

# Changing Market Structure and Evolving Ways to Compete: Evidence from Retail Gasoline

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# Process innovation: from full service to self service



<https://365v.co.kr/article/1481865330356/22000000>



<http://www.ekn.kr/news/article.html?no=326856>



<http://blog.naver.com/PostView.nhn?blogId=pmh0318&logNo=220969572024>



[http://www.ichannela.com/news/main/news\\_detailPage.do?publishId=000000067006](http://www.ichannela.com/news/main/news_detailPage.do?publishId=000000067006)

# Why gasoline market?

Nice to:

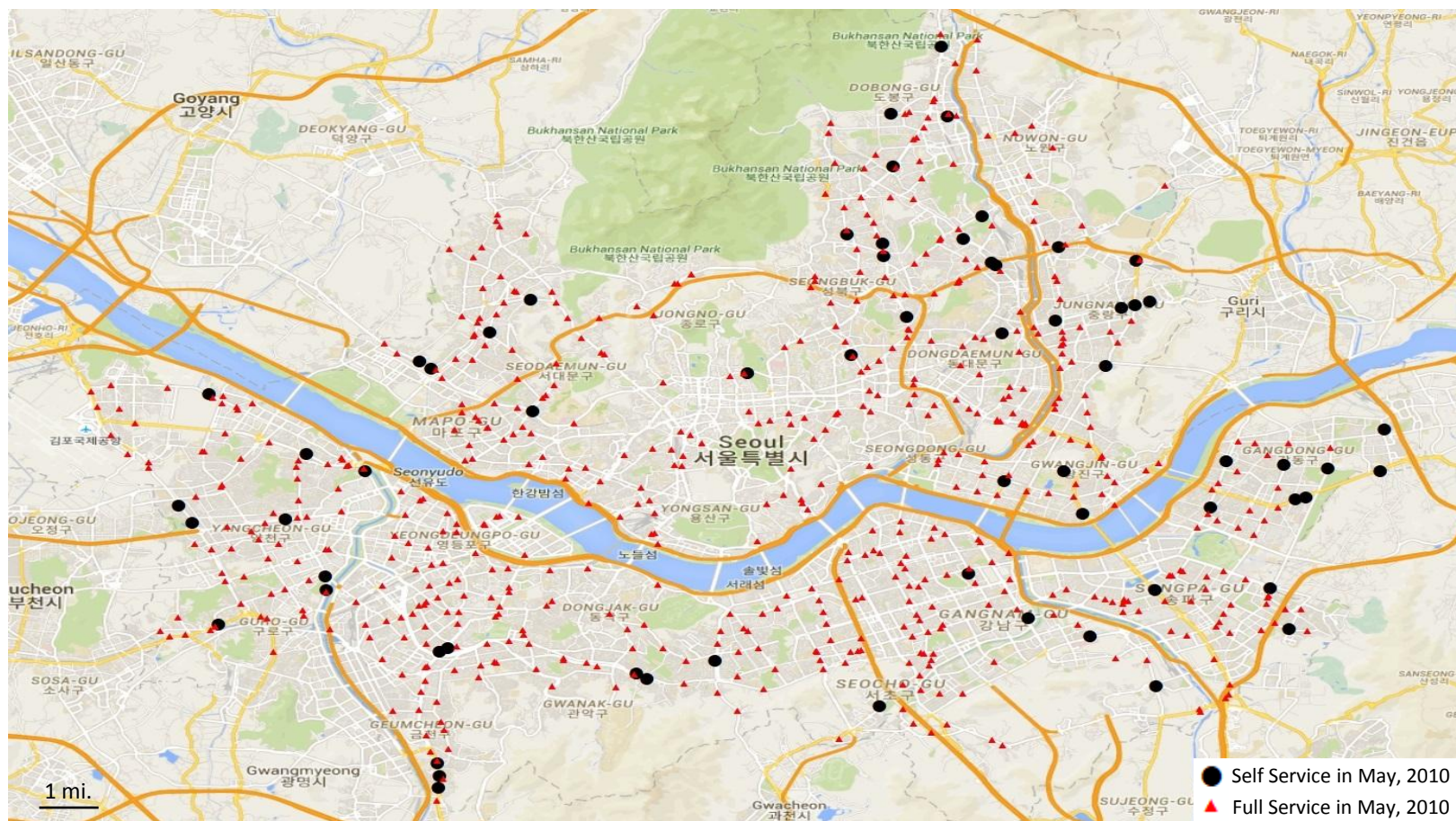
- observe the pricing behavior of sellers by product level
- examine the effect of an innovation of self-service technology on price



