.353	0	1
Thursday	29,695	0.141	0.348	0	1
Friday	29,695	0.143	0.350	0	1
Saturday	29,695	0.141	0.348	0	1
holiday	29,695	0.058	0.234	0	1

In this section, we take a closer look at the distribution of the price data to investigate the possibility that the observed price uniformity is induced by the government-imposed price ceilings, which act as focal points for stations to coordinate their pricing behavior.

The regulatory purpose of price ceilings is to restrict the pricing behavior by the gasoline stations. However, there is ample empirical evidence showing that the regulated price limits are used as a coordinating device in many industries including gasoline retailing. As the first paper investigating this coordinating hypothesis in the Chinese gasoline market, we attempt to explore the change of the price distribution around the price ceiling induced by the focal point effect.[6] In particular, if the price ceiling is served as a focal point, it will not only truncate the (unobserved) distribution of the optimal prices, but also distort the distribution because the unconstrained optimal prices that are still below the ceiling would "jump" to it.

To implement this idea, we count the number of stations setting prices in the 0.2 yuan interval above the bottom decile on each day, indicated by *Nstations_in_range*. Absent of focal point effect, we should expect no change of the number of stations in this fixed interval as the price distribution moves upwards to the price ceilings. In contrast, if the stations would "jump" to the ceiling at some point, we would expect a decrease in the number in the fixed interval as the price distribution moves towards the ceiling. To indicate the move of the distribution, we first anchor the price distribution using the mean price in the bottom decile of all stations' prices on each day; and then use its distance from price ceiling as the explanatory variable, indicated by *distance_to_ceiling*. In addition, we include, in each regression, the wholesale price, the share of stations matching the price ceiling in the previous day, the lasting period of the current price ceiling and day-of-week effect as control variables. We also run the regressions when using the 0.1 yuan interval instead of the 0.2 yuan interval, and the results are presented in Panel B of Table 2.

It can be seen that in the baseline regressions (where all stations are included), *distance_to_ceiling* is significantly positive (see both Panel A and Panel B in Table 2), indicating that the closer the price distribution moves up towards the ceiling, the fewer stations setting prices in the interval chosen above. This is consistent with the focal-point effect hypothesis. This also holds true for the disaggregated regressions for Sinopec and other stations[7]: when the price distribution moves upwards towards the price ceiling, there are fewer Sinopec and other stations setting their prices in the chosen interval. As for PetroChina stations, we find that the effect is somehow different. The coefficient of *distance_to_ceiling* is significantly negative when choosing the 0.2 yuan interval but positive (though insignificant) when choosing the 0.1 yuan interval instead. A possible explanation for this could be as follows. With the majority of PetroChina stations setting their prices exactly at the price ceilings (as depicted in Fig. 3), there would be few variations in the number of PetroChina stations jumping from the chosen interval above the bottom decile to the ceilings as the price distribution approaches the ceilings.

5. Factors affecting the price uniformity behavior

The analysis in Section 4 provides some evidence consistent with the focal point hypothesis. In this section, we further investigate the factors that affect the price uniformity behavior of gasoline stations. Following the study on price uniformity (as reaching the market mode price) by Eckert and West (2005), we study the probability of a station setting prices at the ceiling via a Profit model.

[6] We thank an anonymous referee for this insightful suggestion.

[7] In the disaggregated regressions for PetroChina, Sinopec and other stations, *Nstations_in_range* is the number of stations affiliated to the corresponding company in the 0.2 yuan interval above the bottom decile of all stations' prices on each day. The variable *distance_to_ceiling* is the same for all regressions, which is the distance between the mean price in the bottom decile of all stations' prices on each day and the price ceiling.

Table 2
Focal point effect: price distribution change as approaching the ceiling[a].

