Economic Impacts of the Green Transition: Evidence from Korean Gas Stations

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Motivation

- Global shift towards sustainable transportation solutions, such as electric vehicles (EVs)
- Escalating importance of establishing efficient and widespread charging networks
- Prominent growth in the number of EV chargers (Bakker et al. 2014, Campbell et al. 2012, Kim et al. 2022)

What are the economic consequences of EV charger growth on Korean traditional fuel retail industry?

Research Questions

How does the change in the number of EV chargers affect

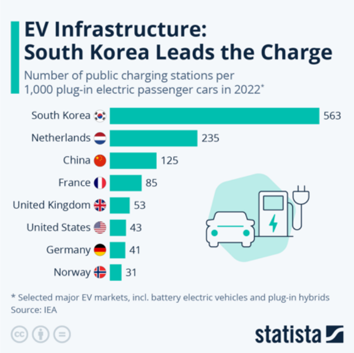
i. average retail gasoline price
ii. average retail diesel price
iii. number of gas stations

in the same cities, counties, or districts (*Si-Gun-Gu*)?

Contribution: first to analyze the causal impacts of increasing EV chargers on nearby gas stations

Why South Korea?

Korea provides an ideal setting for investigating the impacts of the growing EV charging industry



Estimation Strategy

Measuring the causal impact is challenging, due to confounding factors and endogeneity

Identification Strategy: **Exploit policy intervention in Korea**

- Policy requiring existing large apartment complexes to install EV chargers
- **Exogenous supply shift in EV chargers**

⇒ **Two-stage Least Squares (2SLS)** regression is applied

Data

Regional Level Variation: *city-county-districts*

- Gas station data: Oil Price Information Network (Opinet)
- EV charger data: Pollution-free vehicle integrated website

Info. on EV chargers for other years than 2023 is unavailable

- Absence of EV chargers in Korea before 2011

$\Rightarrow$ **Charger counts of 2023 = growth of charger counts rom 2011 to 2023**

Normalize by a km^2 of city area

- Higher EV charger and gas station counts are concentrated in metropolitan cities
- Normalization by city area of each region reduces this concentration

$\Rightarrow$ **Leveraging the normalized variations**

Panel Analysis?

- Ideally, it would be best to use the # EVs as the explanatory variable.
- However, city-county level data is only available for the recent few years.
- Panel analysis using this available data yields robust results.

Econometric Specification

$$\triangle ln(Y_{ij(11-23)}) = \beta_0 + \beta_1 \frac{\Delta EVC_{ij(11-23)}}{City\ Area_i} + \mathbf{X}_{ij11}'\beta_2 + \Delta ln(\mathbf{X}_{ij(11-23)})'\beta_3 + \gamma_j + \epsilon_{ij(11-23)}$$

Y_{ij}: outcome variable in region i, belonging to the Living Zone j LZ

- average gasoline price
- average diesel price
- number of gas stations per 1 square kilometer

⇒ $\triangle ln(Y_{ij(11-23)}) \approx$ growth rate of Y_{ij} value from 2011 to 2023

$\Delta EVC_{ij(11-23)} / City\ Area_i$: main independent variable

- change in the number of EV chargers per a km^2 of city area from 2011 to 2023

r_j: Living Zone fixed effects Explanation

Econometric Specification

$$\triangle ln(Y_{ij(11-23)}) = \beta_0 + \beta_1 \frac{\triangle EVC_{ij(11-23)}}{City\ Area_i} + \mathbf{X}_{ij11}{}'\beta_2 + \Delta ln(\mathbf{X}_{ij(11-23)})'\beta_3 + \gamma_j + \epsilon_{ij(11-23)}$$

$\mathbf{X}_{ij11}{}'$: controls measured in 2011

$\triangle ln(\mathbf{X}_{ij(11-23)})'$: change in the logged controls during the 13-year period

- Demographic, local vehicle demand, gas station competition level, average wage and wealth, real estate prices
- Controls for the maximum available set of control variables, including both predetermined levels and contemporary changes.

