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Was the German fuel discount passed on to consumers?

by

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Abstract

In this article, I analyze whether German gasoline stations passed on the gasoline tax reduction to consumers. I use a difference-in-differences approach with France as the control group, as well as data for all countries in the European Union. The German fuel discount was in effect from June to August 2022. It was intensely debated in the general public whether German gasoline stations had increased prices before the tax reduction. Such a price increase would have made it easier for gasoline stations to disguise a price increase. Further questions follow: How long did it take for the full tax reduction to be passed on to consumers? Did gasoline stations reduce the pass-on after a few weeks? As I am the first to use complete French and German high-frequency data for the entire treatment period, I can examine how the pass-through of the tax cut evolved over time. I find substantial variance in pass-through rates over time. The average pass-through is very high but remains incomplete for all fuel types.

Keywords: pass-through, gasoline market, tax reduction, fuel taxes, petrol prices

JEL classification: H22, L13, L41

Declarations of interest: none

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1 Introduction - The Fuel Discount

The global energy crisis that appeared in 2022 was met by an unprecedented fiscal response from governments throughout Europe. Following the Corona Pandemic and the associated lockdowns to contain the pandemic, the economy of the European Union (EU) started to recover in spring 2021, with positive quarterly growth rates of real gross domestic product (OECD, 2023b) and gross domestic product[2] reaching its 2019 level again in 2021 (OECD, 2023a), and demand for energy surged. Furthermore, the Russian invasion of Ukraine on February 24 and the western reaction with sanctions (Bown, 2022) restricted the supply of fuel to Europe and drove prices further up.[3]

Governments all around the world, especially in Europe, sought to mitigate the effects of strongly increased gasoline prices for consumers by introducing relief packages consisting of tax reductions and additional measures. The German parliament approved a gasoline tax reduction for the period between June 1 and August 31, the so-called fuel discount (referred to as "Tankrabatt" in the public debate), that is, a tax reduction of 14.04 Eurocent per liter (cpl) on diesel and 29.55 cpl on both types of petrol, petrol E5 and petrol E10 (Bundesregierung, 2022).[4] Additionally, the 19% value-added tax (VAT) does not apply to the saved tax. Overall, prices should therefore decline by 16.71 cpl for diesel and 35.16 cpl for both types of petrol if the discount is fully passed on to consumers.[5]

While a tax reduction is administratively easy to implement, per capita payments seemed to be rather difficult to organize in the data-protection environment of the German bureaucratic system, as discussed by Stede et al. (2020). The speed of implementation comes at the cost of less control. Companies may pass on less than the full amount of the tax reduction to increase their profit margins.

A wave of literature on the German tax reduction in 2022 is currently emerging. Similar research is being conducted across Europe to examine the impact of policies to address the energy crisis. Before the end of the temporary German tax reduction, Fuest, Neumeier, and Stöhlker (2022) published first estimates of the pass-through rates for diesel and petrol (E5 and E10), based on a difference-in-differences (DID) approach using French gasoline stations

[2] OECD GDP – output approach, United Kingdom excluded.
[3] Bown (2022) provides a useful timeline of international sanctions against Russia, which is kept up to date by the Peterson Institute For International Economics.
[4] There are two types of petrol in Germany: 1) petrol E5 (also called *Super E5*), which has an octane rating of 95 and a 5% share of ethanol, and 2) petrol E10 (also called *Super E10*), which has a 10% share of ethanol.
[5] Precisely, the effective price decrease, including saved value-added tax, should be $0.1404 * 1.19 = 0.167076$ Euro per liter of diesel and $0.2955 * 1.19 = 0.351645$ Euro per liter of petrol.

as a control group but covering only the first two weeks after the tax reduction took effect. They find a pass-through rate of about 100% for diesel, 85% for petrol E5, and 82% for petrol E10. For the same limited time period, but with weekly instead of high-frequency data, Freitas and Syga (2022) find pass-through rates of 100% for both fuel types. They use weekly price data for Austria, Belgium, Germany, the Netherlands, Poland, and Sweden from the European Commission (2022), even though Sweden decreased its fuel taxes at the beginning of May and increased taxes to below the initial level at the beginning of October 2022.