<http://bundling.tistory.com/84>



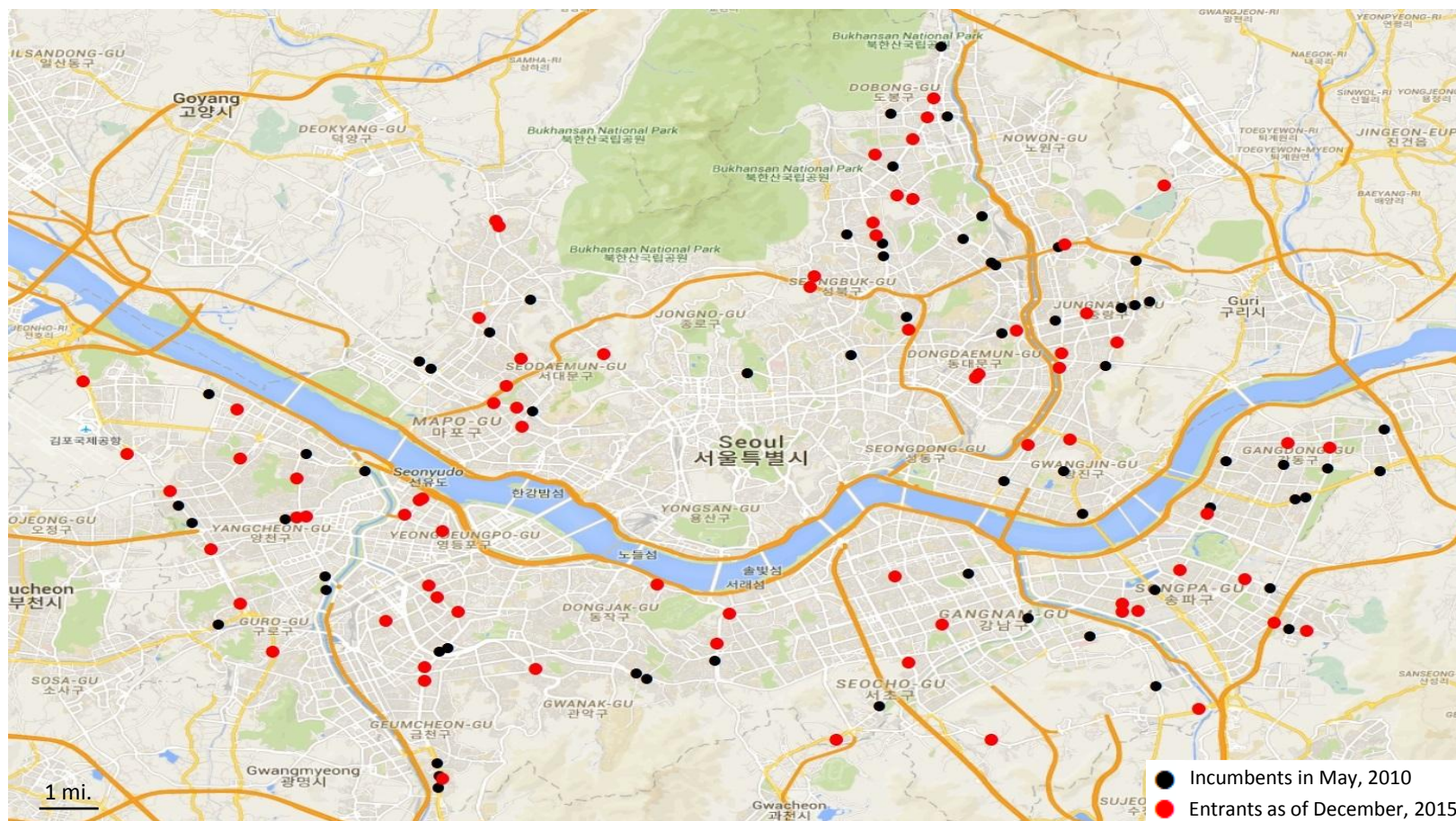
# Research motivation: Market transition