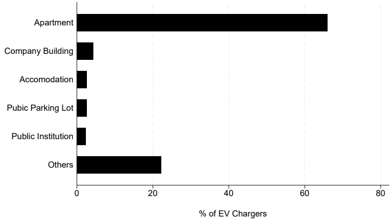
Regression weights: population in 2011

Standard errors clustered by Living Zones

Instrumental Variable Approach

$$IV_i = \frac{APT_{i10}}{City\,Area_i}$$

(APT_{i10}: total number of apartment units in region i in year 2010)



Simple observation: as of 2023 October, more than 60% of the EV chargers are placed at apartments

Instrumental Variable Approach

Act on the Promotion of Development and Distribution of Environmentally Friendly Vehicles

- Requires a certain percentage of parking spaces in large newly built apartment complexes to be equipped with EV chargers.
- Amendments extended this requirement to existing apartments, **mandating that at least 2% of their parking spaces include chargers.**

Instrumental Variable Approach

Relevance of IV:

- APT_{i10} partially represents the targets of the mandatory installation policy, so it can predict $\triangle EVC_{ij(11-23)}$.
- Among the potential areas for EV charger installation, the actual adoption of EV chargers will primarily depend on the number of available apartment units.

c.f. Arguments based on supply-side constraints
(Bhuller et al. 2013; Dettling 2017; Falck et al. 2014)

Exclusion Restriction:

- Unlikely that the introduction of EV chargers was anticipated during the construction of new apartments before 2011
- Because of the time frame difference, the correlation between the IV and the unobservable determinants of $\triangle ln(Y_{ij(11-23)})$ is improbable (conditional on controls)

IV First Stage

Table: First-Stage Regression

Dependent Variable: Δ EVC$_{ij(11-23)}$	(1)	(2)	(3)	(4)
IV_i	0.023***	0.012***	0.014***	0.014***
	(0.001)	(0.002)	(0.001)	(0.001)
Predetermined		✓	✓	✓
Contemporary Change			✓	✓
LZ FE				✓
R^2_{adj}	0.679	0.791	0.830	0.803
F-Stat	1,140.33	33.20	103.77	173.11
Obs.	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Main Results

Table: Main Results

	OLS			2SLS		
Dependent:	$\Delta ln(GP)$ (1)	$\Delta ln(DP)$ (2)	$\Delta ln(\#GS)$ (3)	$\Delta ln(GP)$ (4)	$\Delta ln(DP)$ (5)	$\Delta ln(\#GS)$ (6)
$\frac{\Delta EVC_{ij(11-23)}}{City\ Area_i}$	-0.007	-0.013	-0.007**	-0.074***	-0.087***	0.000
	(0.016)	(0.015)	(0.003)	(0.017)	(0.019)	(0.013)
Controls	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓
R^2_{adj}	0.176	0.180	0.384			
F-Stat				173.11	173.11	159.08
Obs.	228	228	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Effect on Gasoline & Diesel Prices

Spillover Effect

- In areas where the number of EV chargers has significantly increased, **gasoline vehicle owners may benefit from decreased prices and the corresponding rise in real income**

Significant drop in both gasoline prices and diesel prices

- EVs predominantly replace gasoline vehicles (Xing et al., 2021).
- Characteristics of vehicles based on fuel types
  - Gasoline vehicles primarily belong to passenger vehicles, plus, in Korea, roughly 30 percent of diesel vehicles are actually passenger cars.
  - Most EVs in Korea belong to passenger vehicles, but the number of electric trucks cannot be ignored. Table
  - A program offering free commercial license plates for electric trucks has been implemented in Korea.

  ⇒ Korea's unique policy established a substitutional relationship with diesel vehicles.

Effect on the Gas Station Number

The proliferation of EV chargers did not result in a significant change in the number of gas stations.

