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How Parking Prices Affect On-street Parking Duration? Evidence from a User Panel

Le 20/11/25

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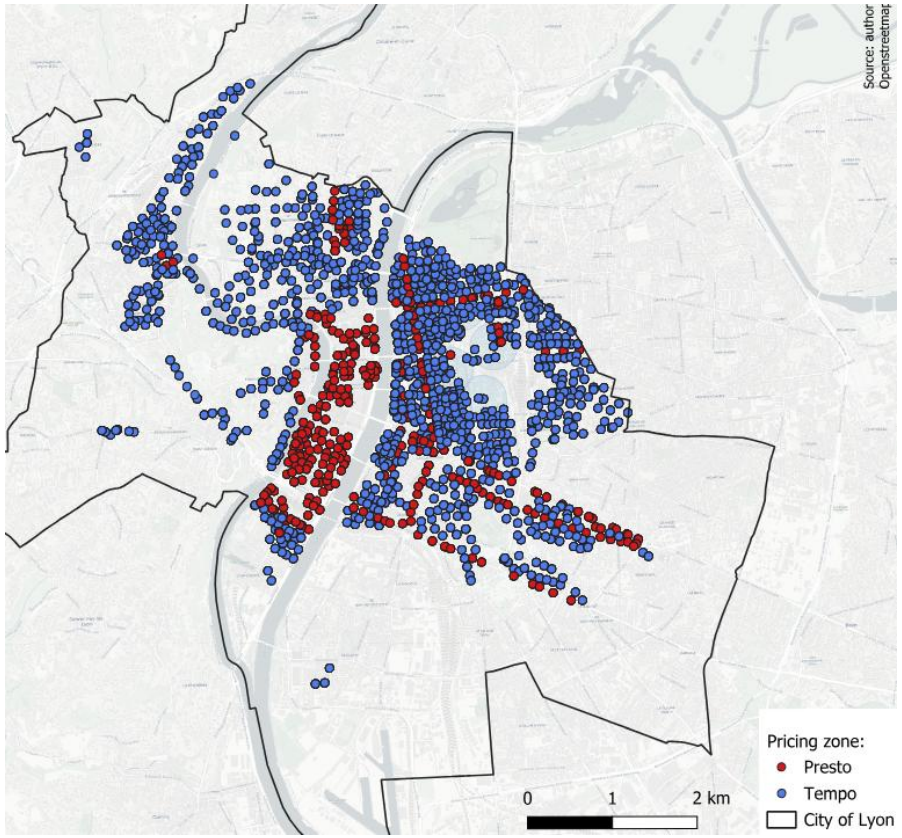
Context & Motivations

- Paid parking: the oldest policy to regulate car use
- Urban issues: occupation of space (Inci 2015, Ossokina et al. 2019), congestion (Hampshire et al. 2018), security (Peprah et al. 2014)..
- Emerging schemes (Oslo, Zurich, San Francisco)
- The city of Lyon: several initiatives

Context & Motivations



JUNE 2024

TARIF VISITEUR HORAIRE

TARIFS VISITEURS	RÉDUIT Véhicules <1 000 kg ou électriques	Tarifs Actuel Tempo	STANDARD	Tarifs Actuel Presto	MAJORÉ Véhicules >1 525 kg à vide ou hybrides rechargeables >1 900 kg ou électriques >2 100 kg
1h	1€	1€	2€	2€	3€
2h	3€	3€	6€	11€	9€
4h	12€	16€	14€	29€	21€
7h	18€	25€	26€	47€	39€
10h/FPS	35€	35€	55€	60€	80€
Répartition estimée des véhicules	20 %		65 %		15 %

Source : VdL

A demand based pricing

A pricing differentiated according the environmental performances of vehicles

Context & Motivations

- Major recent changes have significantly altered on-street parking behavior and durations

- The policy change acts as a natural experiment, allowing us to estimate key parameters of on-street parking demand

1. What is the price elasticity of on-street parking duration?

2. Which user and built environment factors shape this elasticity, and by how much?

Related literature

Two main strands:

1) Parking price elasticity estimates

- Most existing studies focus on parking volumes with a wide range of price elasticity estimates (Shoup 1997, 2005; Seya et al. 2024; Gragera et al. 2021)
- Fewer studies focus on parking duration elasticities. All existing studies suggest also a high variability of price elasticities across contexts with limited differentiation across users or locations (Kelly & Clinch 2009; Cats et al. 2016; Hilvert et al. 2012)

2) Heterogeneity in parking price elasticity. Existing studies focus on:

- Trip Purpose: frequent & commuter users more price-sensitive (Milosavljević 2014; Simićević et al. 2021). Occasional & leisure users show lower sensitivity
- Built environment: higher elasticities where substitutes (Pu et al. 2017). Higher commercial density → higher elasticity (Wang et al. ,2020)

Contribution to the literature

This study takes advantage of a rich dataset on observed car-user behavior, combining multiple administrative data sources from the Ministry and the City of Lyon. Besides,

1) It focuses on on-street parking demand characteristics

- Specific attention paid to price elasticies of the on-street parking duration
- Explores heterogeneities in elasticities accross user characteristics and built environment factors

2) It contributes to the limited econometric evidence on car users' price sensitivity by exploiting a natural experiment