	Main results				Robustness check			
	All	PetroChina	Sinopec	other	All	PetroChina	Sinopec	other
Panel A. Change of the number of stations setting prices in the 0.2 yuan interval above the bottom decile								
distance_to_ceiling	9.719***	−9.231***	10.853***	7.656***	10.687***	−9.212***	11.389***	8.277***
	(2.431)	(1.066)	(1.629)	(1.667)	(3.098)	(1.178)	(1.847)	(1.792)
wholesale_price	−0.078	−0.014	−0.719	−2.012***	4.385***	1.295***	−1.358	0.445
	(1.121)	(0.394)	(0.823)	(0.741)	(1.347)	(0.385)	(0.930)	(0.669)
lag1_ceiling_share	−40.636***	−11.293***	−17.518***	−15.354***				
	(3.392)	(1.580)	(2.150)	(2.528)				
lasting_days	0.012	−0.011	0.021	−0.013	−0.022	−0.015	−0.021	−0.027
	(0.036)	(0.016)	(0.025)	(0.024)	(0.046)	(0.017)	(0.027)	(0.026)
holiday	−1.119	0.253	−1.099**	−0.657	−0.869	0.382	−1.264**	−0.492
	(0.819)	(0.358)	(0.547)	(0.559)	(1.043)	(0.395)	(0.620)	(0.602)
_cons	32.408***	18.096***	11.734**	20.951***	−27.945***	0.671	1.982	−5.043
	(8.625)	(3.440)	(5.416)	(5.734)	(8.925)	(2.681)	(5.992)	(4.111)
Day-of-week effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	239	239	239	234	239	239	239	234
R-squared	0.470	0.402	0.374	0.231	0.135	0.268	0.191	0.104
Panel B. Change of the number of stations setting prices in the 0.1 yuan interval above the bottom decile								
distance_to_ceiling	19.573***	0.857	12.825***	5.572***	20.681***	0.984	13.357***	6.094***
	(2.990)	(0.804)	(1.594)	(1.370)	(3.293)	(0.835)	(1.754)	(1.416)
wholesale_price	0.061	−0.462	−1.386*	−0.064	3.592**	0.252	−2.005**	1.606***
	(1.413)	(0.305)	(0.827)	(0.625)	(1.487)	(0.284)	(0.917)	(0.547)
lag1_ceiling_share	−32.493***	−6.172***	−16.332***	−10.463***				
	(4.269)	(1.219)	(2.154)	(2.126)				
lasting_days	0.112**	0.043***	0.029	0.016	0.083	0.040***	−0.011	0.007
	(0.046)	(0.012)	(0.025)	(0.020)	(0.051)	(0.013)	(0.027)	(0.021)
holiday	−1.250	−0.275	−0.536	−0.769*	−1.157	−0.249	−0.686	−0.688
	(1.001)	(0.269)	(0.533)	(0.458)	(1.092)	(0.276)	(0.580)	(0.469)
_cons	14.446	7.750***	13.087**	6.593	−33.868***	−1.857	4.093	−11.190***
	(10.890)	(2.666)	(5.436)	(4.837)	(9.833)	(1.968)	(5.898)	(3.330)
Day-of-week effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	240	240	240	235	241	241	241	236
R-squared	0.368	0.200	0.401	0.218	0.211	0.112	0.251	0.139

Standard errors in parentheses $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

[a] Note that the number of observations is not equal to the time span of our sample, 241 days, since the bottom decile plus 0.2 yuan would exceed the price ceilings on certain days. Observations in the disaggregated regressions for other stations is always less than observations in the regressions for PetroChina and Sinopec stations and the baseline regressions (where all stations are included), since we lack the wholesale prices for other stations for 5 days.

5.1. Model specification

In particular, we use the dummy variable $pricing\_at\_ceiling_{it}$ mentioned in Section 3.2 as the dependent variable, which indicates whether station i sets price at the ceiling price in period t or not. Therefore, the latent variable and the Probit model can be written as:

$$H^{*}_{it} = X_{it}b + e_{it} \tag{1}$$

$$pricing\_at\_ceiling_{it} = \begin{cases} 1 & \text{if } H^{*}_{it} > 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

where it holds that $e_{it} \mid X_{it} \sim N(0,1)$ and $Cov(e_{it}, e_{js}) = 0$ for $\forall\, i \neq j$ and $\forall\, t \neq s$.