Similarly, Drolsbach, Gail, and Klotz (2022) use weekly data for a short period (until June 19, 2022) for France, Germany, Italy, Austria, and Switzerland. They find substantially lower pass-through rates of about 50% for diesel and 79% for petrol E5, excluding petrol E10 from their analysis. Dovern et al. (2022) use the synthetic control method and data for the entire three months of the tax reduction. They conclude that the tax reduction was passed on to consumers. Moreover, they argue that it took about two weeks until the complete pass-through was reached and that it started to decline already in August, while the tax reduction was still in effect. However, again, they only use weekly price data, presumably from the European Commission (2022).

Empirical evidence on the pass-through of tax changes provides several insights. Carbonnier (2007) and Benzarti and Carloni (2019) found a less than proportional pass-through for tax changes when analyzing the French VAT reforms. Similarly, Carare and Danninger (2008) analyzed the German VAT increase in 2007 and reported less than full pass-through, while Viren (2009) examined tax changes across countries in the EU and also found less than full pass-through. Benedek, Mooij, and Wingender (2015) found mixed evidence for countries within the Eurozone. Specifically, they discovered less than full pass-through for reduced VAT rates but roughly 100% pass-through for the standard rate.

Conversely, Buettner and Madzharova (2021), and Chirakijja et al. (2009), found nearly full pass-through in member states of the EU, and Crossley, Low, and Sleeman (2014) found similar results for the United Kingdom. However, Crossley, Low, and Sleeman (2014) also noted that at least part of the pass-through of the VAT was reversed after a few months. In the United States, Poterba (1996) observed full pass-through, while Besley and Rosen (1999) reported overshifting of sales tax increases.

Montag, Sagimuldina, and Schnitzer (2020) recently analyzed the pass-through rate of the temporary value-added tax reduction in Germany. The tax reduction was a fiscal response to

the Corona Pandemic. Based on high-frequency data for Germany and France, they found pass-through rates of 83% for diesel, 40% for petrol E5, and 61% for petrol E10.

In this article, I analyze the pass-through rate of the temporary tax reduction on fuels in Germany, employing a DID strategy and using French gasoline stations as a control group. I am the first to analyze the temporary tax reduction with high-frequency data, covering the entire period of the tax reduction. Data from the same source have also been used by Montag, Sagimuldina, and Schnitzer (2020) and Fuest, Neumeier, and Stöhlker (2022) and contain the universe[6] of price changes at gasoline stations in Germany and France. Moreover, I am the only one to use the DID strategy with station and date fixed effects, and I control for public and school holidays at the same time. In a next step, I conduct robustness checks based on data for the entire EU from the European Commission (2022). This article contributes to the academic and public debate on the pass-through of tax reductions. Specifically, it answers the question whether German gasoline retailers passed the tax reduction on to consumers or not. The main goal of this article is to analyze whether tax reductions are passed on to consumers in the gasoline market and what dynamics underlie the pass-on process over time. My empirical results contribute to the general literature on tax reductions and the pass-through of these reductions by gasoline retailers to consumers.

Using France as a control group, I find pass-through rates of 87% to 91% on average, depending on the fuel type. The complete high-frequency price data allows me to trace out the evolution of pass-through rates over time, based on daily estimates instead of weekly data as by Dovern et al. (2022). The pass-through rates vary substantially over time, between -10% and 147% for diesel and between 47% and 114% for petrol E5. The results of weekly estimates based on data for 19 countries in the EU are very similar.

The remainder of the article is structured as follows: In Section 2, I describe the data; in Section 3, I describe the identification strategy. Section 4 contains the results and is followed by a discussion of the threats to validity and robustness checks in Section 5. I summarize and conclude in Section 6.

2 Data Description

The German data for gasoline stations and prices are collected by the German Market Transparency Unit for Fuels, which was created to enable the German federal competition

[6] All gasoline prices reported to federal supervision authorities by those gasoline stations obliged to report their price changes in Germany and France.

authority (Bundeskartellamt, 2023) to intervene in cases of market power abuse. The data is made publicly available by registered consumer information service providers. I downloaded the German data from tankerkoenig.de, which receives the data directly from the Market Transparency Unit. The data contain all price changes for all German gasoline stations. The German retail fuel market is well described by Montag, Sagimuldina, and Schnitzer (2020).

