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Spatial Competition and Pass-through of Fuel Taxes: Evidence from a Quasi-natural Experiment in Germany Online-Appendix 2024

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Spatial Competition and Pass-Through of Fuel Taxes Evidence from a Quasi-natural Experiment in Germany

Online Appendix 2024

Abstract: This paper analyses determinants of pass-through for Germany's 2022 temporary fuel discount at its implementation and subsequent termination. Based on a unique dataset of fuel station characteristics and prices, we employ a two-stage Regression Discontinuity in Time (RDiT) methodology to estimate spatial pass-through variation. Our findings indicate that horizontal and vertical market structures exert an asymmetric influence on tax pass-through. Competitive pressure enhances price responsiveness to tax reductions, whereas we find the opposite pattern for the tax increase. Furthermore, independence from upstream markets is associated with lower tax pass-through, indicating the presence of double marginalization.

Keywords: gasoline prices, fuel taxation, spatial competition, tax pass-through, regression discontinuity in time

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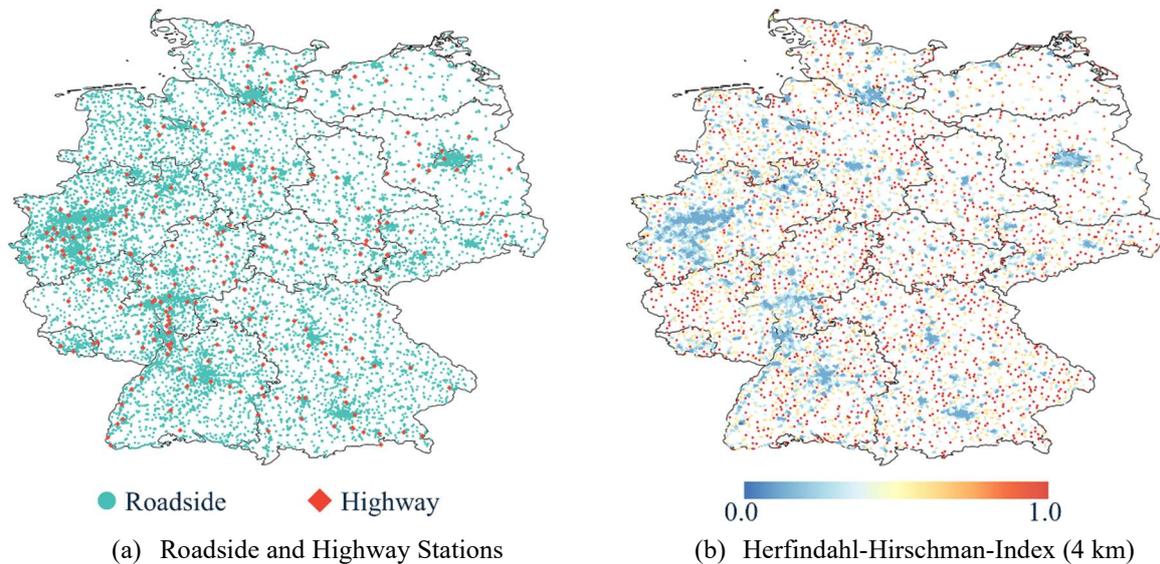
Online appendix to: Spatial Competition and Pass-Through of Fuel Taxes - Evidence from a quasi-natural Experiment in Germany

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A Appendix

Figure A.1: Observed Gas Stations across Germany 2022



Note: Visual representation of (a) all roadside and highway stations and (b) Herfindahl-Hirschman-Index (HHI) of roadside stations during the months of May and June. The HHI is based on a 4 kilometer market delineation.