- Pricing reform implemented in Lyon in June 2024
- Ex-post evaluation of an environmentally differentiated parking tariff
- Identification strategy: IV model with user fixed effects, allowing control for unobserved individual characteristics

Data

1. Parking data
Lyon: on-street parking transactions January 2023-May 2025 (visitor parking)
2. Veh. registration data (« cartes grises »)
France: SIV (weight, fuel type, owner municipality, vehicle age, etc.)
3. Built environnment data
SIRENE database (INSEE): commercial and leisure-related jobs around each parking meter
Lyon metropolitan data on off-street parking facilities

PM ID	Plate ID	Type	long.	lat.	Arrival time	Departure time	Zone
1	AB-1111	Visitor	4.8319	45.7625	9/15 10:06	09/15 11:06	*Presto*
1	CD-2222	Resident	4.8319	45.7625	9/15 11:54	09/15 15:29	*Presto*
2	AC-3333	Visitor	4.8071	45.7750	9/15 11:41	09/15 13:23	*Tempo*

Parking meter data

Plate ID	Weight (kg)	Energy type	Residence zone	Registration date
AB-1111	1,850	Diesel	69100	2015-06-12
CD-2222	1,400	Electric	69001	2022-03-08
AC-3333	2,200	Gasoline	01012	2010-09-27

Car registration data

Econometric methodology

- Standard price-elasticity models can suffer from reverse causality, since parking price depends on duration. IV → isolate the causal effect of price on parking duration

- Dependent variable D_{ik}: parking duration (in minutes) for transaction *k* by user *i*
- Key variable $price_{ik}$: price per minute for transaction *k* by user *i*
- Control variables X_{ik}

- Instrument: exogenous pricing reform of June 2024.
  (i) Strongly correlated with parking price
  (ii) No direct effect on parking duration other than through price.

- User FE (plate ID) → controls for time-invariant user i characteristics

- Two-Stage Least Squares

User FE

$$\text{Second stage:} \quad \ln(D_{ik}) = \alpha_i + \beta \ln(price_{ik}) + \gamma X_{ik} + \varepsilon_{ik},$$

$$\text{First stage:} \quad \ln(price_{ik}) = \alpha_i' + \pi z_{ik} + \delta X_{ik} + \nu_{ik}.$$

Instrument: post-policy dummy

Identification strategy

	Before reform		After reform		
	Tempo	Presto	Class 1 *EV < 2,100 kg* *PHEV < 1,000 kg* *Comb. < 1,000 kg*	Class 2 *Comb. 1,000–1,525 kg* *PHEV 1,000–1,900 kg*	Class 3 *Comb. > 1,525 kg* *PHEV > 1,900 kg* *EV > 2,100 kg*
Duration					
1 hour	1.20 €	2.00 €	1.00 €	2.00 €	3.00 €
2 hours	2.80 €	11.00 €	3.00 €	6.00 €	9.00 €
3 hours	4.00 €	23.00 €	6.00 €	10.00 €	15.50 €
Max (10 h)	35.00 €	60.00 €	35.00 €	55.00 €	80.00 €

Comb. = combustion engine; PHEV = plug-in hybrid electric vehicle; EV = electric vehicle.