French data are publicly available on the open data website of the French government (Ministère de l'Économie, des Finances et de la Souveraineté industrielle, 2022).[7] The data include all price changes for all gasoline stations that sell more than $500\ m^3$ of gasoline per year and are described in detail by Gautier and Le Saout (2015). In France, a fuel discount has also been granted since April 1, 2022. Important for the DID strategy is that the development of gasoline prices over time in Germany and France was similar before the German tank rebate came into effect, as argued by Fuest, Neumeier, and Stöhlker (2022). By using France as a control group, I follow Fuest, Neumeier, and Stöhlker (2022), Freitas and Syga (2022), and Montag, Sagimuldina, and Schnitzer (2020), among others, and discuss the parallel trends assumption in detail in the following section.

My analysis starts on April 14, 2022, similar to previous research, but covers the entire period of the tax reduction and goes until the end of the tax reduction on August 31, 2022. I take the daily average price for each German and French gasoline station and date and work with daily data, similar to Montag, Sagimuldina, and Schnitzer (2020) and Fuest, Neumeier, and Stöhlker (2022).

Crude oil prices are presented in descriptive statistics and approximated by the Brent price, as is commonly done in the literature. The data were retrieved from finanzen.net (2022). The crude oil price for September 5, the Labor Day, when the stock exchange was closed, is approximated by the price of September 6.

Data on public and school holidays in Germany come from Kalenderpedia (2022). Data on public and school holidays in France are gathered from the French government website data.gouv.fr and created by Augusti (2022). Also, data on French communes is retrieved from that website and created by Badaoui (2022). And data on the French holiday zones is publicly available at vacances-scolaires-education.fr (2022).

In Table 1, I show descriptive statistics for the analysis of the German tax reduction with France as a control group. This table is for diesel and contains statistics before the tax

[7] The author would like to thank Lennart Seeger for help with data preparation.

reduction in panel a) and after the tax reduction in panel b), differentiating between the treatment group (German gasoline stations) and the control group (French gasoline stations). Similar descriptive statistics tables for petrol E5 and petrol E10 are presented in Appendix Tables 1 and 2, respectively. The average French diesel price was about 189.4 cpl before the tax reduction and 199.1 cpl afterwards. The average German diesel price was 203.1 cpl before and 197.7 cpl after the tax reduction. On average, the crude oil price increased over time from 66.8 cpl to 69.9 cpl. In France, about 37% of prices are reported during public or school holidays before the German tax reduction and about 61% afterwards, compared to about 23% and 48% in Germany.

Table 1: Descriptive Statistics for France and Germany, Diesel, April 14 to August 31

a) Descriptive Statistics Before Tax Reduction, Diesel

	Mean	Median	SD	N
Non-Treatment-Group:				
Daily Average Diesel Price, EUR/l	1.894	1.889	.08	434600
Crude Oil Closing Price, EUR/l	.668	.67	.023	280917
Public or School Holiday	.367	0	.482	428648
Treatment-Group:				
Daily Average Diesel Price, EUR/l	2.031	2.026	.057	682098
Crude Oil Closing Price, EUR/l	.668	.67	.023	440658
Public or School Holiday	.226	0	.418	682098

b) Descriptive Statistics After Tax Reduction, Diesel

	Mean	Median	SD	N
Non-Treatment-Group:				
Daily Average Diesel Price, EUR/l	1.991	1.987	.132	836858
Crude Oil Closing Price, EUR/l	.699	.7	.022	272339
Public or School Holiday	.609	1	.488	825212
Treatment-Group:				
Daily Average Diesel Price, EUR/l	1.977	1.976	.079	1313545
Crude Oil Closing Price, EUR/l	.699	.7	.022	427105
Public or School Holiday	.482	0	.5	1313545

Furthermore, I use a dataset from the European Commission (2022) that contains weekly gasoline price data for all countries in the EU for diesel and petrol E5 (but not for petrol E10). I exclude all countries with changes in excise duties or value-added taxes between April 14 and August 31, namely Croatia, the Czech Republic, Hungary, Luxembourg, Portugal, and Sweden. Data on these changes is also provided by the European Commission (2022). Moreover, I exclude Malta, which regulated the prices for petrol and diesel for the entire year, and I exclude Slovenia because price caps were in place at several time periods (Sgaravatti, Tagliapietra, and Zachmann, 2021). In contrast to the case with daily price data and solely France as a control group, here with the data for several European countries, I abstain from controlling for holidays when using countries of the EU as a control group.