- The impact of EV-induced demand shock on ICEVs was not substantial enough to force gas stations out of the market.
- Due to substantial closure costs (e.g. land decontamination cost), gas stations cannot easily shut down.
- Gas station owners could strategically adopt EV chargers in their stations to both persist in selling fuels and attract EV drivers.
  - ⇒ Gas stations with EV chargers make up only about 0.36% of all stations, which is negligible.

Impacts on ICEVs

Table: Impact on the Number of ICEVs

Dependent Variable: $\Delta \ln(\widetilde{ICEV}_{ij(11-23)})$				
	(1)	(2)	(3)	(4)
$\frac{\Delta EVC_{ij(11-23)}}{City\ Area_i}$	-0.195*	-0.677***	-0.628***	-0.668***
	(0.108)	(0.157)	(0.090)	(0.079)
Baseline Controls	✓	✓	✓	✓
LZ FE		✓	✓	✓
Transportation Controls 1			✓	✓
Transportation Controls 2				✓
F-stat	119.26	34.04	55.25	58.16
Obs.	147	147	147	143

Notes: *p < 0.10, **p < 0.05, ***p < 0.01

Impacts of Subsidized New EV Purchases

Table: Independent Variable: Subsidized New EV Purchases

Dependent Variable	Δln(Gasoline Price$_{it}$)		Δln(Diesel Price$_{it}$)		Δln(# Gas Stations$_{it}$)	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(EV_{it})$	-0.020***		-0.036***		0.00002	
	(0.006)		(0.010)		(0.00007)	
$\ln(EPV_{it})$		-0.016***		-0.029***		0.00001
		(0.005)		(0.008)		(0.00006)
Baseline Controls	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
F-stat	35.14	41.03	35.14	41.03	36.57	42.10
Obs.	630	625	630	625	630	625

Notes: *p < 0.10, **p < 0.05, ***p < 0.01

Public Transportation Accessibility

Table: Results with Public Transportation and Commuting Time Controls

Dependent Variable	ΔIn(Avg. Gasoline Price)			ΔIn(Avg. Diesel Price)			ΔIn(# Gas Stations)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔEVC	-0.050***	-0.062***	-0.100***	-0.060***	-0.075***	-0.114***	-0.003	0.003	0.005
	(0.008)	(0.014)	(0.018)	(0.012)	(0.016)	(0.022)	(0.010)	(0.016)	(0.019)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Transportation Controls									
Controls 1	✓			✓			✓		
Controls 2		✓			✓			✓	
Controls 3			✓			✓			✓
F-stat	364.63	227.74	81.84	364.63	227.74	81.84	382.02	209.11	47.11
Obs.	228	223	228	228	223	228	228	223	228

1. municipality-level average access times to major facilities
2. municipality-level number of public transit users and transit volumes
3. survey-based province-level population shares by public transportation access time, transit use frequency, and monthly transit cost categories

Robustness Checks

R1. **AC vs DC EV Chargers** Detail

- AC charger: slow charging, placed mainly in residential areas
- DC charger: fast charging, placed mainly in public facilities

R2. **Adding Additional Set of Controls** Table

- intensity of economic activities (GRDP and value added)
- regional tax revenue
- mileage (distance traveled)

R3. **More Checks on the IV** Table

- Controlling for the number of newly built apartment units per city area from 2011 to 2023
- Using a more lagged number of apartment units per city area as an alternative IV
  - i) $IV_i = APT_{i09} / City\,Area_i$
  - ii) $IV_i = APT_{i04} / City\,Area_i$

R4. **Region-Specific Price Deflation** Table

Concluding Remarks

- ✓ We analyze the causal regional impacts of increasing EV chargers on the vehicle fuel retail industry.
- ✓ 100 additional chargers per city area lowered gasoline & diesel prices by 7.4% and 8.7%, but no impact on gas station numbers.
- ✓ Regions with more EV chargers installed experienced actual declines in internal combustion engine vehicle demand.
- ✓ Panel analysis using EV purchases as the explanatory variable also yielded consistent and robust results: regions with higher EV purchases showed fuel price declines with no impact on gas station numbers.
- ✓ Results remained robust even when controlling for public transportation accessibility in each region.