Location of Gasoline Stations in Seoul

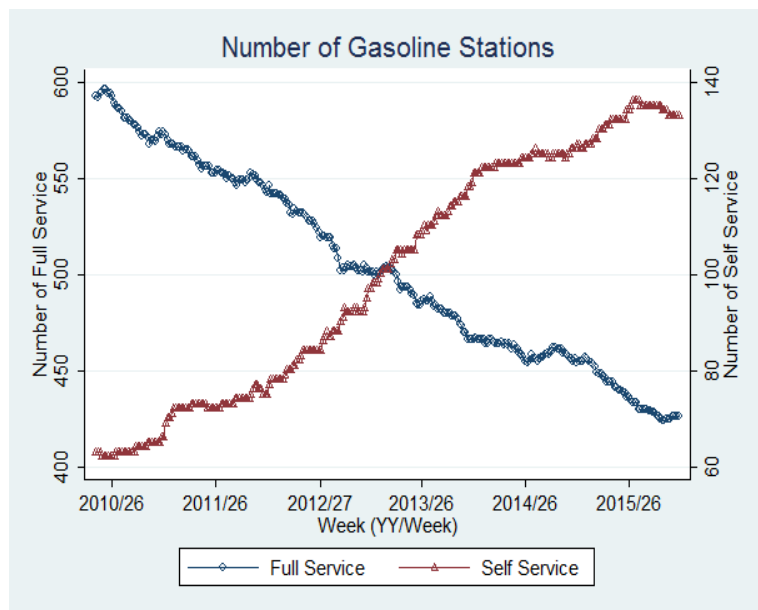


# Research motivation: Market transition

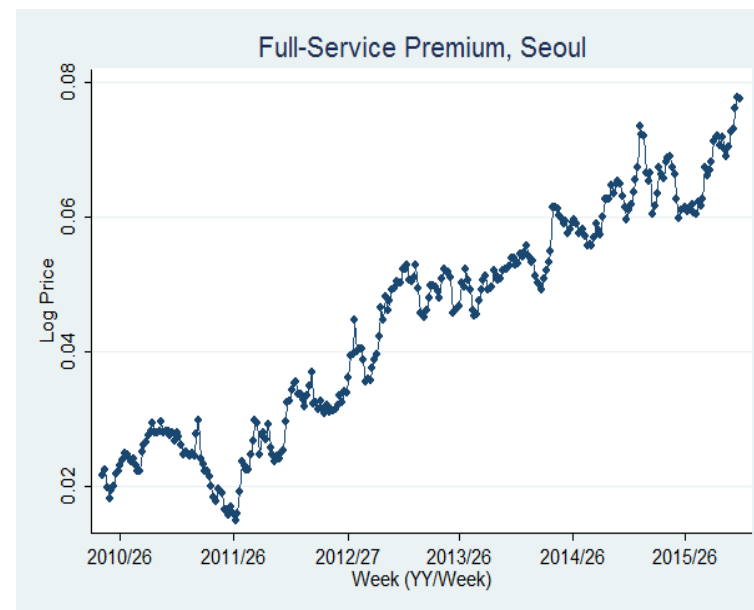


Expansion of Self-Service Stations in Seoul

# Stylized fact: the evolution of full-service premium



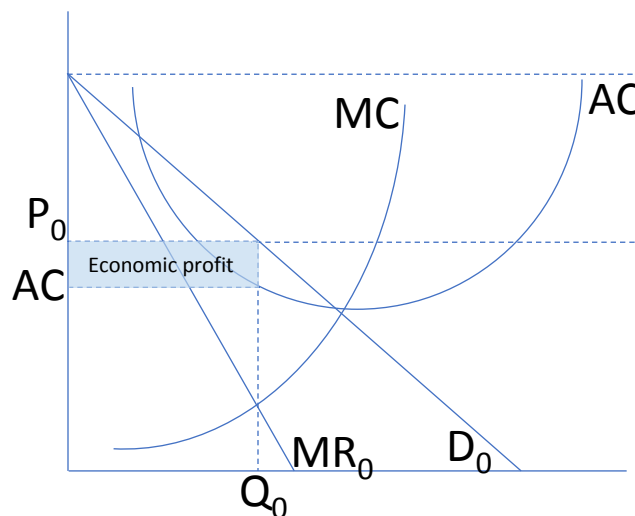
The Change in the Number of Stations



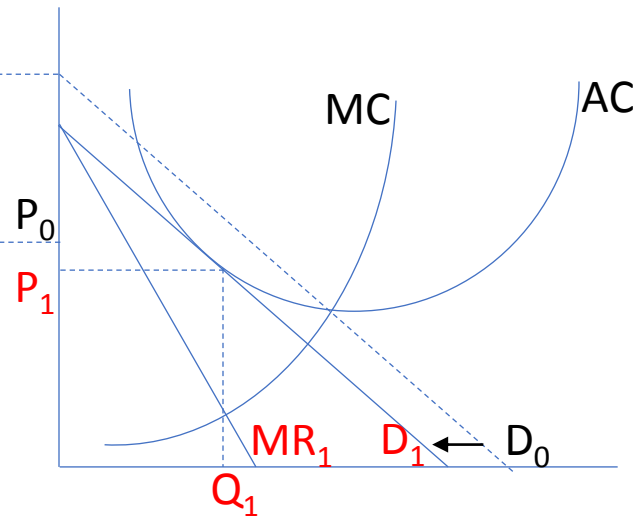
The Increasing Full-Service Premium

# Research question

- Why does the price gap increase during the transition?
  - OBVIOUS if the F-S vs. S-S markets are sufficiently segmented
- Insight from general models of monopolistic competition
  - Positive profit gives another competitor an incentive to enter (i.e., self-serve market)
  - The entry **shifts** incumbent's residual demand to **the left** → **price falls**



<Incumbent: before competitor's entry>



<Incumbent: after competitor's entry>

# Preview of findings

- 1) Competition story alone isn't enough to explain the gap
  - Not OBVIOUS: the markets are not segmented during the transition
  - based on difference-in-difference estimation
  
- 2) Confirmation of competitive effects on prices
  - (direct effect) self-service sellers offer lower price
  - (indirect effect) self-service sellers fall their nearby competitors
  - No significant effect of full-service sellers on prices
  
- 3) Evidence on competition through product differentiation
  - a higher premium to consumers who buy a bundle of gas and services
  - descriptive evidence on product differentiation and supplementary analyses