Before June 2024

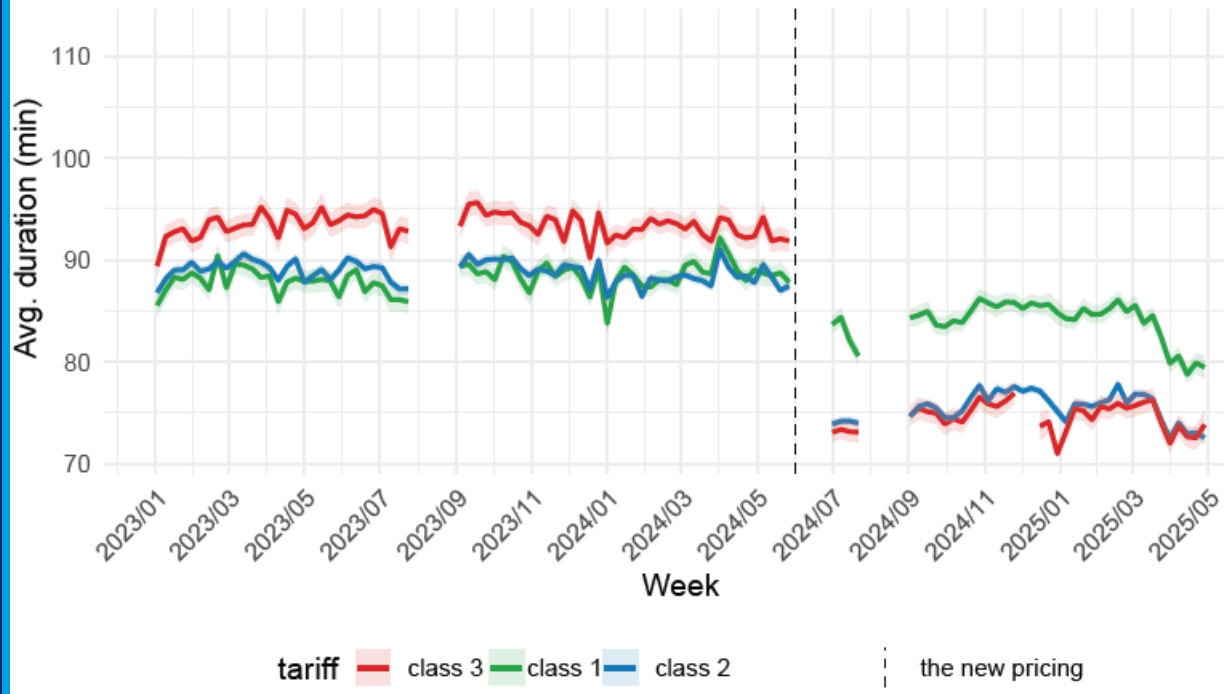
After June 2024

January 2023

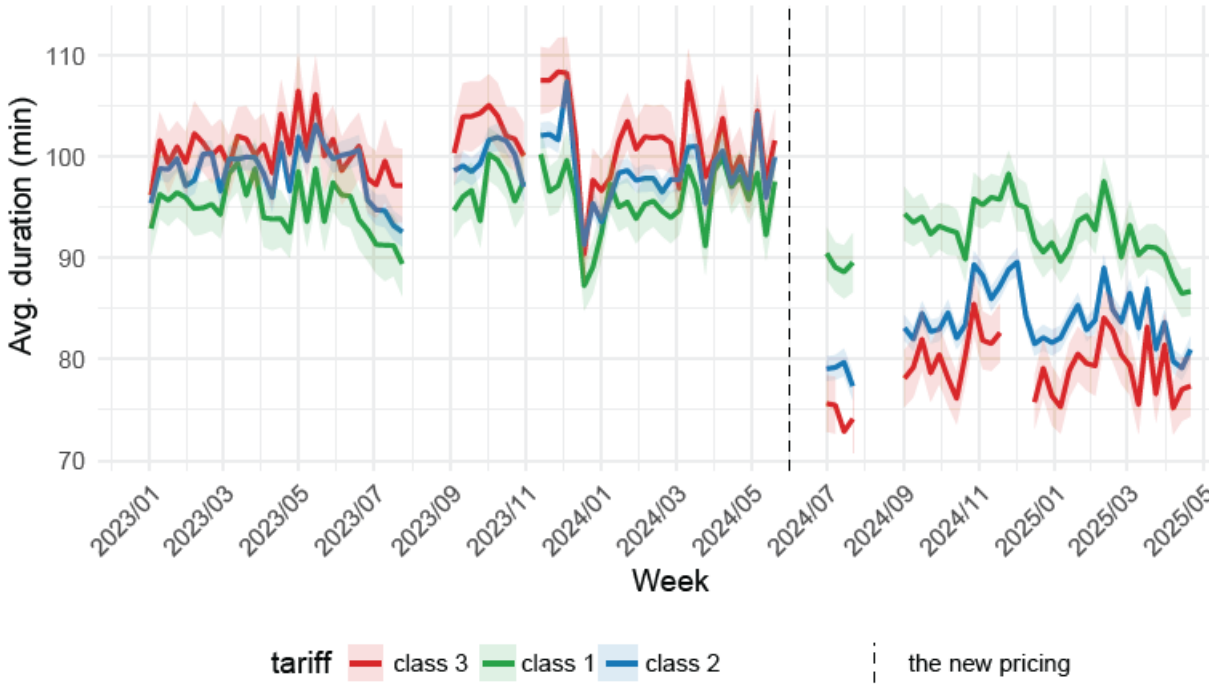
May 2025

Descriptive statistics

- Before the new pricing policy, the average parking duration in Lyon was 91 minutes. After the policy, it fell to 78 minutes .



(a) Average parking duration on weekdays, by tariff class.



(b) Average parking duration on Saturdays, by tariff class.

Main econometric results

	With FE	
	First Stage log(per_minute_price)	**Second Stage** log(parking_duration)
log(per_minute_price)		-0.311*** (0.004)
Instrument: post_pol (1: Yes)	0.352*** (0.002)	
Commercial activities	0.000*** (0.000)	-0.000*** (0.000)
Leisure activities	0.000*** (0.000)	0.000*** (0.000)
Near off-street parking (1: Yes)	-0.004*** (0.001)	0.021*** (0.002)
Weekend (1: Yes)	0.023*** (0.001)	0.106*** (0.001)
Time slot: Afternoon (ref)		
Time slot: Morning	0.016*** (0.000)	0.086*** (0.001)
Time slot: Midday	0.027*** (0.000)	0.147*** (0.001)
School holiday (1: Yes)	0.004*** (0.000)	-0.001* (0.001)
Plate Fixed Effects	Yes (1,361,932)	Yes (1,361,932)
N	7,741,198	7,741,198
Root Mean Squared Error (RMSE)	0.261	0.440
R^2 [a]	0.513	0.458