5.2. Empirical results

We use different model specifications to investigate the determinants of reaching price uniformity (at the price ceilings). The estimation results are present below in Table 3. Since the estimated coefficients of Probit model do not have straightforward interpretations, we calculate the marginal effect of variables on the probability that a station will match the price ceiling on a particular day, as we shall see later on.

To analyze the effect of variables on the probability of price matching (uniformity) for different companies, respectively, we first compute the probability for a typical station to match the price ceiling on a particular day. "A typical station" means a station whose continuous variables are set at the sample means (and the price ceiling remains unchanged) in a location of type 3 (in a county center or on a national/provincial trunk road) on Sunday (non-holiday), with the existence of other stations within a radius of 10 km. Table 4 shows the probability of matching the price ceiling when this typical station belongs to different companies, ceteris paribus. It can be seen that a typical station of PetroChina is the most likely to match the price ceiling, with the probability reaching as high as 87.7%, followed by a station of Sinopec, where the probability of matching the price ceiling is 58.9%. This suggests that in Hohhot, stations of Sinopec are less capable of matching the price ceiling than stations of PetroChina, though Sinopec is also a major oil company. An independent station has the lowest probability to match the price ceiling, indicating its inclination to undercut to increase its sales. This implies that compared with independent stations, the stations of major companies (PetroChina and Sinopec) are more motivated to achieve price uniformity (at the price ceilings).

Table 5 presents the marginal effects of variables on the probability of matching the price ceiling for different companies, respectively. We compute this based on model (5) in Table 3. The marginal effects of all variables are calculated with respect to the "typical station" described above. For continuous variables, the derivative of the probability of matching the price ceiling is presented. For dummy variables, the effect of changing the value from zero to one is presented.[8]

It can be seen that the probability of price matching for a station increases significantly when there are no other stations nearby (within a radius of 10 km). This indicates that when a station is the only supplier,

[8] For the variable *no_station_near*, the marginal effect is evaluated with the variable *Nstations_rival* at zero rather than at its mean given that *no_station_near* = 1 simply implies *Nstations_rival* = 0.

Table 3
Estimation results of the Probit model.