Table A.1: Spatial Competition between Roadside Stations in Germany 2022

	Full Sample		Region Type					
			Urban		Intermediate		Rural	
3km Radius								
Brand Count	4.24	[4.23]	5.74	[5.70]	3.74	[3.74]	2.92	[2.89]
	(2.74)	[(2.72)]	(2.74)	[(2.72)]	(2.54)	[(2.54)]	(1.96)	[(1.93)]
Comp. Count	4.25	[4.21]	6.85	[6.77]	3.33	[3.32]	2.10	[2.06]
	(4.27)	[(4.22)]	(4.85)	[(4.76)]	(3.53)	[(3.54)]	(2.24)	[(2.20)]
HHI	0.41	[0.41]	0.28	[0.28]	0.45	[0.45]	0.53	[0.54]
	(0.30)	[(0.30)]	(0.21)	[(0.21)]	(0.30)	[(0.30)]	(0.32)	[(0.32)]
5km Radius								
Brand Count	6.41	[6.38]	9.20	[9.13]	5.53	[5.53]	3.86	[3.83]
	(3.94)	[(3.93)]	(3.63)	[(3.63)]	(3.50)	[(3.51)]	(2.41)	[(2.39)]
Comp. Count	9.05	[8.96]	16.32	[16.13]	6.35	[6.33]	3.28	[3.23]
	(9.20)	[(9.10)]	(10.56)	[(10.42)]	(6.15)	[(6.17)]	(2.96)	[(2.92)]
HHI	0.29	[0.29]	0.19	[0.19]	0.32	[0.32]	0.41	[0.41]
	(0.24)	[(0.29)]	(0.13)	[(0.13)]	(0.24)	[(0.24)]	(0.28)	[(0.28)]
Observations	14,257	[14,200]	4,791	[4,765]	6,451	[6,429]	3,015	[3,006]

Note: Average values for various measures of spatial competition during May and June. Values for August and September are included in squared brackets. Standard errors are in parentheses.

Table A.2: Pass-Through of the German Fuel Discount by Brand Affiliation

	Tax Reduction			Tax Increase		
	Super E5	Super E10	Diesel	Super E5	Super E10	Diesel
<i>Oligopolistic</i>						
ARAL	-27.22*** (0.01)	-27.22*** (0.01)	-12.13*** (0.01)	27.33*** (0.00)	27.33*** (0.00)	10.70*** (0.00)
SHELL	-27.42*** (0.02)	-27.49*** (0.02)	-11.16*** (0.01)	27.72*** (0.01)	27.77*** (0.01)	10.59*** (0.00)
TOTAL Energies	-27.63*** (0.02)	-27.62*** (0.02)	-12.22*** (0.01)	27.51*** (0.00)	27.51*** (0.00)	11.41*** (0.00)
<i>Other Integrated</i>						
ESSO	-27.10*** (0.01)	-27.08*** (0.02)	-11.57*** (0.01)	25.38*** (0.00)	23.86*** (0.00)	8.34*** (0.00)
JET	-26.16*** (0.02)	-26.16*** (0.02)	-10.82*** (0.01)	26.25*** (0.00)	26.25*** (0.00)	10.06*** (0.00)
<i>Independent</i>						
BFT	-27.22*** (0.03)	-27.15*** (0.03)	-12.18*** (0.01)	25.13*** (0.01)	25.03*** (0.01)	9.38*** (0.01)
AVIA	-25.70*** (0.02)	-25.65*** (0.02)	-10.53*** (0.01)	24.46*** (0.01)	24.31*** (0.01)	9.26*** (0.00)

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

Table A.3: Robustness - Tax Reduction

Bandwidth	96 hours		120 hours		144 hours	168 hours
Donut	9 hours	0 hours	9 hours	18 hours	9 hours	9 hours
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Super E5</i>						
TR	-28.09*** (0.00)	-28.74*** (0.00)	-28.17*** (0.00)	-26.70*** (0.00)	-27.87*** (0.00)	-27.14*** (0.01)
Controls	✓	✓	✓	✓	✓	✓
Constant	9.94*** (0.00)	11.06*** (0.00)	10.41*** (0.00)	9.76*** (0.01)	10.71*** (0.00)	10.23*** (0.00)
Adjusted R^2	0.897	0.871	0.888	0.881	0.878	0.870
<i>Super E10</i>						
TR	-28.07*** (0.00)	-28.72*** (0.00)	-28.16*** (0.00)	-26.68*** (0.00)	-27.86*** (0.00)	-27.13*** (0.01)
Controls	✓	✓	✓	✓	✓	✓
Constant	9.94*** (0.00)	11.05*** (0.00)	10.40*** (0.00)	9.74*** (0.00)	10.70*** (0.00)	10.22*** (0.00)
Adjusted R^2	0.897	0.871	0.888	0.882	0.878	0.871
<i>Diesel</i>						
TR	-12.34*** (0.00)	-13.32*** (0.00)	-12.54*** (0.00)	-11.07*** (0.00)	-11.59*** (0.00)	-11.75*** (0.00)
Controls	✓	✓	✓	✓	✓	✓
Constant	-3.32*** (0.00)	0.23*** (0.00)	-0.45*** (0.00)	-1.69*** (0.00)	-0.66*** (0.00)	-0.67*** (0.00)
Adjusted R^2	0.457	0.427	0.396	0.312	0.340	0.337
Observations	1,438,372	1,934,969	1,814,598	1,599,451	2,199,144	2,603,450