1st stage F-test stat. 1,697,354

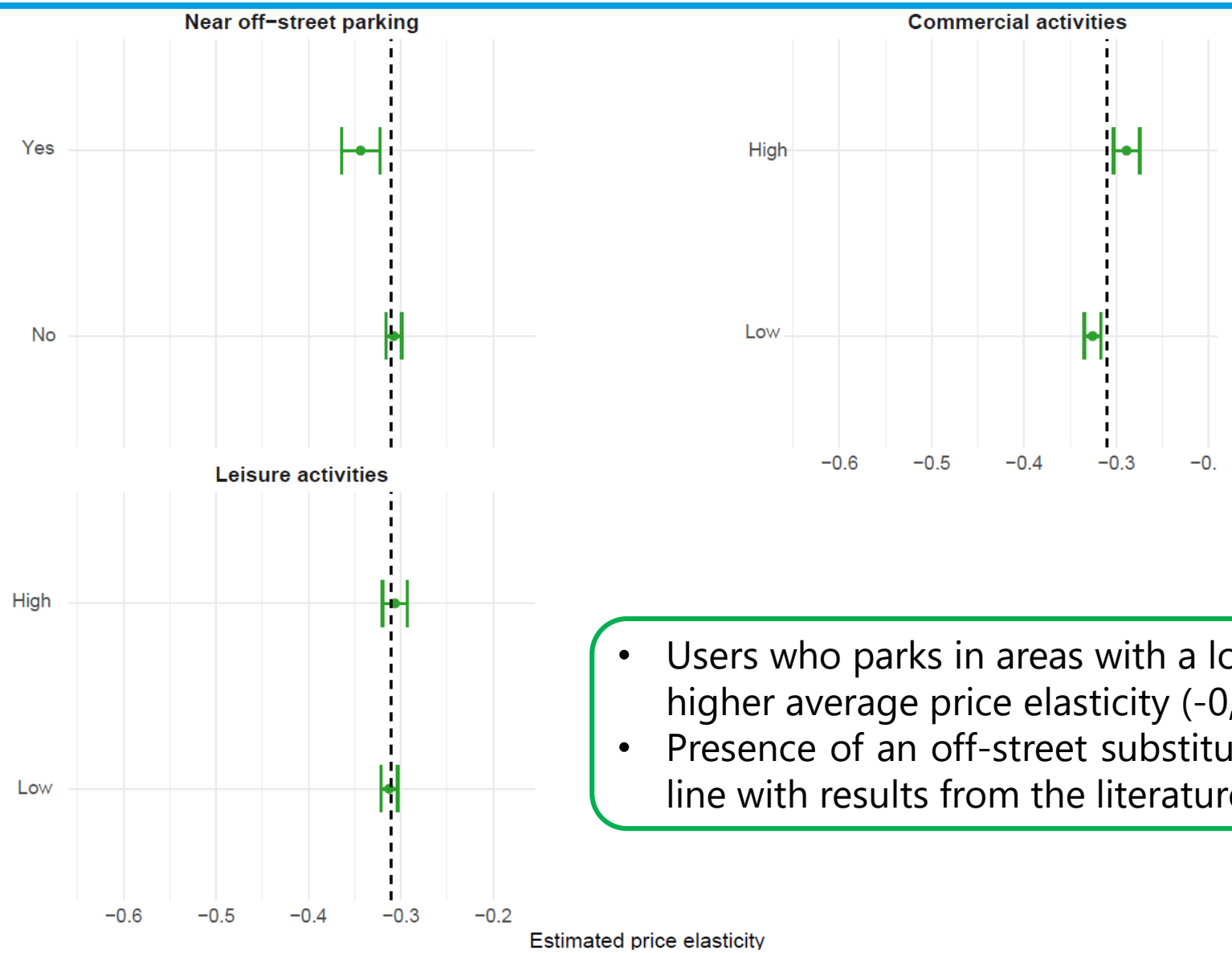
- Wu-Hausman test → endogeneity of price
- The instrument is strong (1st stage F-stat, Stock and Yogo)

- Elasticities consistent with previous RP studies (e.g., Kelly & Clinch, 2009 ≈ –0.4).