# Data

- Overview

- Daily station-level data from May 2010 to December 2015, from OPINET
  - ✓ *Wednesday* only (but the loss of the information is minimal)
- Transactions data, automatically uploaded at OPINET
- Station characteristics: brand, service, multiproduct, location
- Information on stations' promotion & price, collected on May 2017

- Notes

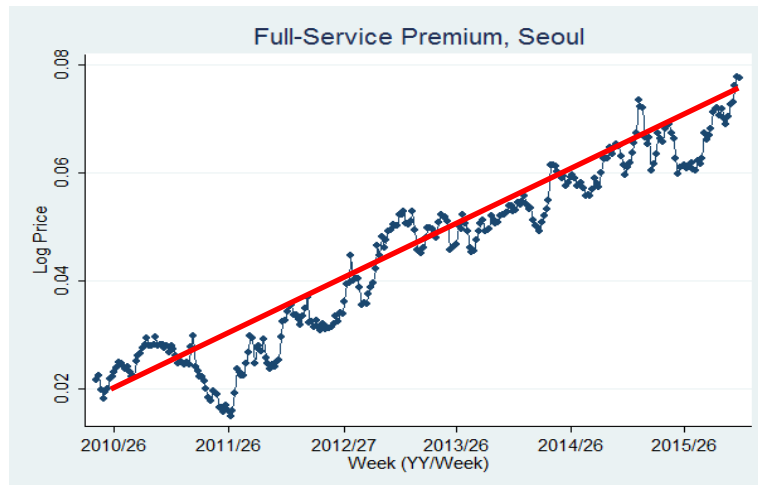
- Inferred information on entry/exit from the price-reporting regulation
- Two measures of competitive conditions: numbers & distances

	Mean	SD	Min	Max	Mean	SD	Min	Max
<b>Number of</b>	<b>Full-Service Competitors</b>				<b>Self-Service Competitors</b>			
Within 0.5 mile (#)	1.98	1.54	0.00	10.0	0.41	0.67	0.00	4.0
Within 1.0 mile (#)	7.15	3.44	0.00	21.0	1.33	1.32	0.00	7.0
<b>Distance to</b>	<b>Full-Service Competitors</b>				<b>Self-Service Competitors</b>			
1st nearest (mi)	0.32	0.22	0.01	2.70	0.89	0.63	0.02	3.50
2nd nearest (mi)	0.50	0.24	0.03	2.71	1.31	0.70	0.12	4.12

# Empirical strategy

is to find economic variables making  $\phi$  insignificant

- Static concept explanation when assuming segmented market
  - Increase in # S-S stations  $\rightarrow$  High competition between S-S
  - Decrease in # F-S stations  $\rightarrow$  Low competition between F-S
  - $\rightarrow$  It predicts an increasing price gap between F-S and S-S
- Identify the increasing price gap b/w F-S vs. S-S
  - $\ln P_{it} = \theta \text{Full}_{it} + \phi (\text{Full}_{it} * \text{Trend}_t) + \mu_t + \varepsilon_{it}$  where  $\text{Trend} \in (0,1]$



	Baseline
Full	0.0168*** (0.004)
Full*Trend	0.0550*** (0.006)
Time FE	Y
Observations	175940

# Empirical strategy

- Hypothesis #1: station characteristics with systematical correlation

- $\ln P_{it} = \zeta X_{it} + \delta_i + \theta \text{Full}_{it} + \phi(\text{Full}_{it} * \text{Trend}_t) + \mu_t + \varepsilon_{it}$

- $X$ : covariates including brands, brand share, multiproduct.

- Hypothesis #2: competition story (two competition measures)

- $\ln P_{it} = \beta_1 \text{Num}_{it}^{SS} + \beta_2 (\text{Num}_{it}^{SS} * \text{Full}_{it}) + \beta_3 \text{Num}_{it}^{FS} + \beta_4 (\text{Num}_{it}^{FS} * \text{Full}_{it})$   
 $+ \zeta X_{it} + \delta_i + \theta \text{Full}_{it} + \phi(\text{Full}_{it} * \text{Trend}_t) + \mu_t + \varepsilon_{it}$