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

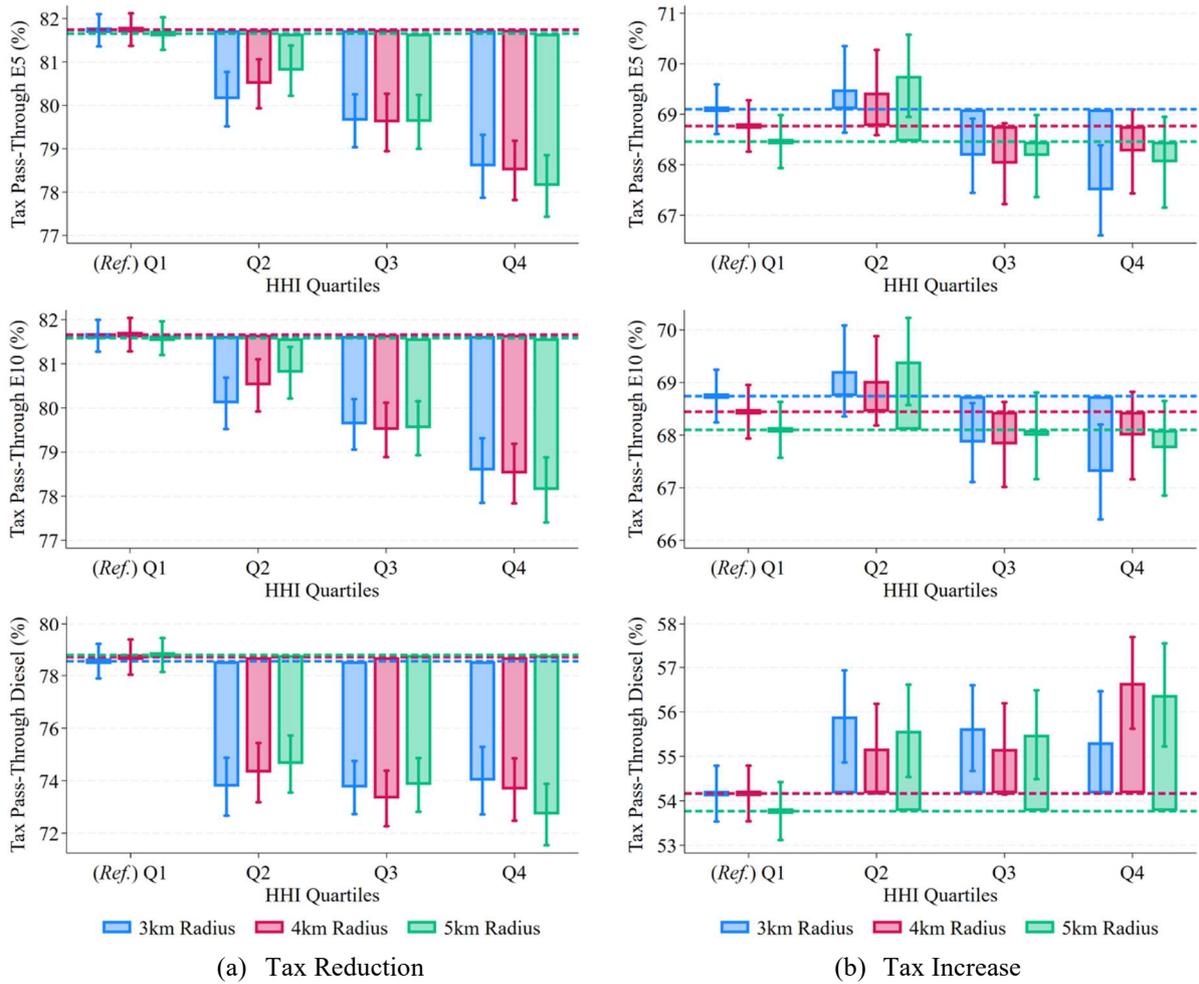
Table A.4: Robustness - Tax Increase

Bandwidth	96 hours		120 hours		144 hours	168 hours
Donut	9 hours	0 hours	9 hours	18 hours	9 hours	9 hours
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Super E5</i>						
TR	24.22*** (0.00)	23.64*** (0.00)	24.12*** (0.00)	24.86*** (0.00)	26.06*** (0.00)	26.68*** (0.00)
Controls	✓	✓	✓	✓	✓	✓
Constant	-5.09*** (0.00)	-4.66*** (0.00)	-5.05*** (0.00)	-4.85*** (0.01)	-5.95*** (0.00)	-6.12*** (0.00)
Adjusted R^2	0.768	0.763	0.773	0.776	0.753	0.744
<i>Super E10</i>						
TR	24.13*** (0.00)	23.55*** (0.00)	24.02*** (0.00)	24.74*** (0.00)	25.96*** (0.00)	26.59*** (0.00)
Controls	✓	✓	✓	✓	✓	✓
Constant	-4.99*** (0.00)	-4.56*** (0.00)	-4.94*** (0.00)	-4.74*** (0.01)	-5.84*** (0.00)	-6.02*** (0.00)
Adjusted R^2	0.763	0.758	0.768	0.771	0.748	0.738
<i>Diesel</i>						
TR	10.66*** (0.00)	8.67*** (0.00)	9.24*** (0.00)	8.90*** (0.00)	9.95*** (0.00)	10.25*** (0.00)
Controls	✓	✓	✓	✓	✓	✓
Constant	3.45*** (0.00)	4.60*** (0.00)	4.05*** (0.00)	4.33*** (0.00)	3.86*** (0.00)	3.87*** (0.00)
Adjusted R^2	0.357	0.355	0.363	0.349	0.328	0.308
Observations	1,427,828	1,921,610	1,800,621	1,585,042	2,210,222	2,621,176

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

Figure A.2: Tax Pass-Through (%) by HHI over Market Boundaries