Control Variables X_{ik}

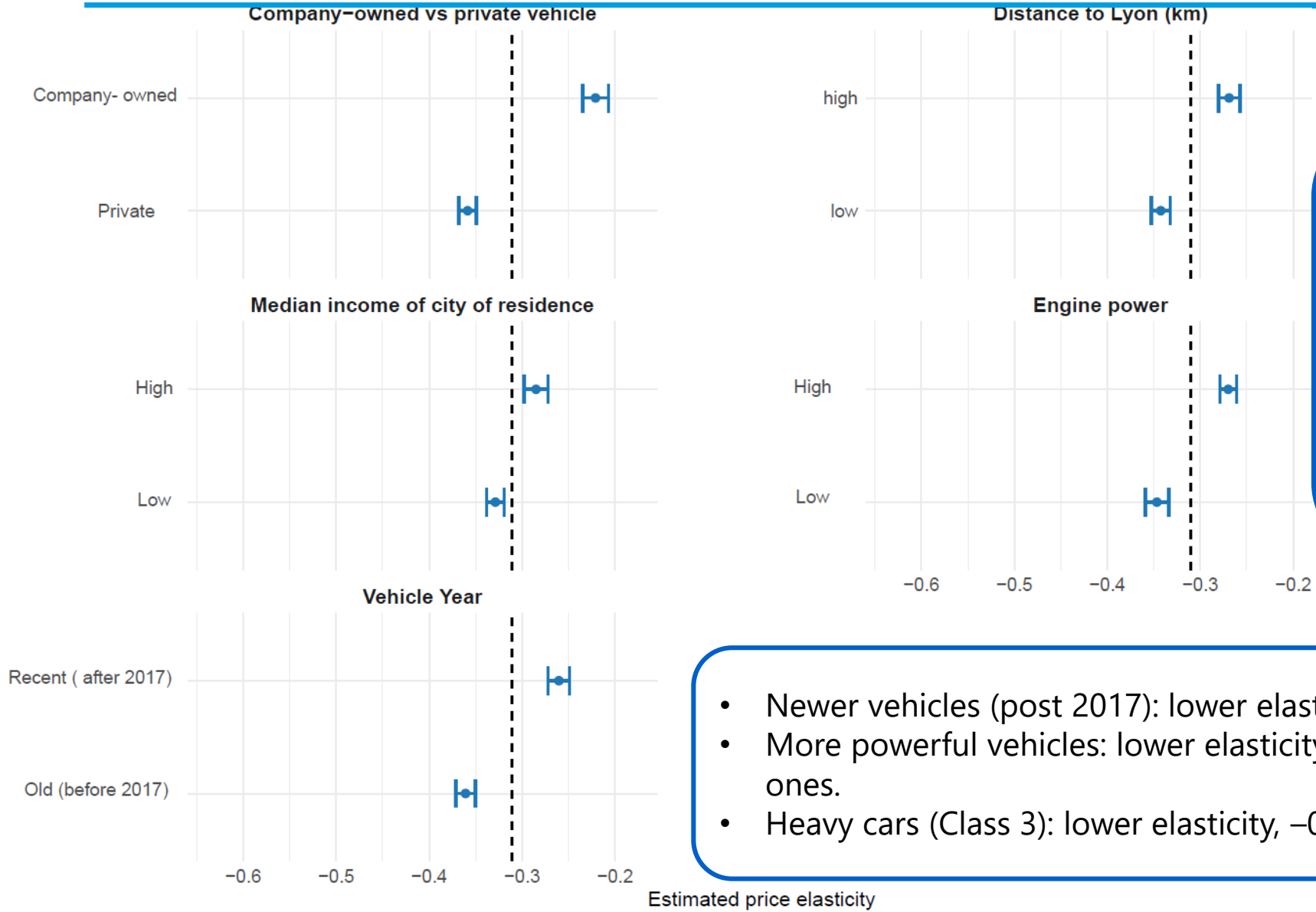
- **Saturday** & **school holidays** → longer durations.
- **Built environment:**
  → Higher concentration of commercial jobs : shorter stays.
  → Higher density of leisure activities (bars, cinemas, etc.): longer stays.

Heterogeneity – Built environment



- Users who parks in areas with a low density of commercial activities: higher average price elasticity (-0,33 vs -0,29)
- Presence of an off-street substitute: higher price by about –0.04, in line with results from the literature