Table 2: Tax Changes for alle Countries in the EU, 2022

Country	Country Code	Tax change for E5	Tax change for diesel	Other relief changes	In control group?
Austria	AT	0	0		Yes
Belgium	BE	8	1		Yes
Bulgaria	BG	0	0		Yes
Croatia	HR	2	2		No
Cyprus	CY	1	1		Yes
Czech Republic	CZ	2	1		No
Denmark	DK	1	1		Yes
Estonia	EE	0	0		Yes
Finland	FI	0	0		Yes
France	FR	0	0	3	Yes
Germany	DE	2	2	2 (Introduction and end of subsidized public local transport ticket)	-
Greece	GR	0	0		Yes
Hungary	HU	20	20		No
Ireland	IE	3	3		Yes
Italy	IT	1	1		Yes
Latvia	LV	0	0		Yes
Lithuania	LT	0	0		Yes
Luxembourg	LU	3	3		No
Malta	MT	0	0	Subsidies fixed prices for petrol E5 to 1.21 €/l and diesel to 1.34 €/l	No
Netherlands	NL	2	2		Yes
Poland	PL	1	1		Yes
Spain	ES	0	0		Yes
Portugal	PT	11	11		No
Romania	RO	1	1		Yes
Sweden	SE	3	3		No
Slovenia	SI	1	1	Price regulation: max of 1.56 €/l for petrol and 1.668 €/l for diesel in March and April 2022	No
Slovakia	SK	0	0		Yes

Note, that a change is either an increase or a decrease. In case of Germany, there was one tax decrease on June 1 and one increase on September 1.

On July 25, 2022, the Weekly Oil Bulletin data from the European Commission (2022) showed a drastic decrease in petrol and diesel prices for Estonia. Since there is no media

coverage of any event that would have caused such a drop in prices, I assume that this single data observation is false and exclude it.[8]

Table 3: Germany and EU Control Group Countries: Descriptive Statistics, Diesel

a) Before Tax Reduction

	Mean	Median	SD	N
AT diesel with tax	1.848	1.849	.019	6
BE diesel with tax	1.971	1.967	.048	6
BG diesel with tax	1.612	1.627	.039	6
CY diesel with tax	1.781	1.789	.035	6
DE diesel with tax	2.046	2.039	.025	6
DK diesel with tax	2.029	2.027	.05	6
EE diesel with tax	1.84	1.85	.039	6
ES diesel with tax	1.873	1.87	.024	6
FI diesel with tax	2.22	2.225	.024	6
FR diesel with tax	1.877	1.877	.039	6
GR diesel with tax	1.869	1.865	.029	6
IE diesel with tax	1.923	1.929	.02	6
IT diesel with tax	1.808	1.816	.025	6
LT diesel with tax	1.767	1.772	.022	6
LV diesel with tax	1.869	1.874	.03	6
NL diesel with tax	1.995	1.993	.035	6
PL diesel with tax	1.565	1.558	.016	6
RO diesel with tax	1.739	1.751	.026	6
SK diesel with tax	1.765	1.772	.034	6
Crude Oil Closing Price, EUR/l	.657	.656	.04	6
b) After Tax Reduction				
AT diesel with tax	1.968	2.01	.111	13
BE diesel with tax	2.023	2.005	.098	13
BG diesel with tax	1.724	1.726	.054	13
CY diesel with tax	1.904	1.884	.062	13
DE diesel with tax	1.987	1.977	.055	13
DK diesel with tax	2.135	2.122	.107	13
EE diesel with tax	1.914	1.945	.078	12
ES diesel with tax	1.95	1.933	.1	13
FI diesel with tax	2.255	2.244	.138	13
FR diesel with tax	1.966	1.961	.111	13
GR diesel with tax	1.964	1.941	.104	13
IE diesel with tax	2.016	2.009	.098	13
IT diesel with tax	1.895	1.894	.1	13
LT diesel with tax	1.882	1.863	.085	13
LV diesel with tax	1.928	1.939	.115	13
NL diesel with tax	2.064	2.061	.092	13
PL diesel with tax	1.602	1.605	.06	13
RO diesel with tax	1.807	1.807	.028	13
SK diesel with tax	1.848	1.861	.059	13
Crude Oil Closing Price, EUR/l	.657	.661	.044	13

Austria did not change its tax during the observation period. Belgium decreased its tax between March 14 and 21 by 14.463 cents per liter (cpl) and increased it in small steps

[8] A request to the "Europe Direct Contact Centre" about this anomaly was not answered in a revealing manner. The author would like to thank the Estonian researcher Katri Urke for looking for relevant information in Estonian.

starting before September 12 (by 3.305 cpl), but not during the German temporary tax reduction.