Variables	(1)	(2)	(3)	(4)	(5)
	pricing_at_ceiling				
PetroChina	0.568***	0.583***	0.581***	0.646***	1.376***
	(0.110)	(0.112)	(0.112)	(0.112)	(0.118)
Sinopec	0.226***	0.135**	0.134**	0.067	0.376***
	(0.068)	(0.068)	(0.068)	(0.069)	(0.071)
no_station_near	1.151***	1.243***	1.242***	1.312***	1.113***
	(0.116)	(0.123)	(0.123)	(0.121)	(0.121)
Nstations_rival	−0.021**	−0.020**	−0.019**	−0.028***	−0.009
	(0.009)	(0.008)	(0.008)	(0.009)	(0.009)
Dist_Major	−0.381***	−0.369***	−0.369***	−0.378***	−0.338***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.016)
*PetroChina*Dist_Major*	0.391***	0.378***	0.378***	0.383***	0.332***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.016)
*Sinopec*Dist_Major*	0.435***	0.441***	0.442***	0.446***	0.416***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)
Dist_Other	0.056***	0.055***	0.055***	0.056***	0.052***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
*PetroChina*Dist_Other*	−0.069***	−0.067***	−0.068***	−0.071***	−0.058***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
*Sinopec*Dist_Other*	−0.117***	−0.121***	−0.121***	−0.116***	−0.108***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
location_type1	0.646***	0.632***	0.636***	0.683***	0.674***
	(0.035)	(0.042)	(0.042)	(0.042)	(0.043)
location_type2	0.226***	0.193***	0.195***	0.152***	0.183***
	(0.031)	(0.032)	(0.032)	(0.033)	(0.035)
location_type4	0.572***	0.568***	0.569***	0.536***	0.769***
	(0.082)	(0.082)	(0.082)	(0.082)	(0.086)
wholesale_price	1.156***	1.168***	1.176***	1.175***	0.621***
	(0.096)	(0.096)	(0.097)	(0.097)	(0.102)
price_ ceiling	−1.295***	−1.318***	−1.331***	−1.324***	−0.448***
	(0.080)	(0.080)	(0.081)	(0.081)	(0.088)
$\Delta price\_ceiling^{+}$	−0.846**	−0.805**	−0.877**	−0.878**	−1.268***
	(0.352)	(0.354)	(0.364)	(0.364)	(0.379)
$\Delta price\_ceiling^{-}$	0.308	0.249	0.020	0.032	1.169
	(0.648)	(0.657)	(0.683)	(0.683)	(0.773)
gasgun		−0.006	−0.006	−0.017***	−0.012**
		(0.006)	(0.006)	(0.006)	(0.006)
carport		0.025***	0.025***	0.025***	0.035***
		(0.002)	(0.002)	(0.002)	(0.002)
population				0.009***	0.014***
				(0.001)	(0.001)
income				−0.000***	−0.000***
				(0.000)	(0.000)
lag1_ceiling_share					3.103***
					(0.102)
dur_days					0.001
					(0.002)
Monday			−0.071*	−0.071*	−0.038
			(0.039)	(0.039)	(0.041)
Tuesday			−0.019	−0.019	0.111***
			(0.041)	(0.041)	(0.042)
Wednesday			0.131***	0.131***	0.206***
			(0.040)	(0.040)	(0.041)
Thursday			0.129***	0.129***	0.124***
			(0.041)	(0.041)	(0.042)
Friday			−0.074*	−0.074*	−0.103**
			(0.039)	(0.039)	(0.041)
Saturday			0.080*	0.078*	0.180***
			(0.041)	(0.041)	(0.042)
holiday			−0.021	−0.021	0.034
			(0.048)	(0.048)	(0.054)
Constant	2.264***	2.180***	2.201***	2.309***	−2.911***
	(0.296)	(0.299)	(0.306)	(0.308)	(0.372)
Observations	27,674	27,440	27,440	27,440	27,321

Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

i.e., a monopoly in a local market, it is more likely to match the price ceilings. The effect of the two distance variables also turns out to be statistically significant and they are found different for different companies (due to the significance of the interaction terms; see model (5) in Table 3). Specifically, when a PetroChina station is located closer to the stations of its rival companies, it will be more likely to match the price ceilings (which are also the market mode prices). This implies that PetroChina may act as a price leader, actively attempting to reach price coordination with its rival stations nearby, which is consistent with its largest market share (61% of the gas stations in Hohhot) and also indicates its market power (does not necessarily undercut price even when its rival stations are nearby). For a Sinopec station, a 1 km

Table 4
Probability of matching the price ceiling for a typical station of different companies.

	Probability of matching
PetroChina	0.877***
	(0.009)
Sinopec	0.589***
	(0.024)
other	0.035***
	(0.009)

Standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

increase in the distance to the (nearest) station of its rival major (i.e., PetroChina) on average increases its probability of matching the price ceilings by 3.0%, while a 1 km increase in the distance to the (nearest) independent station decreases its probability of price matching by 2.2%. This implies that when a Sinopec station is close to that of a PetroChina (which has the largest market share), it tends to undercut to gain more market share. In contrast, when a Sinopec station is close to an independent station (which is usually owned by small companies), it may still remain the capability to match the price ceilings. For an independent station, being closer to the gas stations of major companies will increase its probability of matching the price ceilings, suggesting that the independent stations are easily influenced by the nearby major companies to reach possible coordination. In contrast, being farther away from the other independent stations will increase an independent station's probability of matching the price ceilings, which indicates the price competition among the independent stations: undercutting for market share when staying close while maintaining high price when being far away from each other. The differentiated marginal effect of distance variables for different companies is consistent with their market share in the market and their capability to match the price ceilings. While PetroChina has the largest market share and actively seeks for potential price coordination, Sinopec submits to competition from PetroChina and independent stations seem to undercut their independent rivals nearby.