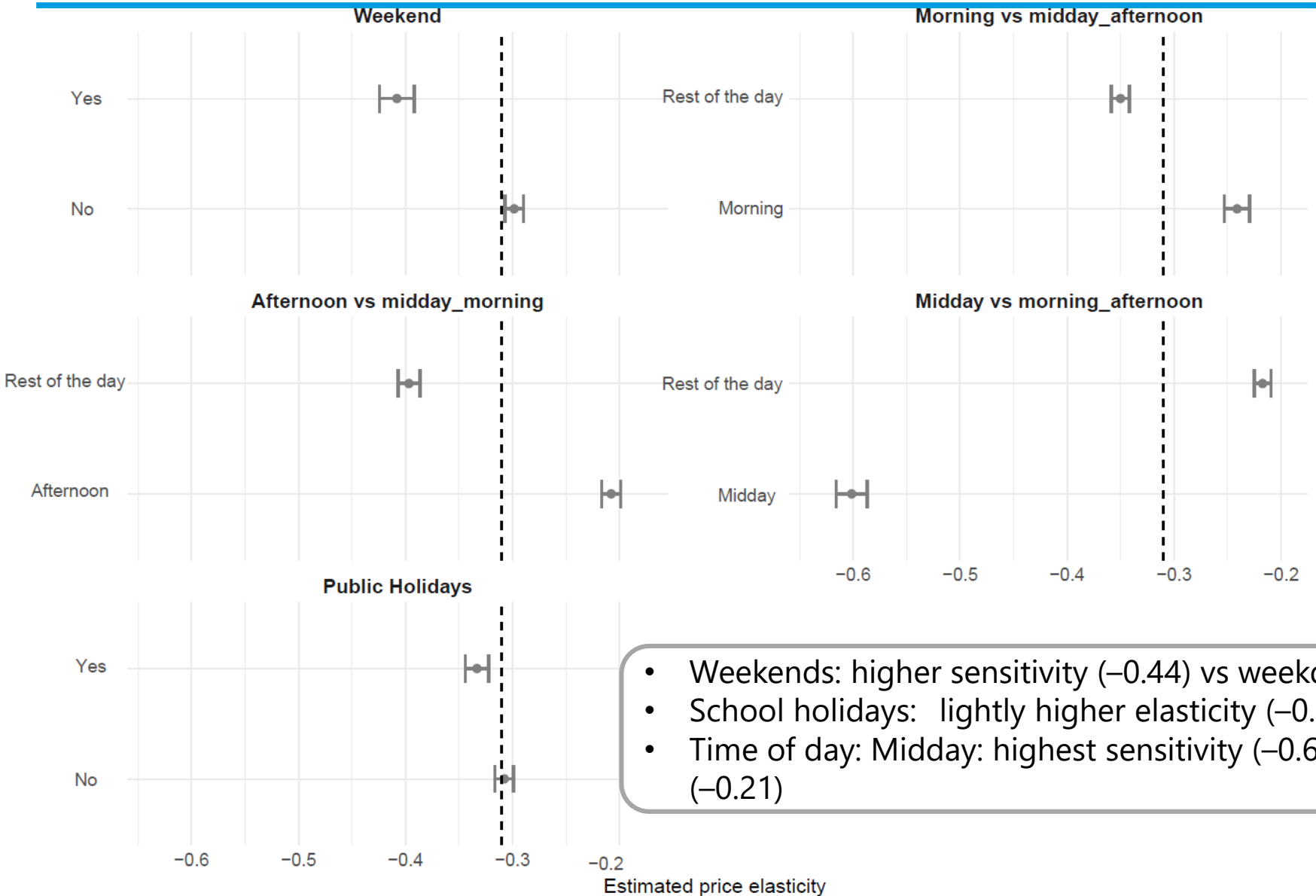
Heterogeneity - User characteristics



- Drivers living >19.4 km away: lower price elasticity (–0.27 vs –0.34).
- Users from wealthier municipalities (≥ €24,570 median income): lower sensitivity (–0.28 vs –0.33).
- Companies: much lower elasticity (–0.22 vs –0.36)

- Newer vehicles (post 2017): lower elasticity, –0.26 vs –0.36 for older ones.
- More powerful vehicles: lower elasticity –0.27 vs –0.35 for less powerful ones.
- Heavy cars (Class 3): lower elasticity, –0.30 vs –0.41 for others.

Heterogeneity - Temporal settings

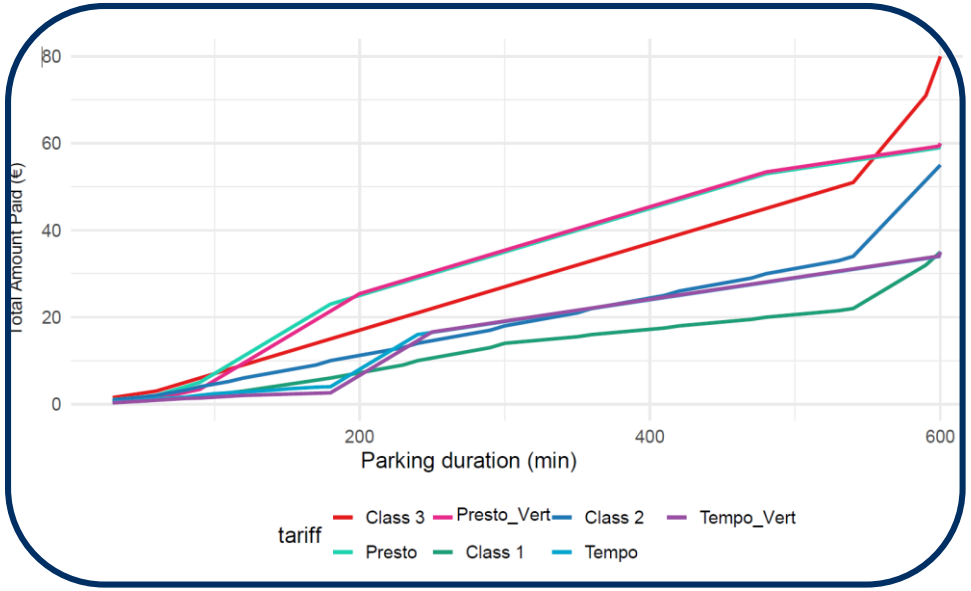


- Weekends: higher sensitivity (–0.44) vs weekdays (–0.30).
- School holidays: lightly higher elasticity (–0.33 vs –0.31).
- Time of day: Midday: highest sensitivity (–0.60). Afternoon: lowest sensitivity (–0.21)

Robustness – Alternative measure of price

	Using per-minute price		Using marginal price	
	First Stage log(per_minute_price)	**Second Stage** log(parking_duration)	**First Stage** log(marginal_price)	**Second Stage** log(parking_duration)
log(per_minute_price)		-0.311*** (0.004)		
log(marginal_price)				-0.315*** (0.004)
Instrument: post_pol (1: Yes)	0.352*** (0.002)		0.347*** (0.002)	
Commercial activities	0.000*** (0.000)	-0.000*** (0.000)	0.000*** (0.000)	-0.000*** (0.000)
Leisure activities	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Near off-street parking (1: Yes)	-0.004*** (0.001)	0.013*** (0.001)	0.002 (0.001)	0.015*** (0.001)
Weekend (1: Yes)	0.023*** (0.001)	0.063*** (0.001)	0.047*** (0.001)	0.071*** (0.001)
Time slot: Morning	0.016*** (0.000)	0.072*** (0.001)	0.018*** (0.001)	0.072*** (0.001)
Time slot: Midday	0.027*** (0.000)	0.109*** (0.001)	0.048*** (0.001)	0.115*** (0.001)
School holiday (1: Yes)	0.004*** (0.000)	-0.009*** (0.001)	0.002* (0.001)	-0.010*** (0.001)
Plate Fixed Effects	Yes (1,361,932)	Yes (1,361,932)	Yes (1,361,932)	Yes (1,361,932)
N	7,741,198	7,741,198	7,741,198	7,741,198
RMSE	0.261	0.440	0.533	0.498
R^2	0.513	0.458	0.303	0.396