Concluding Remark

Thank You

Motivation

"The *decline* in gas stations appears to be due to business challenges stemming from the
increased adoption of eco-friendly vehicles such as electric vehicles."
(*Korean Petroleum Quality & Distribution Authority, 2023.04*)

"**With the increase in electric vehicles**, approximately three-quarters of the current gas stations nationwide will *shut down* by 2040."
(*Korea Energy Economics Institute, 2023.05*)

These issues are closely related to the...

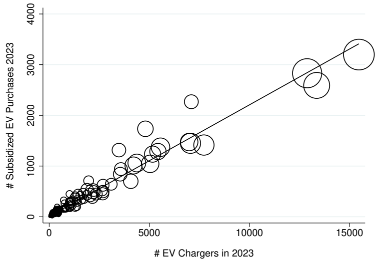
⇒ spillover effects of emerging industries on traditional industries

⇒ transition risks associated with conventional energy sources

Evidence for Assumption 1

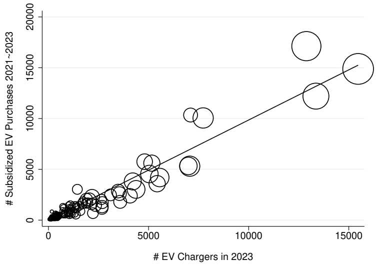
Back

Number of EV Chargers and Subsidized EV purchases
at the City- and County-Levels



(a)

EV chargers 2023 ↔ # subsidized EV purchases 2023



(b)

EV chargers 2023 ↔ # subsidized EV purchases 2021 - 2023

Assumptions

A1: The number of EV chargers is positively correlated with the demand for EV

- Evidence from literature

  (Choi and Keum 2019; Li et al. 2017; Springel 2021)

- Evidence from data on the number of subsidized EV purchases

  figure

A2: EVs and internal combustion engine vehicles (ICEVs) are substitutes

- Nygaard (2016): EVs are found to replace about 40% of conventional vehicles use

- Xing et al. (2021): EVs primarily replace fuel-efficient gasoline vehicles

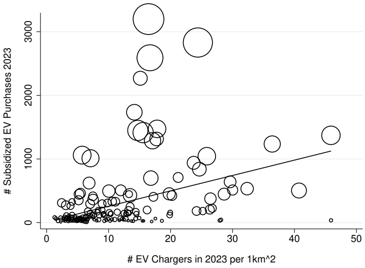
Related Literature & Contribution

- Optimal placement of EV chargers
  (Ge et al. 2011; Lam et al. 2014; Mouli et al. 2016)
- Korean EV charging infrastructure
  (Choi and Keum 2019; Lee and Yoon 2022; Suk 2019)
- Fuel market prices and competition, Consumers' fuel search behavior
  (Hastings 2004; Houde 2012; Byrne and de Roos 2017)
- Charging choices of (potential) EV owners
  (Dorsey et al. 2024; Grigolon et al. 2024)
- EV charging networks (subsidies, interoperability etc.)
  (Li et al. 2017; Li (wp); Springel 2021)

Evidence for Assumption 1

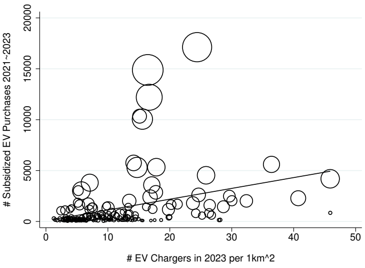
Back

Number of EV Chargers per $1km^2$ of City Area and Subsidized EV purchases at the City- and County-Levels



(a)

2023 ↔ 2023



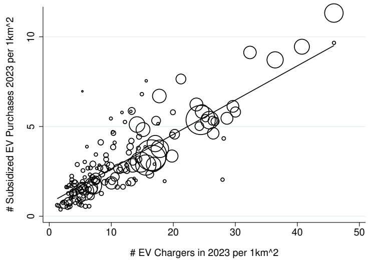
(b)