Table 5
Marginal effects of variables on the price matching probability of different companies.

	PetroChina	Sinopec	Other
no_station_near	0.109***	0.318***	0.211***
	(0.008)	(0.027)	(0.039)
Nstations_ rival	−0.002	−0.003	−0.001
	(0.002)	(0.004)	(0.001)
Dist_Major	−0.001***	0.030***	−0.026***
	(0.000)	(0.003)	(0.005)
Dist_Other	−0.001***	−0.022***	0.004***
	(0.000)	(0.002)	(0.001)
location_type1	0.089***	0.227***	0.093***
	(0.007)	(0.016)	(0.016)
location_type2	0.033***	0.069***	0.017***
	(0.006)	(0.013)	(0.005)
location_type4	0.096***	0.251***	0.114***
	(0.008)	(0.024)	(0.022)
wholesale_price	0.126***	0.241***	0.048***
	(0.025)	(0.038)	(0.017)
price_ceiling	−0.091***	−0.174***	−0.035***
	(0.020)	(0.033)	(0.013)
$\Delta price\_ceiling^{+}$	−0.258***	−0.493***	−0.099***
	(0.078)	(0.148)	(0.036)
$\Delta price\_ceiling^{-}$	0.237	0.455	0.091
	(0.157)	(0.301)	(0.064)
gasgun	−0.002**	−0.005**	−0.001*
	(0.001)	(0.002)	(0.000)
carport	0.007***	0.014***	0.003***
	(0.001)	(0.001)	(0.001)
population	0.003***	0.006***	0.001***
	(0.000)	(0.000)	(0.000)
income	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)
lag1_ceiling_share	0.630***	1.207***	0.241***
	(0.033)	(0.045)	(0.052)
dur_days	0.000	0.000	0.000
	(0.000)	(0.001)	(0.000)
Monday	−0.008	−0.015	−0.003
	(0.008)	(0.016)	(0.003)
Tuesday	0.021***	0.043***	0.010**
	(0.008)	(0.016)	(0.004)
Wednesday	0.037***	0.078***	0.019***
	(0.008)	(0.016)	(0.005)
Thursday	0.023***	0.048***	0.011**
	(0.008)	(0.016)	(0.004)
Friday	−0.022**	−0.040**	−0.007**
	(0.009)	(0.016)	(0.003)
Saturday	0.033***	0.068***	0.016***
	(0.008)	(0.016)	(0.005)
holiday	0.007	0.013	0.003
	(0.011)	(0.021)	(0.005)

Standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

It can be seen that the location type of gas stations will also affect the probability of matching the price ceilings. Compared to a station in a county center or on a national/provincial trunk road (location type 3, which is chosen as the baseline location type and has the largest number of stations), stations in the city area (location type 1) have a significantly higher probability to match the price ceilings, which might be due to the higher gasoline demand faced by those stations. At the same time, the stations on a township road or in the countryside (location type 4) are also more likely to match the price ceilings due to the inconvenience for their consumers to search. Besides, an increase in the wholesale price would increase the probability of price matching. This is consistent with the argument by Rotemberg and Saloner (1986) and Haltiwanger and Harrington Jr. (1991), which states that when the current cost rises, gains from the possible deviations (from the focal points) would decrease, making price coordination easier to sustain.