Note: ***p < 0.01, **p < 0.05, *p < 0.1. Robust standard errors are in parentheses. The first-stage F-statistics are as follows: using the per-minute price, $F = 1,697,354$, $p < 2.2 \times 10^{-16}$; using the marginal price, $F = 394,572$, $p < 2.2 \times 10^{-}$ ntional



Fee schedule

choosing the right measure of price: marginal price, total price, or average unit price.

Conclusion

•Average price elasticity: –0.31

•**Proximity to alternatives:** Users near off-street parking are more price-sensitive.
•**Spatial context:** Commercial areas → lower price elasticities.
•**User characteristics:**
→ Local residents, lower-income users, and individuals → higher elasticity;
→ distant residents, high-income users, companies → lower elasticity.
•**Vehicle characteristics:** Newer, powerful, or heavier vehicles → lower price sensitivity.
•**Temporal patterns:** Weekends, school holidays, and midday trips → higher elasticity; afternoons → more inelastic demand

Policy implications:
•Support differentiated pricing by veh. weight, age, or power to align with willingness to pay.
•Opportunities for week/weekend pricing to manage demand
•Future research: Include more individual characteristics, off-street parking data, and trip purposes for a fuller understanding of price elasticities.

Future research

Price Shock Responses:

- Shorter parking duration:
  Users may continue to park but reduce their stay time.

- Fewer trips(volume elasticity):
  Some users may choose not to come at all when prices rise.
  → Requires methods to estimate missing / unobserved trips

- Fraud and avoidance behaviors:
  → acceptability issue : fraud data

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References

Abadie, A., Athey, S., Imbens, G.W., andWooldridge, J. M. (2023). When Should You Adjust Standard Errors for Clustering?*. The Quarterly Journal of Economics, 138(1):1–35.

Ahmadi Azari, K., Arintono, S., Hamid, H., and Rahmat, R. A. O. K. (2013). Modelling demand under parking and cordon pricing policy. Transport Policy, 25:1–9

Ajeng, C. and Gim, T.-H. T. (2018). Analyzing on-Street Parking Duration and Demand in a Metropolitan City of a Developing Country: A Case Study of Yogyakarta City, Indonesia. Sustainability, 10(3):591.

Albert, G. and Mahalel, D. (2006). Congestion tolls and parking fees: A comparison of the potential effect on travel behavior. Transport Policy, 13(6):496–502.

Brons, M., Nijkamp, P., Pels, E., and Rietveld, P. (2008). A meta-analysis of the price elasticity of gasoline demand. A SUR approach. Energy Economics, 30(5):2105–2122.

Cameron, A. C. and Miller, D. L. (2015). A Practitioner's Guide to Cluster-Robust Inference. Journal of Human Resources, 50(2):317–372. Publisher: University of Wisconsin Press Section: Symposium on Empirical Methods.

Cats, O., Zhang, C., and Nissan, A. (2016). Survey methodology for measuring parking occupancy: Impacts of an on-street parking pricing scheme in an urban center. Transport Policy, 47:55–63.

Coglianese, J., Davis, L. W., Kilian, L., and Stock, J. H. (2015). Anticipation, Tax Avoidance, and the Price Elasticity of Gasoline Demand.

Contoyannis, P., Hurley, J., Grootendorst, P., Jeon, S.-H., and Tamblyn, R. (2005). Estimating the price elasticity of expenditure for prescription drugs in the presence of non-linear price schedules: an illustration from Quebec, Canada. Health Economics, 14(9):909–923.

Ghuzlan, K. A., Al-Omari, B. H., and Khasawneh, M. A. (2016). Parking Demand for Residential Apartment Buildings in Jordan. ITE Journal.

Gragera, A., Hybel, J., Madsen, E., and Mulalic, I. (2021). A model for estimation of the demand for on-street parking. Economics of Transportation, 28:100231.

Hagen, O. H. and Tennøy, A. (2021). Street-space reallocation in the Oslo city center: Adaptations, effects, and consequences. Transportation Research Part D: Transport and Environment, 97:102944.

Hausman, J. A. (1978). Specification Tests in Econometrics. Econometrica, 46(6):1251–1271. Publisher: [Wiley, Econometric Society].

Hilvert, O., Toledo, T., and Bekhor, S. (2012). Framework and Model for Parking Decisions. Transportation Research Record, 2319(1):30–38. Publisher: SAGE Publications Inc.

INSEE (2023). Sirene [dataset].

Kelly, J. A. and Clinch, J. P. (2009). Temporal variance of revealed preference on-street parking price elasticity. Transport Policy, 16(4):193– 199.

Kim, H., Goodchild, A., and Boyle, L. N. (2022). Modeling the competing demands of carriers, building managers, and urban planners to identify balanced solutions for allocating building and parking resources. Transportation Research Interdisciplinary Perspectives, 15:100656.