Note: Heterogeneous pass-through levels for E5 and Diesel of the tax (a) reduction and (b) subsequent increase by market concentration quartiles over alternative market delineations. Each bar indicates the pass-through difference and 95% confidence interval regarding the bottom HHI quartile. The HHI is based on a 4 kilometer market delineation. Analogous regression results are presented in table A.5.

Table A.5: Heterogeneous Pass-Through across Alternative Market Delineations

	Tax Reduction			Tax Increase		
	3 km	4 km	5 km	3 km	4 km	5 km
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Super E5</i>						
TR	-28.74*** (0.07)	-28.74*** (0.07)	-28.71*** (0.07)	24.30*** (0.09)	24.18*** (0.09)	24.07*** (0.09)
TR × HHI Q ₂	0.56*** (0.11)	0.44*** (0.10)	0.30*** (0.10)	0.14 (0.15)	0.23 (0.15)	0.46*** (0.15)
TR × HHI Q ₃	0.73*** (0.11)	0.75*** (0.12)	0.72*** (0.11)	-0.32** (0.13)	-0.26** (0.14)	-0.10 (0.15)
TR × HHI Q ₄	1.10*** (0.13)	1.14*** (0.12)	1.23*** (0.13)	-0.56*** (0.16)	-0.18 (0.15)	-0.14 (0.16)
Constant	10.79*** (0.04)	10.84*** (0.04)	10.84*** (0.04)	-5.02*** (0.05)	-4.94*** (0.05)	-4.81*** (0.05)
<i>Super E10</i>						
TR	-28.70*** (0.06)	-28.71*** (0.07)	-28.68*** (0.07)	24.17*** (0.09)	24.07*** (0.09)	23.94*** (0.10)
TR × HHI Q ₂	0.54*** (0.10)	0.40*** (0.11)	0.28*** (0.10)	0.17 (0.16)	0.21 (0.15)	0.46*** (0.15)
TR × HHI Q ₃	0.71*** (0.10)	0.76*** (0.11)	0.72*** (0.11)	-0.31** (0.13)	-0.22 (0.14)	-0.04 (0.15)
TR × HHI Q ₄	1.07*** (0.13)	1.11*** (0.12)	1.21*** (0.13)	-0.51*** (0.16)	-0.16 (0.15)	-0.12 (0.16)
Constant	10.77*** (0.04)	10.82*** (0.04)	10.82*** (0.04)	-4.90*** (0.05)	-4.83*** (0.05)	-4.68*** (0.05)
Observations	1,814,598	1,814,598	1,814,598	1,800,621	1,800,621	1,800,621