2023 ↔ 2021 - 2023

Evidence for Assumption 1

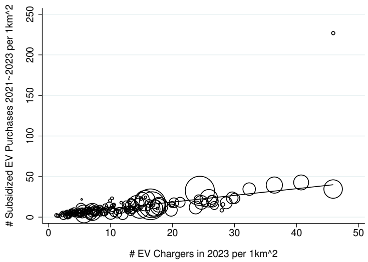
Back

Number of EV Chargers per $1km^2$ of City Area and
Subsidized EV purchases per $1km^2$ of City Area at the City- and County-Levels



(a)

2023 ↔ 2023



(b)

2023 ↔ 2021 - 2023

Summary Statistics (Gas Stations)

Table: Descriptive Statistics of Changes in Average Gasoline/Diesel Prices, and in the Number of Gas Stations from 2011 to 2023

	number of obs.	mean	std. dev.	min.	max
Δ gasoline price (in KRW)	228	-280.02	41.44	-388.17	38.86
Δ diesel price (in KRW)	228	-178.71	42.51	-259.73	131.12
Δ # gas stations	228	-8.74	9.34	-56	8
Δ # gas stations per $1km^2$ of *city area*	228	-0.20	0.23	-1.08	0.35

Notes: The units of observations are cities, counties, and districts. In the fourth row, "city area"" refers to the area of a region excluding agricultural, forestry, and natural environmental conservation zones. Sejong city is excluded since it did not formally exist in 2011. All dependent variables were calculated after averaging them on an annual basis.

Summary Statistics - EV Chargers

Table: Descriptive Statistics of Changes in the Number of EV Chargers from 2011 to 2023

	number of obs.	mean	std. dev.	min.	max
Δ# EV chargers	228	1,095.09	1,207.21	26	6,990
Δ# AC EV chargers	228	964.97	1,109.59	5	6,622
Δ# DC EV chargers	228	100.14	89.27	8	730
per $1km^2$ of city area					
Δ# EV chargers	228	21.04	24.44	1.31	143.29
Δ# AC EV chargers	228	18.23	22.93	0.44	135.57
Δ# DC EV chargers	228	2.23	1.95	0.21	13.54

Notes: The units of observations are cities, counties, and districts. In the second panel, “city area”” refers to the area of a region excluding agricultural, forestry, and natural environmental conservation zones. Sejong city is excluded from the sample.

Data Sources (Control Variables)

Regional-level (city, county, district)

- **Demographic Data**: Year-Centered Census Data,
  Population and Housing Census, National Statistics Office
- **Vehicle Registration Status Data**: Vehicle Registration Status Report,
  Ministry of Land, Infrastructure, and Transport, Korea
- **Real Estate Market Price data**: Transaction Price Disclosure System,
  Ministry of Land, Infrastructure and Transport, Korea
- **Labor income related data**:
  - Local Area Labor Force Survey, National Statistical Office
  - Korean Labor Income Panel Study (KLIPS), Korea Labor Institute
- **Production data**: GRDP and Total Value Added,
  Regional Production Statistics, National Statistics Office

EV Purchases by Age Groups

Back

Table: Electric Vehicle Registration Status by Age Group at the End of 2021

Age Group	# Registered EVs	Percentage
- 10s	60	0.0%
20s	3,886	2.5%
30s	26,469	16.7%
40s	45,091	28.5%
50s	43,207	27.3%
60s	31,793	20.1%
70s	7,173	4.5%
80s	639	0.4%
90s -	65	0.0%
Total	158,383	100%