As for the effect of price ceiling regulation, the coefficient for price ceilings is significant and negative, suggesting that for a lower price ceiling, stations are more likely to match, i.e., the probability to reach price uniformity would be higher. In particular, the coefficient of $\Delta price\_ceiling_t^{+}$ is significantly negative and the coefficient of $\Delta price\_ceiling_t^{-}$ is positive (but insignificant). This implies that the increase of price ceiling would lower the probability of stations matching the price ceiling, and this effect would be larger if the price ceiling increases more (see Table 5). That is, stations may fail to match the price ceiling immediately when the price ceiling increases, possibly due to the more potential benefits to deviate with a higher price ceiling. This is somehow consistent with the existing literature on other markets that argue that a lower price ceiling may increase firms' probability for price coordination (see, e.g., Knittel and Stango, 2003, for the evidence on the U.S. credit card market). Meanwhile, the decrease of price ceiling would raise the probability of stations matching the price ceiling, though this effect is not significant. This may reflect the asymmetric patterns of stations' pricing strategy when price ceiling increases or decreases. To some extent, we find the evidence of asymmetric pricing behavior when price ceiling increases or decreases on the top of the well-documented asymmetric pricing behavior when cost increases or decreases (Bacon, 1991; Borenstein et al., 1997; Bachmeier and Griffin, 2003; Deltas, 2008; Chesnes, 2016; Polemis and Tsionas, 2017).

Regarding the service capacity, the results show that a station having more carports for gas filling will have a higher probability to set prices at the ceilings, indicating the stations with larger service capacity are more likely to have the market power to match the price ceilings. Moreover, the market characteristics, including local population and income per capita, have significant effect on the price matching probability as well, with a larger population increasing the probability of price matching due to possibly larger market demand, and higher income decreasing the matching probability due to the potentially more informed consumers, though the magnitude of this effect is hardly noticeable.

Past behavior can also affect the current pricing behavior. The larger the share of stations in the same district is observed to match the price ceiling the day before, the higher the probability of price matching today as well. This indicates pricing inertia, which accords with the literature (see, e.g., Eckert and West, 2005). Moreover, the variables for controlling the day-of-week are statistically significant but have varying signs, indicating the possible price cycle within a week and relatively higher prices on Wednesday and Thursday (see, e.g., Byrne and de Roos (2019), for the evidence of price jumps on Wednesday and Thursday).

6. Conclusions and further research

This paper analyzes the pricing behavior in the Chinese retail gasoline market under the price ceiling regulation by the government, using station-level panel data of Hohhot, Inner Mongolia. Our results show that the mode prices of the gasoline stations are consistent with the price ceilings set by the government, i.e., the majority of stations set prices right at the ceilings set by the government. This implies that the price ceiling regulation in Chinese gasoline market may serve as a focal point for the gasoline stations to reach price uniformity. We corroborate the focal point hypothesis by providing evidence showing that some stations would "jump" to the ceilings as their prices approaches the ceilings. Also, we find that local market structure, distance between stations, station capacity, market characteristics, and past pricing behavior will affect the probability of gas stations to match the ceiling prices.

This paper provides the first empirical evidence based on station-level data regarding the price uniformity/matching behavior in the Chinese gasoline retail oil market. Moreover, we find that a lower price ceiling would increase the probability that stations reach price uniformity, which provides another piece of evidence to the literature regarding the unintended effect of price ceiling regulation. While the purpose of this price control is to prevent monopoly extracting excessive consumer surplus (Shajarizadeh and Hollis, 2015), some recent studies suggest that price ceilings could act as "focal points" for tacit collusion which enables firms to set higher prices (see, e.g., Sen et al., 2011). Our results confirm that the price ceilings set by the government could serve as "focal points" for a retail gasoline market to reach price uniformity, which may potentially increase the prices. At the same time, one can also see the effect of market competition among different stations, which would affect the probabilities for some stations to reach this price uniformity.