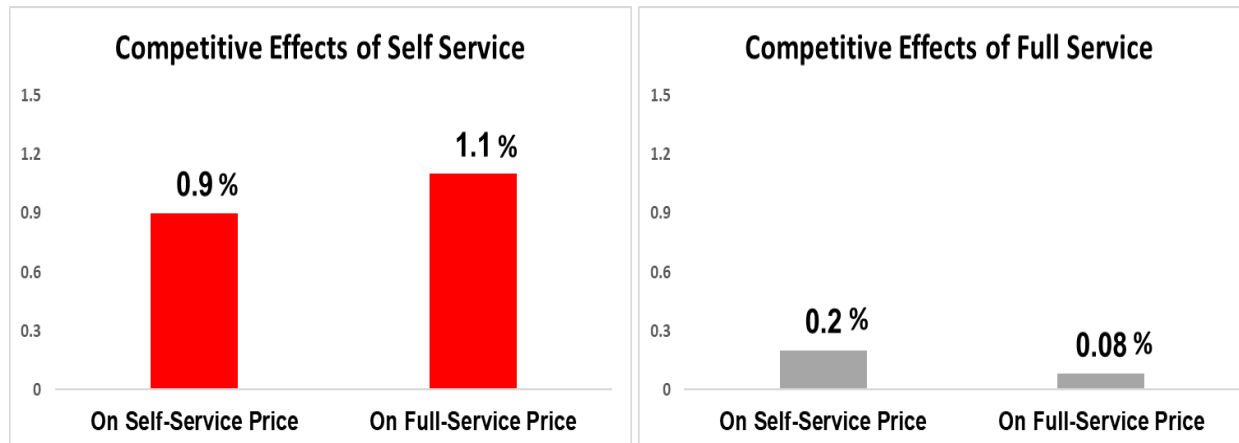
- $\ln P_{it} = \beta_1 \ln \text{Dist}_{it}^{SS} + \beta_2 (\ln \text{Dist}_{it}^{SS} * \text{Full}_{it}) + \beta_3 \ln \text{Dist}_{it}^{FS} + \beta_4 (\ln \text{Dist}_{it}^{FS} * \text{Full}_{it})$   
 $+ \zeta X_{it} + \delta_i + \theta \text{Full}_{it} + \phi(\text{Full}_{it} * \text{Trend}_t) + \mu_t + \varepsilon_{it}$

# Result #1: competition story doesn't explain well

	Baseline	Controls Included	Nums included	Distances Included
Full	0.0168*** (0.004)	0.0196*** (0.006)	0.0231** (0.010)	0.0168* (0.010)
Full*Trend	0.0550*** (0.006)	0.0477*** (0.006)	0.0486*** (0.006)	0.0495*** (0.006)
Station FE	N	Y	Y	Y
Controls	N	Y	Y	Y
Observations	175940	175940	175940	175940