The French relief package did technically not consist of a tax or duty reduction but rather of a discount on petrol and diesel, namely *l'aide exceptionnelle à l'acquisition de carburants* (in English, exceptional aid for the acquisition of fuels), as described in the decree (Ministère de la Transition Énergétique, 2022). This subsidy is paid to the producers of gasoline, specifically the distributors furthest up the distribution network, and only for quantities sold (Ministère de la Transition Énergétique, 2022). Therefore, it works like the tax reduction, which also occurs at a stage before retailing. To account for such cases, I introduced the column "other relief changes" in Table 2. Also, Germany introduced other reliefs than the tax reduction, namely the so-called 9-Euro-Ticket for local public transport, which was introduced simultaneously with the tax relief on June 1 and ended on August 31.[9]

Descriptive statistics for the weekly diesel prices of all countries in the EU that are in the control group plus Germany are presented in Table 3. There are data for six weeks before the German tax reduction and for 13 weeks after the reduction was put into force, hence covering the entire treatment period plus 6 weeks before the treatment.[10] Diesel prices (excluding Germany) are on average over all countries almost 8 cpl higher during the treatment period. Crude oil prices are only 4 cpl higher on average. Similar descriptive statistics for petrol E5 are moved to Appendix Table 3.

3 Identification Strategy

In this section, I outline the proposed estimation strategy and examine the control groups. The first subsection presents the econometric model. The second subsection discusses the use of French gasoline stations as a control group, while the third subsection examines the use of countries in the European Union as an additional control group.

3.1 Difference-in-differences Model

To test whether the German fuel discount was passed on to consumers, I apply DID estimation techniques. First, I use French gasoline stations as the control group, and then I use several countries in the EU as a control group. The model can be formalized as follows:

[9] The ticket was valid for the month of acquisition. Thus, if it was acquired on June 20, then it could be used until the end of June. It was valid for the local public transport in Germany.
[10] For Estonia, there are only 12 weeks because one week was excluded, as discussed before.

$$p_{i,t} = \beta_0 + \beta_1 p_t + \beta_2 d_i + \beta_3 p_t * d_i + u_{i,t} \quad (1)$$

with the dependent variable $p_{i,t}$ being the price of gasoline stations. The coefficient β_0 is the constant. The regressor p_t takes the value 1 for the observations in the post-shock period and 0 otherwise. Thus, β_1 captures the average change in the price from the pre- to post-treatment periods for the control group. The regressor d_i is a dummy variable that indicates whether a station i is treated. Therefore, it takes the value 1 for German stations and the value 0 for the control group (e.g., French stations). The coefficient β_2 captures the pre-shock difference in the price between Germany and the control group. Finally, the main coefficient β_3 captures the effect of the tax reduction, hence the average treatment effect (ATE).

I include fixed effects on the station and the date level and control for public and school holidays. Including the holiday control variable as well as time and station fixed effects changes the formal model to:

$$p_{i,t} = \beta_0 + \beta_1 p_t * d_i + \beta_2 h_{i,t} + \mu_i + \delta_t + u_{i,t}. \quad (2)$$

In equation (2), the control variable for public and school holidays is $h_{i,t}$. The μ_i and δ_t are station and date fixed effects, respectively. Finally, I present several robustness checks in Section 5 of this article.