Lehner, S. and Peer, S. (2019). The price elasticity of parking: A meta-analysis. Transportation Research Part A: Policy and Practice, 121:177–191.

Li, J., Wu, S., and Feng, X. (2021). Optimization of On-Street Parking Charges Based on Price Elasticity of the Expected Perceived Parking Cost. Sustainability, 13(10):5735. Number: 10.

Li, X., Guh, D., Lacaille, D., Esdaile, J., and Anis, A. H. (2007). The impact of cost sharing of prescription drug expenditures on health careutilization by the elderly: Own- and cross-price elasticities. Health Policy, 82(3):340–347.

Litman, T. (2009). Transportation elasticities: how prices and others factors affect travel behavior. Victoria Transport Policy Institute.

Low, R., Tekler, Z. D., and Cheah, L. (2020). Predicting Commercial Vehicle Parking Duration using Generative Adversarial Multiple Imputation Networks. Transportation Research Record, 2674(9):820–831. Publisher: SAGE Publications Inc.

Mingardo, G., van Wee, B., and Rye, T. (2015). Urban parking policy in Europe: A conceptualization of past and possible future trends. Transportation Research Part A: Policy and Practice, 74:268–281.

Moody, C. E. and Marvell, T. B. (2020). Clustering and Standard Error Bias in Fixed Effects Panel Data Regressions. Journal of QuantitativeCriminology, 36(2):347–369.

Ottosson, D. B., Chen, C., Wang, T., and Lin, H. (2013). The sensitivity of on-street parking demand in response to price changes: A case study in Seattle, WA. Transport Policy, 25:222–232.

References

Parmar, J., Das, P., Azad, F., Dave, S., and Kumar, R. (2020a). Evaluation of Parking Characteristics: A case study of Delhi. TransportationResearch Procedia, 48:2744–2756.

Parmar, J., Das, P., and Dave, S. M. (2020b). Study on demand and characteristics of parking system in urban areas: A review. Journal of Traffic and Transportation Engineering (English Edition), 7(1):111–124.

Pierce, G., Willson, H., and Shoup, D. (2015). Optimizing the use of public garages: Pricing parking by demand. Transport Policy, 44:89–95.

Pu, Z., Li, Z., Ash, J., Zhu, W., and Wang, Y. (2017). Evaluation of spatial heterogeneity in the sensitivity of on-street parking occupancy to price change. Transportation Research Part C: Emerging Technologies, 77:67–79.Qin, H., Zheng, F., Yu, B., and Wang, Z. (2022). Analysis of the Effect of Demand-Driven Dynamic Parking Pricing on on-Street Parking Demand. IEEE Access, 10:70092–70103.

Roth, G. J. (1965). Paying for parking. Number 33 in Hobart paper. Institute of Economic Affairs, London.

Russo, A., van Ommeren, J., and Dimitropoulos, A. (2019). The Environmental and Welfare Implications of Parking Policies. OECD Environment Working Papers 145.

Sen, S., Ahmed, M. A., and Das, D. (2016). A Case Study on On-Street Parking Demand Estimation for 4-Wheelers in Urban CBD. Journal of Basic and Applied Engineering Research, 3(3):54–258.

Seya, H., Asaoka, T., Chikaraishi, M., and Axhausen, K.W. (2024). Estimating the price elasticity of demand for off-street parking in Hiroshima City, Japan. Transportation Research Part A: Policy and Practice, 183:104051.

Shoup, D. (2005). The high cost of free parking. Routledge.

Shoup, D. C. (1997). Evaluating the effects of cashing out employer-paid parking: Eight case studies. Transport Policy, 4(4):201–216.

Simicevic, J. and Milosavljevic, N. (2014). Revealed preference off-street parking price elasticity,. Transport Research Arena.

Simicevic, J., Milosavljevic, N., and Kaplanovic, S. (2021). The impact of user sensitivity on parking price sustainability. Transportation Planning and Technology, 44(3):262–272. Publisher: Routledge eprint: https://doi.org/10.1080/03081060.2021.1883227

Stock, J. H. and Yogo, M. (2002). Testing for Weak Instruments in Linear IV Regression.

Sytral Mobilites (2015). EDGT 2015 - Enquete de Deplacement Grand Territoire 2015 - Lyon [dataset].

Verhoef, E., Nijkamp, P., and Rietveld, P. (1995). The economics of regulatory parking policies: The (IM)possibilities of parking policies I traffic regulation. Transportation Research Part A: Policy and Practice, 29(2):141–156.

Vickrey William (1954). The economizing of curb parking space. Traffic Engineering. Traffic engineering, 25(2):62–67.

Wang, H., Li, R., Wang, X. C., and Shang, P. (2020). Effect of on-street parking pricing policies on parking characteristics: A case study of Nanning. Transportation Research Part A: Policy and Practice, 137:65–78.

Wooldridge, J. M. (2016). Introductory econometrics: a modern approach. South-Western cengage learning.

Wu, D.-M. (1973). Alternative Tests of Independence between Stochastic Regressors and Disturbances. Econometrica, 41(4):733–750. Publisher: [Wiley, Econometric Society].

Xie, M., Wu, X., Ji, S., Gao, Y., and Wang, Y. (2024). Spatial effects of factors influencing on-street parking duration in newly built-up areas: A case study in Xi'an, China. Cities, 152:105250.