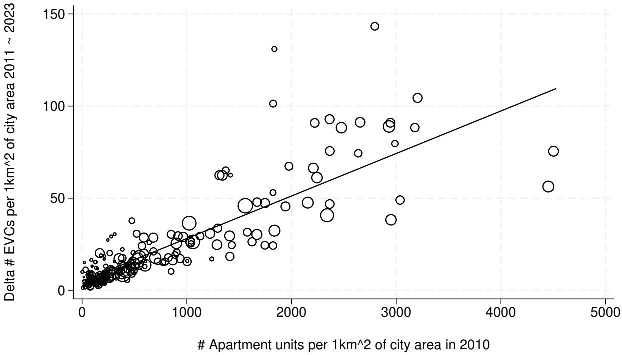
Living Zone (LZ) System

- Created by the Statistics Development Institute of the National Statistical Office
- Structured based on the fact that economic activities and living areas transcend administrative boundaries
- Consists of 55 mutually exclusive regions targeting the actual living areas of residents
- Can be used to control for the unobserved heterogeneity across the actual living spaces (Park et al. 2023)

  ⇒ In our specific research context, used to mitigate estimation bias caused by the potential movement of residents from one area to another for refueling

Back

IV First Stage



Each circle: region (circle size: population in 2011)

Straight line: weighted linear fit

IV Falsification Tests

[noframenumbering] Examine whether the IV is significantly correlated with the pre-period (2008-2010) changes in the outcome variables

Table: Falsification Tests

Dependent Variable	Δ ln(Gasoline Price 2008∼2010)		Δ ln(Diesel Price 2008∼2010)		Δ ln(# Gas Stations 2008∼2010)	
	(1)	(2)	(3)	(4)	(5)	(6)
IV_i	0.041 (0.047)	0.115 (0.070)	-0.040 (0.079)	-0.097 (0.117)	0.145 (0.093)	0.156 (0.103)
Predetermined (2008)	✓	✓	✓	✓	✓	✓
Contemporary Change (2008–2010)		✓		✓		✓
LZ FE	✓	✓	✓	✓	✓	✓
R^2_{adj}	0.008	0.078	0.405	0.424	0.479	0.482
Obs.	228	228	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Average Gasoline Price - Positive Spillover Effect

- A simple back-of-the-envelope calculation:

  Consider a representative gasoline vehicle owner who drives as much as average annual mileage with average fuel efficiency...

  - If the owner refuels in an area that has witnessed the installation of the average number EVCs per $1km^2$ over the 13-year period, the effect would be **KRW 417,339 (USD 300)**
  - If the owner refuels in an area that has witnessed the installation of the maximum number EVCs per $1km^2$ over the 13-year period, the effect would be **KRW 2,841,877 (USD 2,030)**

▸ Calculation

Back-of-the-Envelope Calculation

- Benefit for a representative owner refuels in an area that has witnessed the installation of 21 (average) EVCs per $1km^2$ over the 13-year period

$$[(\text{KRW } 1,928/\ell \times 0.074)] \times \left(\frac{21}{100}\right) \times \left(\frac{10,366 \text{ km} \times 13}{9.6744 \text{ km}/\ell}\right) = \text{KRW } 417,339 \tag{1}$$

$$(\approx USD\ 300)$$

- Benefit for a representative owner refuels in an area that has witnessed the installation of 143 (max) EVCs per $1km^2$ over the 13-year period

$$[(\text{KRW } 1,928/\ell \times 0.074)] \times \left(\frac{143}{100}\right) \times \left(\frac{10,366 \text{ km} \times 13}{9.6744 \text{ km}/\ell}\right) = \text{KRW } 2,841,877 \tag{2}$$

$$(\approx USD\ 2,030)$$

average gasoline price per liter (in 2011 Korea)
effect of EVC growth (coefficient estimate)
average annual mileage for gasoline vehicles (in 2022 Korea)
average fuel economy of gasoline vehicles (purchased b/w 2001 and 2024 Korea)

Back

Subsidized EV Vehicle Types

Back

Table: Annual Number of Subsidized EV Purchases from 2021 to 2023 by Vehicle Types