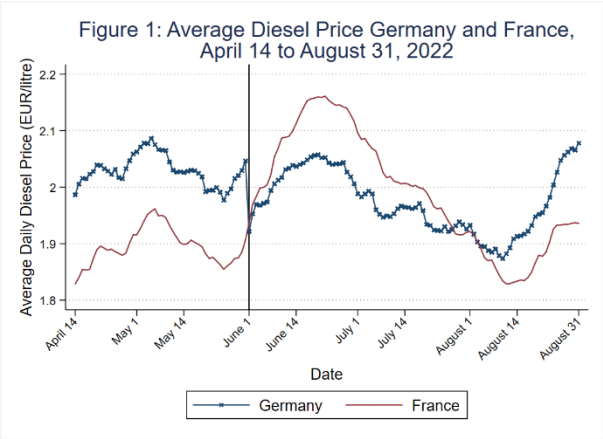
3.2 France as a Control Group

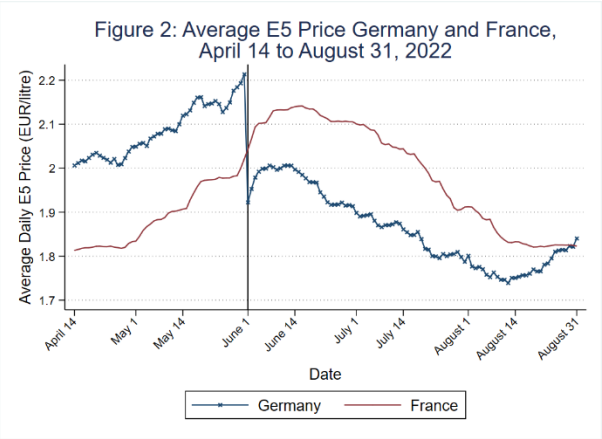
As a neighboring country of Germany, the French economy is in many ways similar to the German economy. Both countries are of similar size, are wealthy, and are located in the west of Europe, which alleviates concerns that transitory shocks could affect them differently. Both countries established mechanisms to promote transparency in the gasoline market, ensuring the availability of very accurate price data. To causally identify the effect of the German tax reduction on gasoline prices, two assumptions must be satisfied. Firstly, there should be no economic shocks affecting Germany and France asymmetrically other than the tax reduction itself. Secondly, there should be no spillover effects from the German tax reduction on the French gasoline market.

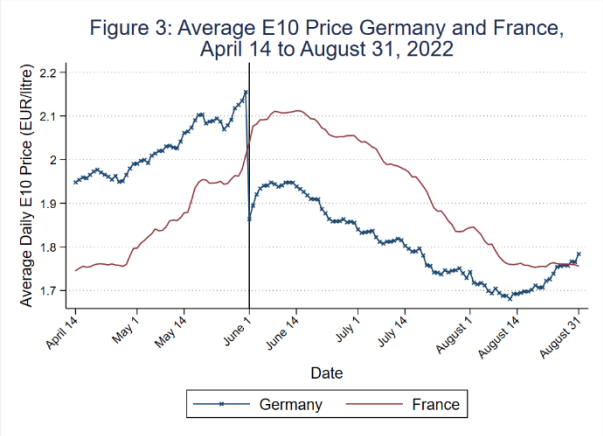
I use fixed effects on the station level to control for any time-invariant differences between gasoline stations in Germany and France. Date-fixed effects are used to control for symmetric shocks. Due to their geographic proximity, supply shocks should affect German and French gasoline stations similarly and are therefore controlled for through date-fixed effects. Furthermore, both countries are members of the European Single Market; hence, there are no

border controls and regulations are harmonized. Moreover, I control in detail for public and school holidays because they could affect the demand side notably. During the period studied, there were no travel restrictions due to the pandemic in either country.

Figures 1, 2, and 3 show that the common trends assumption for Germany and France is fulfilled before the treatments for diesel, petrol E5, and petrol E10, respectively. Also, Appendix Figures 1-3 show the common trend depicting the evolution of the difference between German and French average prices over time.