Table A.5. continued

	Tax Reduction			Tax Increase		
	3 km	4 km	5 km	3 km	4 km	5 km
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Diesel</i>						
TR	-13.13*** (0.06)	-13.15*** (0.06)	-13.16*** (0.06)	9.05*** (0.05)	9.05*** (0.05)	8.98*** (0.06)
TR × HHI Q ₂	0.80*** (0.09)	0.73*** (0.10)	0.69*** (0.09)	0.29*** (0.09)	0.17** (0.09)	0.30*** (0.09)
TR × HHI Q ₃	0.80*** (0.09)	0.90*** (0.09)	0.83*** (0.09)	0.25*** (0.08)	0.17* (0.09)	0.29*** (0.09)
TR × HHI Q ₄	0.76*** (0.11)	0.84*** (0.10)	1.01*** (0.10)	0.19** (0.10)	0.42*** (0.09)	0.44*** (0.10)
Constant	-0.13*** (0.04)	-0.08** (0.04)	-0.09** (0.04)	3.91*** (0.03)	3.96*** (0.03)	4.06*** (0.04)
Observations	1,814,598	1,814,598	1,814,598	1,800,621	1,800,621	1,800,621

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level. The HHI is based on a 4 kilometer market delineation.

Table A.6: Heterogeneous Pass-Through by HHI over Vertical Integration

	Tax Reduction			Tax Increase		
	oligopol.	oth. indegr.	independ.	oligopol.	oth. indegr.	independ.
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Super E5</i>						
TR	-28.88*** (0.09)	-28.69*** (0.11)	-28.66*** (0.15)	24.99*** (0.15)	23.40*** (0.16)	23.93*** (0.16)
TR × HHI Q ₂	0.19 (0.14)	0.43** (0.19)	0.81*** (0.22)	0.23 (0.24)	0.23 (0.28)	0.08 (0.26)
TR × HHI Q ₃	0.31** (0.14)	0.75*** (0.20)	1.17*** (0.25)	-0.22 (0.24)	-0.22 (0.29)	-0.38 (0.23)
TR × HHI Q ₄	0.41** (0.17)	0.53** (0.23)	1.80*** (0.23)	-0.11 (0.25)	0.36 (0.32)	-0.38 (0.24)
Constant	10.90*** (0.05)	10.61*** (0.06)	10.92*** (0.08)	-5.26*** (0.07)	-5.06*** (0.08)	-4.51*** (0.08)
Observations	688,117	457,959	668,522	681,107	452,711	666,803

Table A.6. continued

	Tax Reduction			Tax Increase		
	oligopol.	oth. indegr.	independ.	oligopol.	oth. indegr.	independ.
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Super E10</i>						
TR	-28.89*** (0.09)	-28.67*** (0.11)	-28.56*** (0.15)	25.02*** (0.15)	22.98*** (0.16)	23.96*** (0.16)
TR × HHI Q ₂	0.19 (0.14)	0.42** (0.19)	0.72*** (0.23)	0.23 (0.24)	0.13 (0.28)	0.01 (0.26)
TR × HHI Q ₃	0.32** (0.15)	0.74*** (0.20)	1.17*** (0.22)	-0.23 (0.24)	-0.24 (0.29)	-0.35 (0.23)
TR × HHI Q ₄	0.41** (0.17)	0.52** (0.25)	1.69*** (0.22)	-0.11 (0.25)	0.37 (0.33)	-0.47** (0.24)
Constant	10.91*** (0.05)	10.60*** (0.06)	10.87*** (0.08)	-5.28*** (0.07)	-4.70*** (0.08)	-4.52*** (0.08)
<i>Diesel</i>						
TR	-13.16*** (0.08)	-13.01*** (0.09)	-13.21*** (0.11)	9.54*** (0.09)	8.48*** (0.09)	9.02*** (0.10)
TR × HHI Q ₂	0.69*** (0.14)	0.65*** (0.17)	0.84*** (0.17)	0.20 (0.14)	-0.06 (0.17)	0.22 (0.16)
TR × HHI Q ₃	0.69*** (0.13)	0.78*** (0.17)	1.16*** (0.17)	0.13 (0.14)	-0.03 (0.17)	0.25 (0.15)
TR × HHI Q ₄	0.55*** (0.15)	0.51** (0.20)	1.13*** (0.17)	0.52*** (0.15)	0.36* (0.19)	0.30** (0.15)
Constant	0.10* (0.05)	-0.35*** (0.06)	-0.09 (0.07)	3.51*** (0.05)	4.07*** (0.05)	4.26*** (0.07)
Observations	688,117	457,959	668,522	681,107	452,711	666,803

Note: Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level. The HHI is based on a 4 kilometer market delineation.