This paper focuses on uncovering the pricing patterns that we observed in the Chinese retail gasoline market, which suggests the important role of price ceilings in reaching price uniformity (through, e.g., the potential collusive/coordination behavior). However, we did not make an analysis regarding how the potential coordination among stations forms. A direction for further research would be to investigate how the potential coordination is initiated and arranged among stations, which is of great significance and help for policy makers in the retail oil market in China. We also plan to pursue the continuous modelling framework in our future research for a better understanding of the pricing strategies in the Chinese retail gasoline market, in addition to the current discrete choice framework focusing on the price-ceiling matching behavior.

Acknowledgements

The authors gratefully thank two anonymous referees and the editor Prof. Bachmeier for their helpful comments and suggestions on the preliminary draft of this paper, according to which the content was improved. The authors also would like to thank the inspiring comments from Xinye Zheng and the seminar participants at the School of Applied Economics, Renmin University of China for their helpful discussions and comments on this paper. All errors and omissions remain the sole responsibility of the authors. Financial support from the National Natural Science Foundation of China (No. 71603267 to Xiao-Bing Zhang) is gratefully acknowledged. Ying Zheng is grateful for the financial support from Fundamental Research Funds for the Central Universities, and the Research Funds of Renmin University of China (19XNF013).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eneco.2020.104950.

References

Andreoli-Versbach, P., Franck, J., 2015. Econometric evidence to target tacit collusion in oligopolistic markets. J. Compet. Law Econ. 11 (2), 463–492.
Bachmeier, L., Griffin, J., 2003. New evidence on asymmetric gasoline price responses. Rev. Econ. Stat. 85 (3), 772–776.
Bacon, R.W., 1991. Rockets and feathers: the asymmetric speed of adjustment of UK retail gasoline prices to cost changes. Energy Econ. 13 (3), 211–218.
Barron, J.M., Umbeck, J.R., 1984. The effects of different contractual arrangements: the case of retail gasoline markets. J. Law Econ. 27 (2), 313–323.
Binmore, K., Samuelson, L., 2006. The evolution of focal points. Games Econ. Behav. 55 (1), 21–42.
Blass, A.A., Carlton, D.W., 2001. The choice of organizational form in gasoline retailing and the cost of laws that limit that choice. J. Law Econ. 44 (2), 511–524.
Borenstein, S., 1991. Selling costs and switching costs: explaining retail gasoline margins. RAND J. Econ. 22 (3), 354–369.
Borenstein, S., Shepard, A., 1996. Dynamic pricing in retail gasoline markets. RAND J. Econ. 27 (3), 429–451.
Borenstein, S., Cameron, A.C., Gilbert, R., 1997. Do gasoline prices respond asymmetrically to crude oil price changes? Q. J. Econ. 112 (1), 305–339.
Byrne, D.P., de Roos, N., 2019. Learning to coordinate: a study in retail gasoline. Am. Econ. Rev. 109 (2), 591–619.
Carranza, J.E., Clark, R., Houde, J.-F., 2015. Price controls and market structure: evidence from gasoline retail markets. J. Ind. Econ. 63 (1), 152–198.
Chesnes, M., 2016. Asymmetric pass-through in U.S. gasoline prices. Energy J. 37 (1), 153–180.
Christie, W.G., Schultz, P.H., 1994. Why do NASDAQ market makers avoid odd-eight quotes? J. Financ. 49 (5), 1813–1840.
Clark, R., Houde, J.-F., 2013. Collusion with asymmetric retailers: evidence from a gasoline price-fixing case. Am. Econ. J. Microecon. 5 (3), 97–123.