Robust standard errors in parentheses, clustered by station

- Competitive effects: when the distance to nearby competitors doubles

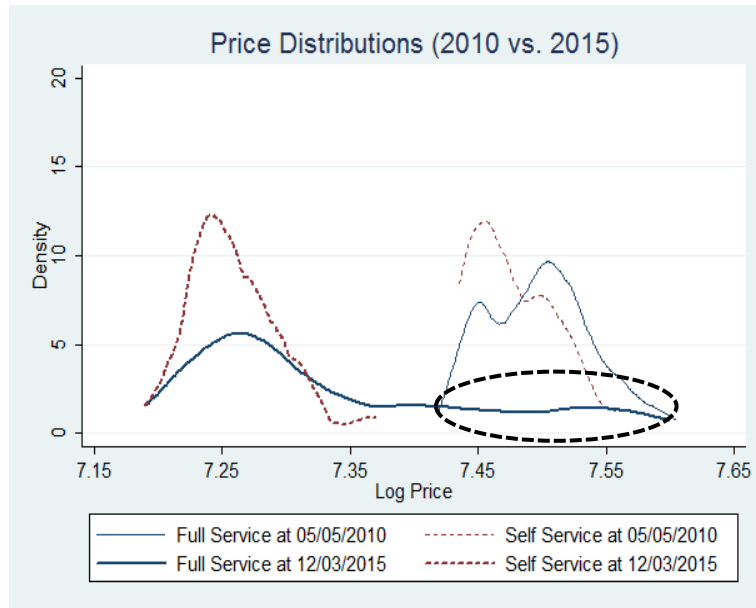


Red: significance at the 1% level & Grey: insignificance at the 10% level

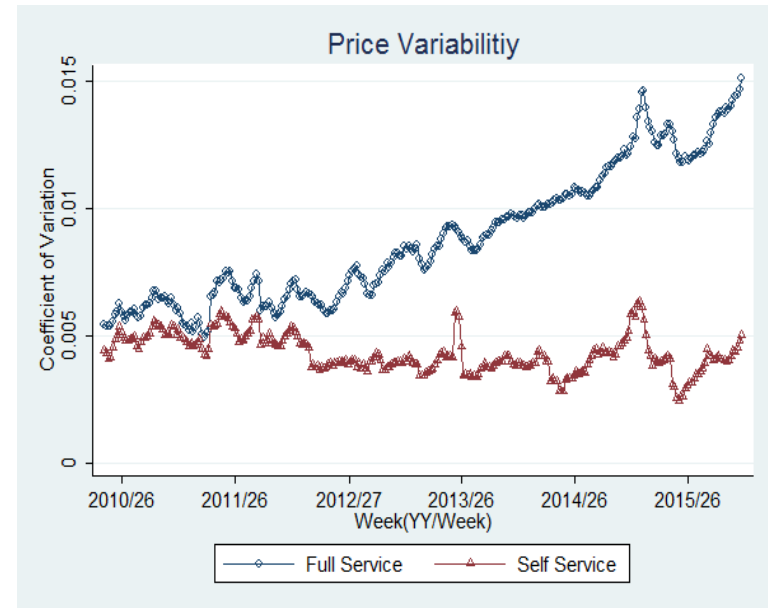


# Stylized fact: the evolution of full-service premium

- Take a closer look at the increasing full-service premium



Price distributions on 2010 vs. 2015



Time Series of Coefficient of Variation

# Result #2: product differentiation and its softening effect

- In which theory a seller charges a higher premium?
- Product differentiation and its softening effect on competition
  - Mazzeo (2002, RESTAT), motel industry
  - Basker & Noel (2009, JEMS) and Matsa (2011, QJE), supermarket
- Search friction and its softening effect on competition
  - Sorensen (2000, JPE) and Ching (2010, IJIO), pharmaceutical market
  - Lewis (2011, IJIO) and Kim (2018, RIO), retail gasoline
  - Ellison and Ellison (2009, Econometrica), online shopping

# Result #2: product differentiation and its softening effect



(a)



(b)



(c)



(d)

# Result #2: product differentiation and its softening effect

- Provide “free” bundled offers (collected on May 17, 2017)

	# Full Service	# Self Service
Reward points	29	4
Carwash	9	3
Carwash & Coffee	1	0
Carwash & Coffee & Washer fluid	1	0
Coffee or Tea	3	1
Coffee & Washer fluid	1	0
Coffee & Facial tissue	2	0
A bottle of water	3	0
Facial tissue	1	1
A bottle of water or Facial tissue	1	1
Car Inspection	2	0
Service for Diplomatic vehicle	1	0
Coffee, Soda, Noodle, Copy/Fax, Lounge	0	1
<b>Total #: 539 stations</b>	<b>55/392 (14%)</b>	<b>11/147 (7%)</b>

May 17, 2017	Full Service		Self Service	
	# Stations	Avg. Log Price	# Stations	Avg. Log Price
Bundled	55	7.444	11	7.321
Not Bundled	337	7.360	136	7.298
<b>Difference</b>		<b>0.085</b>		<b>0.023</b>
P-value		<b>(0.000)</b>		<b>(0.073)</b>
All	392	7.372	147	7.300
<b>Difference</b>		<b>0.072</b>	<b>← full-service premium</b>	
P-value		<b>(0.000)</b>		

**bundling premium** →



# Result #2: product differentiation and its softening effect

- Supplement descriptive evidence using my price panel
- Identify stations in my sample that provide
  1. bundled products in 2017
  2. not bundled products in 2017

May 05, 2010	Full Service		Self Service	
	# Stations	Avg. Log Price	# Stations	Avg. Log Price
Bundled in 2017	48	7.514	2	7.503
Not bundled in 2017	290	7.499	50	7.475
<b>Difference</b>		<b>little →</b> 0.015		0.028
P-value		(0.011)		(0.268)
All	338	7.501	52	7.476
<b>Difference</b>				0.025
P-value				(0.000)

**full-service premium**

Dec 16, 2015	Full Service		Self Service	
	# Stations	Avg. Log Price	# Stations	Avg. Log Price
Bundled in 2017	55	7.407	7	7.282
Not bundled in 2017	332	7.326	115	7.258
<b>Difference</b>		<b>significant →</b> 0.081		0.023
P-value		(0.000)		(0.156)
All	387	7.338	122	7.259
<b>Difference</b>				0.078
P-value				(0.000)

**full-service premium**

# Result #2: product differentiation and its softening effect

- Supplement the descriptive evidence, using **price data**
- Examine the stability of price rankings
  - Search models
    - ✓ Uninformed consumers and price dispersion for one homogenous good
  - Insight from models of search
    - ✓ Customers search for a low price, so sellers' relative prices change from one time to the next
  - **Hypothesis**
    - ✓ Sellers' relative prices should go up and down if a product of sellers is homogenous (holding other station characteristics constant)
- Create price rankings for each week and calculate transition probabilities

# Result #2: product differentiation and its softening effect

Price Octile Transition Matrix, from one week to the next

		T+1								Total	
		1	2	3	4	5	6	7	8		
T	Lowest 12.5%	1	77.35	20.03	2.14	0.35	0.09	0.04	0.00	0.00	100.0
		2	18.32	59.12	20.58	1.69	0.21	0.07	0.00	0.02	100.0
		3	2.73	18.19	59.71	18.25	0.97	0.11	0.02	0.01	100.0
		4	0.67	2.38	15.30	66.23	14.92	0.45	0.04	0.01	100.0
		5	0.28	0.43	1.74	12.83	73.93	10.56	0.20	0.03	100.0
		6	0.15	0.13	0.20	0.68	9.37	81.04	8.37	0.07	100.0
		7	0.04	0.06	0.08	0.17	0.37	7.43	86.53	5.35	100.0
		Highest 12.5 %	8	0.06	0.05	0.05	0.05	0.07	0.28	4.87	94.58
Total			12.37	12.56	12.48	12.56	12.46	12.45	12.52	12.60	100.0