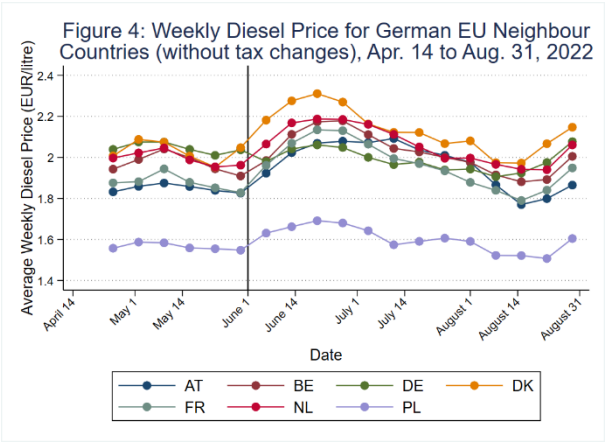


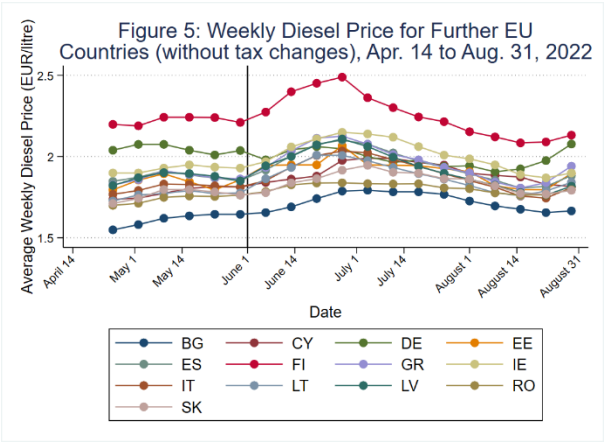


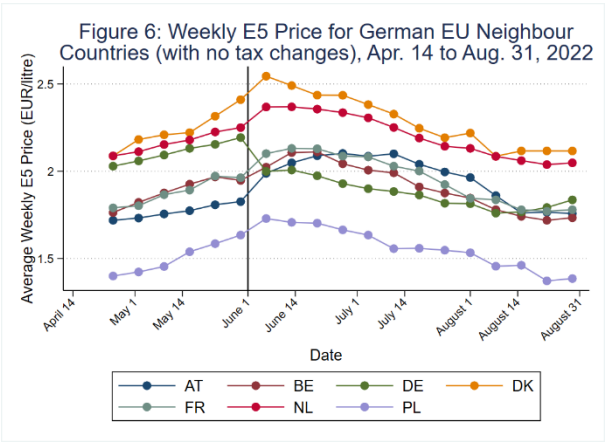
There were several fuel discounts on the French mainland in 2022. On April 1, the first discount of 18 cpl was introduced. The discount was increased to 30 cpl on September 1. Thus, it is not possible to conduct a robustness check to check for treatment reversal. The French discount changed to 10 cpl on November 16. It ended on December 31. Overall, there were no tax changes or reforms during the period studied (April 14 to August 31).

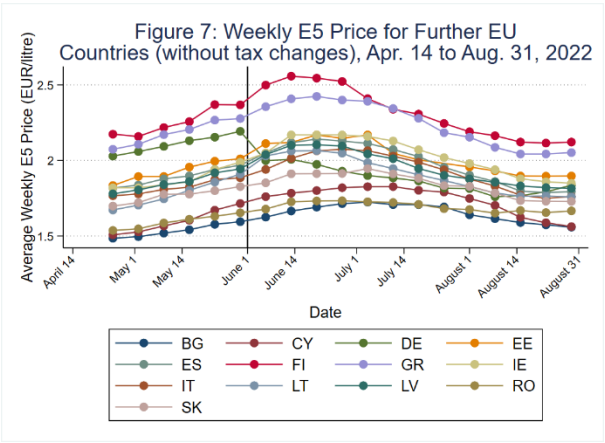
3.3 Countries in the European Union as a Control Group

Figures 4 and 5 show the weekly diesel price for Germany and for those German EU neighbor countries that had no tax changes in the relevant time period (April 14 to August 31).[11] Similarly, Figures 6 and 7 show prices for petrol E5. I exclude all countries with their own tax changes or reforms in the relevant time period, as described in the data section. Again, prices in all these countries of the EU seem to have followed a similar trend prior to the German tax reduction, as well as afterwards, apart from Germany itself. Price levels, however, vary substantially across different countries. Therefore, I conduct robustness checks with different country groups.









Again, I use station and date fixed effects in DID regressions to control for time-invariant differences and symmetric shocks. The fact that the data from the EU are weekly price data makes it redundant to control in detail for public and school holidays because holidays vary substantially from day to day and throughout the regions of each country.

[11] See Table 2 for country codes.

4 Results

The present section is partitioned into two subsections, wherein the regression results for the estimates utilizing various control groups are presented. The first subsection features the regression outcomes when French gasoline stations are used as a control group. In the second subsection, I present the regression results for estimates utilizing all countries within the EU that have maintained constant tax policies throughout the period analyzed as a control group.