B Appendix

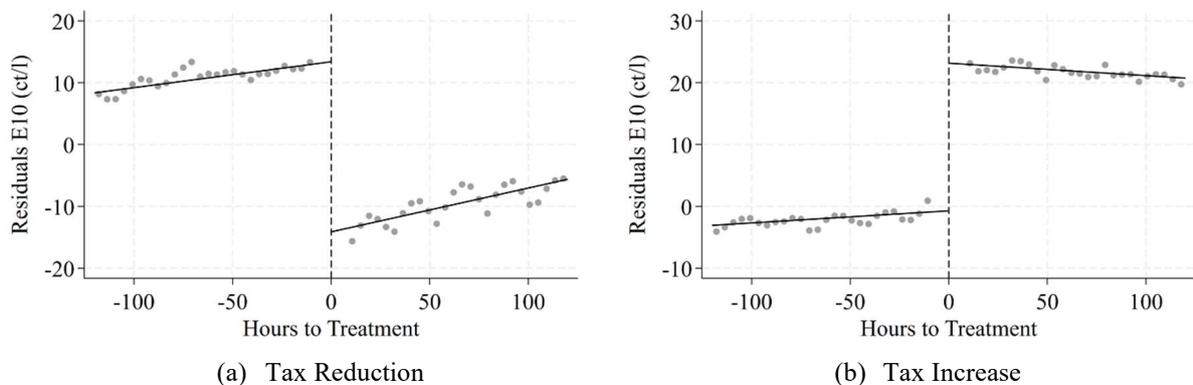
Table B.1: Average Pass-Through of the German Fuel Discount - Super E10

	Tax Reduction				Tax Increase			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TR	-27.51*** (0.01)	-29.03*** (0.00)	-27.63*** (0.01)	-28.16*** (0.00)	23.88*** (0.01)	24.05*** (0.00)	24.32*** (0.01)	24.02*** (0.00)
Seasonality	✓	✓	✓	✓	✓	✓	✓	✓
Supply Shifter		✓		✓		✓		✓
Demand Shifter			✓	✓			✓	✓
Constant	13.38*** (0.01)	11.61*** (0.00)	11.81*** (0.01)	10.40*** (0.00)	-0.72*** (0.00)	-1.36*** (0.00)	-3.49*** (0.01)	-4.94*** (0.00)
Observations	1,955,587	1,900,622	1,858,494	1,814,598	1,957,908	1,877,722	1,860,486	1,800,621

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

RDiT estimates indicate the effect of the tax intervention on retail prices in cents per liter. Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

Figure B.1: RDiT Plot (E10) - Average Nationwide Effect of the Fuel Discount in Germany 2022



Note: Graphical representation of the RDiT Estimates for E10 during the tax (a) reduction and (b) subsequent increase. Each dot illustrates average residuals across roadside stations in bins of 4 hours that account for seasonality effects. The linear function represents the time trend before and after the treatment, each for a period of 120 hours.

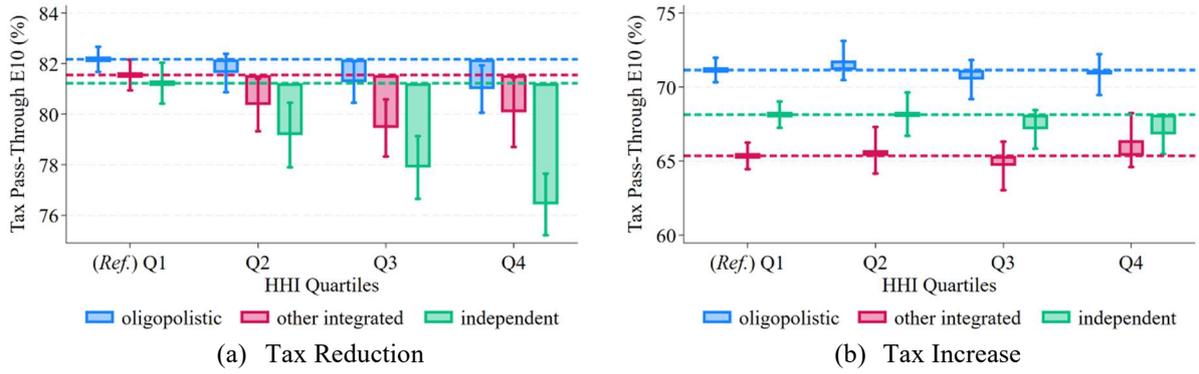
Table B.2: Heterogeneous Pass-Through of the German Fuel Discount - Super E10