# Result #2: product differentiation and its softening effect

Price Octile Transition Matrix, from one week to the next

		T+1								Total	
		1	2	3	4	5	6	7	8		
T	Lowest 12.5%	1	77.35	20.03	2.14	0.35	0.09	0.04	0.00	0.00	100.0
		2	18.32	<b>59.12</b>	20.58	1.69	0.21	0.07	0.00	0.02	100.0
		3	2.73	18.19	<b>59.71</b>	18.25	0.97	0.11	0.02	0.01	100.0
		4	0.67	2.38	15.30	<b>66.23</b>	14.92	0.45	0.04	0.01	100.0
		5	0.28	0.43	1.74	12.83	<b>73.93</b>	10.56	0.20	0.03	100.0
		6	0.15	0.13	0.20	0.68	9.37	<b>81.04</b>	8.37	0.07	100.0
		7	0.04	0.06	0.08	0.17	0.37	7.43	<b>86.53</b>	5.35	100.0
		Highest 12.5 %	8	0.06	0.05	0.05	0.05	0.07	0.28	4.87	<b>94.58</b>
Total			12.37	12.56	12.48	12.56	12.46	12.45	12.52	12.60	100.0

✓ Relative prices are more stables for higher-priced stations



# Result #2: product differentiation and its softening effect

- Ranking stability test:

$$\text{Stable}_{it} = \beta \text{Octile}_{it-1} + \theta \text{Full}_{it} + \gamma \mathbf{X}_{it} + \delta_i + \mu_t + \varepsilon_{it}$$

$$\text{where stable} = \begin{cases} 1 & \text{if Octile}_{it-1} = \text{Octile}_{it}; \\ 0 & \text{if Octile}_{it-1} \neq \text{Octile}_{it}. \end{cases}$$

	Baseline	By Service
Octile	<b>0.0296***</b> <b>(0.002)</b>	0.0092* (0.005)
Octile*Full		<b>0.0251***</b> <b>(0.006)</b>
Full	0.0433*** (0.016)	-0.0390*** (0.023)
Num <sup>SS</sup>	-0.0000 (0.004)	0.0003 (0.004)
Num <sup>FS</sup>	0.0095*** (0.0023)	0.0104*** (0.0023)
Station and Time FE	Yes	Yes
Observations	174648	174648
% predicted outside [0, 1 ]	2%	3%

# Conclusion

- By service level, different strategic choices are chosen:
  - F-S stations increasingly differentiate their product to compete for less-price-sensitive consumers
  - S-S stations decreases their local competitors' price and compete for price-sensitive consumers

- We do not know what this market will look like in the future

*“기름을 넣는곳 → 기름도(!) 넣는곳”*

택배 받고 자동결제까지... 융합 서비스 다각화 ‘스마트스테이션’

수소, 전기, 휘발유, 경유, LPG 연료를 한 곳에서 채울 수 있는 ‘복합에너지스테이션’

***“There’s a shift in people buying gas based on the quality of the sandwich as opposed to getting a sandwich based on the price of gas,”***

- Vice President for NACS in Bloomberg interview (Aug 18, 2017)

\*NACS: National Association of Convenience Stores in US

감사합니다

# Appendix: summary statistics

Variable	Description	Mean	SD	Min	Max
P	Price of gasoline (unit: KRW/liter)	1904.7	206.7	1317	2490
lnP	Log price of gasoline	7.54	0.11	7.18	7.82
Full	Station offering full-serve gasoline	0.83	0.37	0	1
SK	Station brand: SK Energy	0.36	0.48	0	1
GS	Station brand: GS Caltex	0.25	0.43	0	1
SO	Station brand: S-Oil	0.11	0.31	0	1
HD	Station brand: Hyundai Oilbank	0.12	0.33	0	1
AD	Station brand: Alddle	0.02	0.13	0	1
Unbranded	Station brand: Unbranded	0.03	0.17	0	1
Brand Share	Share of same-brand stations within 1.5 miles	0.27	0.16	0	1
Multi	Station selling regular and premium gasoline	0.33	0.47	0	1
Store <sup>a</sup>	Station having a convenience store	0.09	0.28	0	1
Carwash <sup>a</sup>	Station having an automatic carwash equipment	0.67	0.46	0	1
Repair <sup>a</sup>	Station having a auto-repair facility	0.26	0.44	0	1
Income <sup>b</sup>	Household monthly income (unit: KRW million)	3.69	0.43	2.72	4.49
Car <sup>b</sup>	Number of vehicles (unit: thousand)	104.0	41.8	37.2	193.65
Stations	Number of gasoline stations in Seoul	602.8	25.4	558	658