Vehicle Type	2021 (1)	2022 (2)	2023 (3)	Year Average (2021～2023) (4)
Passengers Vehicle	65,583	109,806	94,792	90,060.333
	(69.823%)	(74.307%)	(67.687%)	(70.775%)
Van (Electric Bus)	1,335	1,688	2,034	1,685.667
	(1.421%)	(1.142%)	(1.452%)	(1.325%)
Truck	27,010	38,280	43,219	35,503
	(28.756%)	(24.551%)	(30.861%)	(27.900%)
Total	93,938	147,774	140,045	127,292
	(100%)	(100%)	(100%)	(100%)

AC vs DC EV Chargers

AC vs DC EV chargers ▸ Table ▸ Figure

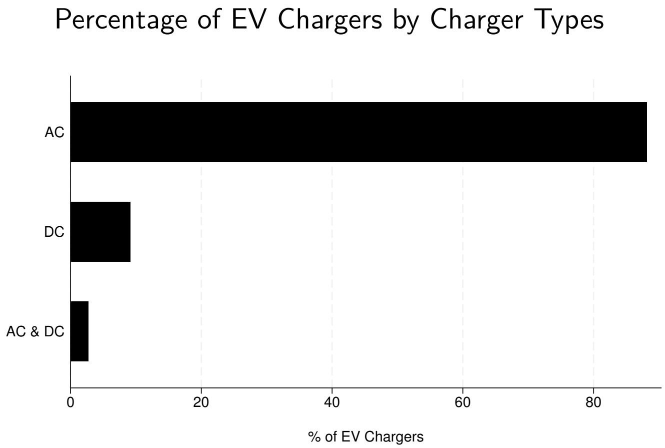
- AC charger: slow charging method (4 to 6 hours), placed in residential areas
- DC charger: fast charging method (30 to 60 minutes), placed in public institutions, facilities, etc.

⇒ EV consumers primarily use AC chargers at home.

⇒ DC chargers may not be correlated with the EV demand.

EV Charger Types

Back



AC vs DC EV Chargers

Back

Table: Second-Stage, Separating AC and DC EV Chargers

Dependent Variable	Δln(Gasoline Price) (1)	Δln(Diesel Price) (2)	Δln(# gas Stations) (3)	Δln(Gasoline Price) (4)	Δln(Diesel Price) (5)	Δln(# Gas stations) (6)
$\Delta AC\ EVC$	-0.076*** (0.017)	-0.089*** (0.020)	0.000 (0.013)			
$\Delta DC\ EVC$				-5.654 (4.343)	-6.659 (5.046)	0.000 (0.965)
First Stage Regression						
IV	0.014*** (0.001)	0.014*** (0.001)	0.014*** (0.001)	0.001 (0.001)	0.001 (0.001)	0.002 (0.002)
Controls	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓
F-stat	215.07	215.07	196.90	1.65	1.65	1.47
Obs.	228	228	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Adding Additional Set of Controls

Back

Table: Second-Stage, Additionally Controlling for Various Set of Controls

Dependent Variable	ΔIn(Gasoline Price)			ΔIn(Diesel Price)			ΔIn(# Gas Stations)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔEVC	-0.065***	-0.052**	-0.072***	-0.079***	-0.066***	-0.086***	0.004	0.003	0.000
	(0.015)	(0.014)	(0.017)	(0.017)	(0.017)	(0.019)	(0.015)	(0.014)	(0.012)
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Additional Set of Controls									
GRDP & VA	✓			✓			✓		
Tax Revenue		✓			✓			✓	
Mileage			✓			✓			✓
F-stat	152.16	161.38	183.40	152.16	161.38	183.40	96.19	88.56	152.45
Obs.	228	228	228	228	228	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Price Deflation

Back

Table: Second-Stage, Deflated Price Dependent Variable

Dependent Variable	ΔIn(Gasoline Price)		ΔIn(Diesel Price)	
	(1)	(2)	(3)	(4)
ΔEVC	-0.098***	-0.099***	-0.113***	-0.114***
	(0.017)	(0.017)	(0.020)	(0.020)
Controls (Original)	✓		✓	
Controls (Deflated)		✓		✓
LZ FE	✓	✓	✓	✓
F-stat	173.11	168.52	173.11	168.52
Obs.	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