Deltas, G., 2008. Retail gasoline price dynamics and local market power. J. Ind. Econ. 56 (3), 613–628.
Deng, H., Ma, A.C., 2010. Market structure and pricing strategy of china's automobile industry. J. Ind. Econ. 58 (4), 818–845.
Eckert, A., West, D.S., 2005. Price uniformity and competition in a retail gasoline market. J. Econ. Behav. Organ. 56 (2), 219–237.
Foros, Ø., Steen, F., 2013. Vertical control and price cycles in gasoline retailing. Scand. J. Econ. 115 (3), 640–661.
Genakos, C., Koutroumpis, P., Pagliero, M., 2014. The Impact of Maximum Markup Regulation on Prices. Carlo Alberto Notebooks.
Haltiwanger, J., Harrington Jr., J.E., 1991. The impact of cyclical demand movements on collusive behavior. RAND J. Econ. 22 (1), 89–106.
Hu, W.-M., Xiao, J., Zhou, X., 2014. Collusion or competition? Interfirm relationships in the chinese auto industry. J. Ind. Econ. 62 (1), 1–40.
Huang, T., 2018. On the pricing mechanism reform and market behavior in China. Mod. Econ. Inf. 8, 357 (in Chinese).
Knittel, C.R., Stango, V., 2003. Price ceilings as focal points for tacit collusion: evidence from credit cards. Am. Econ. Rev. 93 (05), 1703–1729.
Lewis, M.S., 2012. Price leadership and coordination in retail gasoline markets with price cycles. Int. J. Ind. Organ. 30 (2012), 342–351.
Ma, H., Oxley, L., 2012. The emergence and evolution of regional convergence clusters in China's energy markets. Energy Econ. 34 (1), 82–94.
Ma, H., Oxley, L., Gibson, J., 2009. Gradual reforms and the emergence of energy market in China: evidence from tests for convergence of energy prices. Energy Policy 37 (11), 4834–4850.
Polemis, M.L., Tsionas, M.G., 2017. Asymmetric price adjustment in the US gasoline industry: evidence from Bayesian threshold dynamic panel data models. Int. J. Econ. Bus. 24 (1), 91–128.
Rotemberg, J.J., Saloner, G., 1986. A Supergame-theoretic model of price wars during booms. Am. Econ. Rev. 76 (3), 390–407.
Schelling, T.C., 1960. The Strategy of Conflict. Harvard University Press, Cambridge, MA.
Schelling, T.C., 1980. The intimate contest for self-command. Public Interest 60, 94–118.
Scherer, F.M., Ross, D., 1990. Industrial Market Structure and Economic Performance. third ed. Houghton Mifflin, Boston.
Sen, A., Clemente, A., Jonker, L., 2011. Retail gasoline price ceilings and regulatory capture: evidence from Canada. Am. Law Econ. Rev. 13 (2), 532–564.
Shajarizadeh, A., Hollis, A., 2015. Price-cap regulation, uncertainty and the price evolution of new pharmaceuticals. Health Econ. 24 (8), 966.

Shy, O., 2014. Measuring some effects of the 2011 debit card interchange fee reform. Contemp. Econ. Policy 32 (4), 769–783.
Slade, M.E., 1987. Interfirm rivalry in a repeated game: an empirical test of tacit collusion. J. Ind. Econ. 35 (4) The Empirical Renaissance in Industrial Economics, 499–516.
Slade, M.E., 1992. Vancouver's gasoline-price wars: an empirical exercise in uncovering supergame. Rev. Econ. Stud. 59 (2), 257–276.
Verlinda, J.A., 2008. Do rockets rise faster and feathers fall slower in an atmosphere of local market power? Evidence from the retail gasoline market. J. Ind. Econ. 56 (3), 581–612.
Zhang, W., 2014. Research on Pricing in Concert under the Monopoly and Regulation of China's Market of Refined Oil. Zhejiang Sci-Tech University (in Chinese).
Zhang, X., Peng, X., 2018. Empirical study on influencing factors of oil product prices in China based on a VAR model. J. China Univ. Pet. (Ed. Soc. Sci.) 34 (2), 22–30 (in Chinese).
Zhang, Y., Round, D.K., 2011. Price wars and price collusion in China's airline markets. Int. J. Ind. Organ. 29 (4), 361–372.