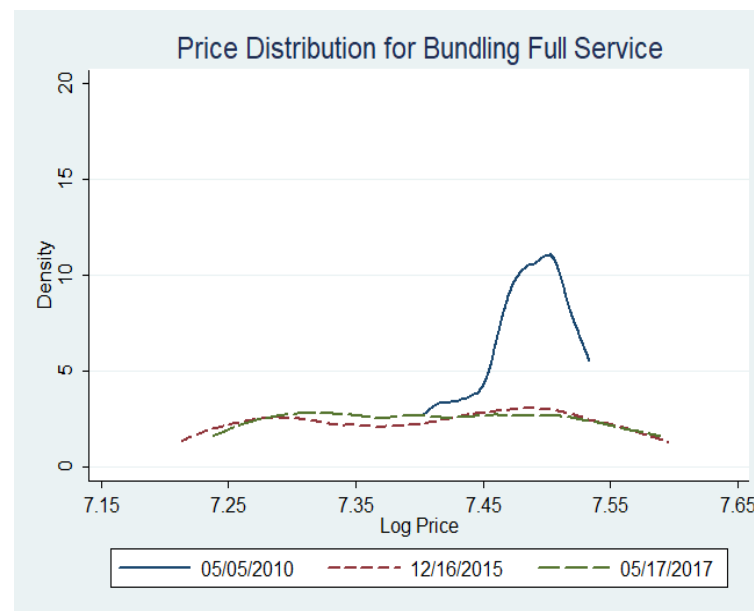
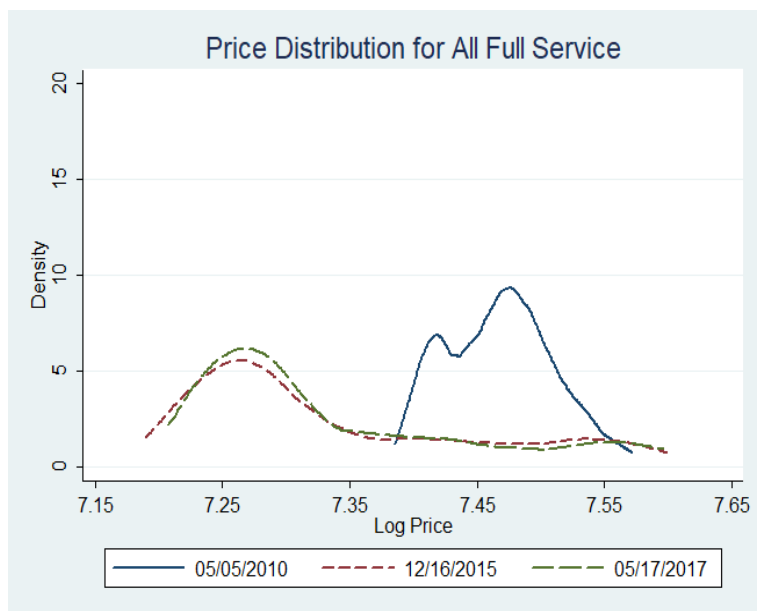
Note: Average across all stations in all time periods, except for Income and Car

<sup>a</sup> Observations at the station level in two days; the first Wednesday of May 2010 and 2011

<sup>b</sup> Observations at the district level in two months; May 2010 and May 2011



# Appendix: price distribution comparison



# Appendix: who exits? who converts?

- Define F-S stations' choices based on entry & exit information
  - “permanent exit”
  - “conversion to SS”
  - “FS continuation”
- Assume one choice for each station during the sample period:
  - # of full-service stations in the market: 593 (first day)

	permanent exit	conversion to SS	FS continuation
# of instances, 2010-2015	122	65	406

# Appendix: who exits? who converts?

- Station  $i$ 's decision to be correlated with intensity of competition:

$$\log\left(\frac{\pi_{i,j}}{\pi_{i,J}}\right) = \alpha_j + \beta_j \text{Num}_i^{\text{SS1}} + \gamma_j \text{Num}_i^{\text{FS1}} + \zeta_j \mathbf{Z}_i + \varepsilon_j$$

where  $j = \{\text{"permanent exit" or "conversion to SS"}\}$  and  $J = \text{"FS continuation"}$

- $\frac{\pi_{i,j}}{\pi_{i,J}}$ : the odds that full-service station  $i$  falls in category  $j$  as opposed to the baseline outcome
  - $\text{Num}^{\text{SS1}}; \text{Num}^{\text{FS1}}$ : the number of self- and full-service competitors within one mile
  - $\mathbf{Z}$ : covariates (e.g., presence of store/carwash/repair, brand, income, car, multiproduct)
  - $\varepsilon$ : robust standard error, clustered by Numric
- ✓  $\beta$  and  $\gamma$  are **the relative-probability ratios** of one decision to “FS continuation”

# Appendix: who exits? who converts?

- Relative probability, as opposed to “FS continuation”

	(1) May 05, 2010	(2) May 04, 2011
<b>Outcome: permanent exit</b>		
Num <sup>SS1</sup>	<b>1.293**</b> <b>(0.145)</b>	1.286*** (0.125)
Num <sup>FS1</sup>	1.047* (0.023)	1.073*** (0.026)
<b>Outcome: conversion to SS</b>		
Num <sup>SS1</sup>	<b>1.413*</b> <b>(0.267)</b>	1.345** (0.178)
Num <sup>FS1</sup>	1.021 (0.032)	1.048 (0.033)
Control variables	Y	Y
Observations	591	546

\*\* p<5%; \* p<10%

- ✓ Greater price-competition **drives** high-cost sellers **out** of a market