More Checks on the IV

Back

Table: Second-Stage, More Checks on the IV

Dependent Variable	ΔIn(Gasoline Price)			ΔIn(Diesel Price)			ΔIn(# Gas Stations)		
		2009 IV	2004 IV		2009 IV	2004 IV		2009 IV	2004 IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ*EVC*	-0.084***	-0.072***	-0.062***	-0.106***	-0.086***	-0.083***	0.005	0.001	-0.001
	(0.023)	(0.016)	(0.019)	(0.025)	(0.019)	(0.021)	(0.013)	(0.012)	(0.013)
New APT	0.001			0.002***			-0.001**		
	(0.001)			(0.001)			(0.000)		
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
F-stat	78.70	142.53	76.80	78.70	142.53	76.80	98.18	124.66	75.02
Obs.	228	228	228	228	228	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Urban vs Rural Heterogeneity

Back

Table: Second-Stage, Urban vs Rural Heterogeneity

Dependent Variable	Δln(Gasoline Price)		Δln(Diesel Price)		Δln(# Gas Stations)	
	Subsample (1)	Urban Control (2)	Subsample (3)	Urban Control (4)	Subsample (5)	Urban Control (6)
ΔEVC	-0.074*** (0.015)	-0.077*** (0.016)	-0.090*** (0.019)	-0.088*** (0.019)	0.001 (0.012)	-0.001 (0.013)
Urban		-0.610** (0.306)		-0.207 (0.279)		-0.163 (0.210)
Controls	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓
F-stat	107.58	182.91	107.58	182.91	124.25	179.13
Obs.	144	228	144	228	144	228

Notes: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Self-Service vs General Gas Stations

Back

Table: Second-Stage, Separating Self-Operated vs General Gas Stations

Dependent Variable	Δln(Gasoline Price)		Δln(Diesel Price)		Δln(# Gas Stations)	
	Self (1)	General (2)	Self (3)	General (4)	Self (5)	General (6)
ΔEVC	-0.055***	-0.053**	-0.066***	-0.063***	0.004	-0.006
	(0.010)	(0.018)	(0.014)	(0.017)	(0.009)	(0.022)
Controls	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓
F-stat	167.40	170.72	167.40	170.72	159.08	159.08
Obs.	222	227	222	227	228	228

Notes: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Excluding Thrifty Gas Stations

Back

Table: Second-Stage, Excluding Thrifty Gas Stations

Dependent Variable	ΔIn(Gasoline Price)		ΔIn(Diesel Price)		ΔIn(# Gas Stations)	
	Total (1)	No Thrifty (2)	Total (3)	No Thrifty (4)	Total (5)	No Thrifty (6)
ΔEVC	-0.074*** (0.017)	-0.075*** (0.018)	-0.087*** (0.019)	-0.088*** (0.020)	0.000 (0.013)	0.001 (0.014)
Controls	✓	✓	✓	✓	✓	✓
LZ FE	✓	✓	✓	✓	✓	✓
F-stat	173.11	173.11	173.11	173.11	159.08	159.08
Obs.	228	228	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Mitigating Potential Collider Bias

Back

Table: Second-Stage, Mitigating Potential Collider Bias

Dependent Variable	ΔIn(Gasoline Price)		ΔIn(Diesel Price)		ΔIn(# Gas Stations)	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔEVC	-0.069***	-0.073***	-0.079***	-0.085***	-0.008	0.000
	(0.015)	(0.016)	(0.020)	(0.018)	(0.014)	(0.013)
Predetermined	✓	✓	✓	✓	✓	✓
Contemporary Change $(2011 \sim 2022)$		✓		✓		✓
LZ FE	✓	✓	✓	✓	✓	✓
F-stat	115.46	187.36	115.46	187.36	115.46	157.20
Obs.	228	228	228	228	228	228

Notes: *p $<$ 0.10, **p $<$ 0.05, ***p $<$ 0.01

Korean Gas Stations and EV Chargers

Self Gas Station

General Gas Station

EVC in an Apartment