	Tax Reduction				Tax Increase			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TR	-28.65***	-28.86***	-28.28***	-28.71***	24.82***	24.31***	24.12***	24.07***
	(0.05)	(0.05)	(0.04)	(0.07)	(0.07)	(0.07)	(0.05)	(0.09)
<i>Brand Category</i>								
TR × oth. integr.	0.31***				-1.51***			
	(0.09)				(0.13)			
TR × independ.	1.07***				-1.10***			
	(0.09)				(0.12)			
<i>Regional Typology</i>								
TR × intermed.		0.74***				-0.57***		
		(0.08)				(0.11)		
TR × rural		1.93***				-0.22		
		(0.13)				(0.15)		
<i>Dist. Next Cxomp.</i>								
TR × (1≤dist.<3)			-0.02				-0.08	
			(0.09)				(0.12)	
TR × (3≤dist.)			0.85***				-0.51***	
			(0.13)				(0.15)	
<i>Herfindahl-Index</i>								
TR × HHI Q ₂				0.40***				0.21
				(0.10)				(0.15)
TR × HHI Q ₃				0.76***				-0.22
				(0.11)				(0.15)
TR × HHI Q ₄				1.11***				-0.16
				(0.12)				(0.15)
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Constant	10.45***	11.00***	10.48***	10.82***	-5.60***	-4.74***	-4.87***	-4.83***
	(0.03)	(0.03)	(0.02)	(0.04)	(0.04)	(0.03)	(0.03)	(0.05)
Observations	1,814,598	1,814,598	1,814,598	1,814,598	1,800,621	1,800,621	1,800,621	1,800,621

Note: Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level. The HHI is based on a 4 kilometer market delineation.

Figure B.2: Tax Pass-Through (%) by HHI over Vertical Integration for E10



Note: Heterogeneous pass-through levels for E10 of the tax (a) reduction and (b) subsequent increase by market concentration quartiles over brand categories. Each bar indicates the pass-through difference and 95% confidence interval regarding the bottom HHI quartile. The HHI is based on a 4 kilometer market delineation Analogous regression results are presented in table B.2.

C Appendix

Table C.1: Average Pass-Through of the German Fuel Discount - Super E5 (Highway Stations)

	Tax Reduction				Tax Increase			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TR	-27.62***	-27.97***	-28.25***	-26.70***	26.45***	27.39***	27.15***	27.40***
	(0.16)	(0.01)	(0.02)	(0.00)	(0.23)	(0.00)	(0.18)	(0.00)
Seasonality	✓	✓	✓	✓	✓	✓	✓	✓
Supply Shifter		✓		✓		✓		✓
Demand Shifter			✓	✓			✓	✓
Constant	16.98***	13.66***	16.11***	12.17***	-6.35***	-5.75***	-9.49***	-9.34***
	(0.08)	(0.03)	(0.05)	(0.02)	(0.10)	(0.02)	(0.12)	(0.02)
Observations	49,061	40,478	47,360	39,224	49,785	44,410	48,076	43,176

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

Table C.2: Average Pass-Through of the German Fuel Discount - Super E10 (Highway Stations)

	Tax Reduction				Tax Increase			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TR	-27.68***	-28.02***	-28.30***	-26.75***	26.40***	27.34***	27.10***	27.35***
	(0.16)	(0.01)	(0.02)	(0.00)	(0.23)	(0.00)	(0.19)	(0.00)
Seasonality	✓	✓	✓	✓	✓	✓	✓	✓
Supply Shifter		✓		✓		✓		✓
Demand Shifter			✓	✓			✓	✓
Constant	16.95***	13.68***	16.09***	12.19***	-6.28***	-5.70***	-9.42***	-9.28***
	(0.08)	(0.03)	(0.05)	(0.03)	(0.10)	(0.02)	(0.12)	(0.02)
Observations	49,061	40,478	47,360	39,224	49,785	44,410	48,076	43,176

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

Table C.3: Average Pass-Through of the German Fuel Discount - Diesel (Highway Stations)

	Tax Reduction				Tax Increase			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TR	-12.92*** (0.06)	-13.24*** (0.00)	-12.85*** (0.01)	-12.84*** (0.00)	10.35*** (0.13)	9.38*** (0.00)	11.13*** (0.08)	9.85*** (0.02)
Seasonality	✓	✓	✓	✓	✓	✓	✓	✓
Supply Shifter		✓		✓		✓		✓
Demand Shifter			✓	✓			✓	✓
Constant	2.53*** (0.04)	2.65*** (0.02)	1.09*** (0.03)	1.03*** (0.02)	7.35*** (0.06)	5.56*** (0.01)	4.65*** (0.08)	2.56*** (0.02)
Observations	49,061	40,478	47,360	39,224	49,785	44,410	48,076	43,176

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

Table C.4: Robustness - Tax Reduction (Highway Stations)

Bandwidth	96 hours		120 hours		144 hours	168 hours
Donut	9 hours	0 hours	9 hours	18 hours	9 hours	9 hours
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Super E5</i>						
TR	-26.85*** (0.01)	-27.63*** (0.00)	-26.70*** (0.00)	-25.05*** (0.01)	-27.07*** (0.00)	-26.79*** (0.04)
Controls	✓	✓	✓	✓	✓	✓
Constant	11.76*** (0.03)	12.56*** (0.02)	12.17*** (0.02)	11.71*** (0.04)	12.90*** (0.02)	12.73*** (0.03)
Adjusted R^2	0.824	0.814	0.825	0.827	0.821	0.824
<i>Super E10</i>						
TR	-26.89*** (0.01)	-27.66*** (0.00)	-26.75*** (0.00)	-25.12*** (0.01)	-27.10*** (0.00)	-26.84*** (0.04)
Controls	✓	✓	✓	✓	✓	✓
Constant	11.76*** (0.03)	12.57*** (0.02)	12.19*** (0.02)	11.73*** (0.03)	12.91*** (0.02)	12.75*** (0.03)
Adjusted R^2	0.824	0.814	0.825	0.827	0.821	0.824
<i>Diesel</i>						
TR	-12.85*** (0.01)	-13.54*** (0.00)	-12.84*** (0.00)	-11.81*** (0.01)	-12.17*** (0.00)	-11.61*** (0.02)
Controls	✓	✓	✓	✓	✓	✓
Constant	0.98*** (0.02)	1.16*** (0.01)	1.03*** (0.02)	0.40*** (0.02)	1.00*** (0.01)	0.29*** (0.03)
Adjusted R^2	0.489	0.473	0.445	0.400	0.399	0.385
Observations	32,169	42,108	39,224	35,234	46,414	56,333

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.

Table C.5: Robustness - Tax Increase (Highway Stations)

Bandwidth	96 hours		120 hours		144 hours	168 hours
Donut	9 hours	0 hours	9 hours	18 hours	9 hours	9 hours
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Super E5</i>						
TR	26.92*** (0.00)	27.65*** (0.00)	27.40*** (0.00)	26.73*** (0.01)	29.21*** (0.00)	30.03*** (0.02)
Controls	✓	✓	✓	✓	✓	✓
Constant	-9.01*** (0.02)	-9.52*** (0.02)	-9.34*** (0.02)	-8.86*** (0.03)	-10.57*** (0.01)	-10.63*** (0.02)
Adjusted R^2	0.750	0.751	0.757	0.756	0.747	0.744
<i>Super E10</i>						
TR	26.87*** (0.00)	27.61*** (0.00)	27.35*** (0.00)	26.68*** (0.01)	29.18*** (0.00)	29.99*** (0.02)
Controls	✓	✓	✓	✓	✓	✓
Constant	-8.95*** (0.02)	-9.46*** (0.02)	-9.28*** (0.02)	-8.81*** (0.03)	-10.52*** (0.01)	-10.58*** (0.03)
Adjusted R^2	0.748	0.748	0.754	0.753	0.744	0.741
<i>Diesel</i>						
TR	10.62*** (0.00)	10.42*** (0.00)	9.85*** (0.00)	8.90*** (0.01)	10.89*** (0.00)	11.48*** (0.02)
Controls	✓	✓	✓	✓	✓	✓
Constant	2.45*** (0.02)	2.41*** (0.01)	2.56*** (0.02)	3.20*** (0.03)	1.96*** (0.01)	2.04*** (0.02)
Adjusted R^2	0.378	0.398	0.397	0.391	0.383	0.376
Observations	34,646	46,248	43,176	38,969	52,367	61,635

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Covariates include crude oil prices, exchange rates, traffic volumes, temperature, precipitation, and indicators for weekdays, hour of the day, and holidays, as well as station fixed effects. Standard Errors are block-bootstrapped sampled 1,000 times at the station level.