4.1 Results with France as a Control Group

Table 4 and Table 5 show the results for diesel and for petrol, respectively. The period considered reaches from April 14 to August 31, and French gasoline retailers are the control group.

Table 4: Difference-in-Differences Regressions (Germany & France), Diesel

	OLS	Station_FE	Station_Date_FE
Treated Stations	0.1281***	0.0000	
	(0.0008)	(.)	
Discount Period	0.1122***	0.1122***	
	(0.0004)	(0.0004)	
Treated Stations # Discount Period	-0.1487***	-0.1484***	-0.1489***
	(0.0004)	(0.0004)	(0.0004)
Public or School Holiday	-0.0655***	-0.0660***	-0.0130***
	(0.0004)	(0.0004)	(0.0002)
Constant	1.9173***	1.9961***	1.9345***
	(0.0007)	(0.0002)	(0.0003)
Observations	3249503	3249503	3249503
R^2	0.252	0.325	0.651
Adjusted R^2	0.252	0.325	0.651
Pass-Through Rate	89%	89%	89%
Station FE	No	Yes	Yes
Date FE	No	No	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	24,113	24,113	24,113

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In Table 4, column 1, the first coefficient of the ordinary least squares estimation (OLS), "Treated Stations", indicates that German gasoline retailers demanded on average 12.81 Eurocents per liter (cpl) more than their French counterparts before the duty reduction. In columns 1 and 2, the second coefficient, "Discount Period", shows that diesel prices were about 11.22 cpl higher on average for the control group in June, July, and August compared to April 14 to May 31. The coefficient is the same regardless of the use of station-fixed effects.

The third coefficient, "Treated Stations # Discount Period", indicates that the ATE was a price reduction of 14.89 cpl on average. It is very similar for all three estimation techniques and most precisely estimated in column 3, the specification with entity and time fixed effects. This corresponds to a pass-through rate of 89% for diesel on average. According to the fourth coefficient, "Public or School Holiday", holidays accounted for 1.3 cpl lower diesel prices on average in the entire dataset.

Similarly, gasoline stations' average pass-through of the tax reduction was 91% and 87% for petrol E5 and E10, respectively, as shown in Table 5. The effect of public and school holidays is smaller in magnitude and only statistically significant at the 1 percent confidence level. I present analogous tables to Table 4 for petrol E5 and petrol E10 in the Appendix, Tables 4 and 5, respectively.

Table 5: Difference-in-Differences Regressions (Germany & France), E5 and E10

	E5	E10
Treated Stations # Discount Period	-0.3189***	-0.3056***
	(0.0009)	(0.0006)
Public or School Holiday	-0.0006**	-0.0081***
	(0.0002)	(0.0002)
Constant	1.9680***	1.8868***
	(0.0003)	(0.0003)
Observations	2466599	2825185
R^2	0.886	0.884
Adjusted R^2	0.886	0.884
Pass-Through Rate	91%	87%
Station FE	Yes	Yes
Date FE	Yes	Yes
VCE	cluster	cluster
VCE Type	Robust	Robust
No. Clusters	18,492	20,946

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The next question that arises is how the pass-through of the tax reduction evolved over time. Appendix Figures 1, 2, and 3 show the difference between German and French prices over time. Two observations can be made from the graphs: 1) It is difficult to tell whether German gasoline stations increased their prices prior to the tax reduction relative to the French stations, and 2) The difference in prices seems to vary substantially over time.

The next question I will answer is whether gasoline stations increased their prices prior to the tax reduction. I use a DID estimation, specifying three "pre-treatment" periods, to compare them with the entire time period before. The first pre-treatment period is the entire week before the discount, hence the last week of May, because the discount took effect on June 1. The second pre-treatment period would be the last two days, and the third pre-treatment

period would be the last day of May. These three time periods are compared to the entire time before, e.g., April 14 to May 23 for the first case. The results for diesel are presented in Table 6. Again, station and date fixed effects are used, and I control for public and school holidays.

Table 6: Was There a Price Increase in Last Week/Last Two Days/Last Day Before? DID Regressions (Germany & France), Diesel

	Last Week of May	Last Two Days of May	Last Day of May
One Day before tax reduction # Treated Stations	0.0047***	0.0082***	0.0068***
	(0.0005)	(0.0005)	(0.0005)
Public or School Holiday	0.0020***	0.0014***	0.0015***
	(0.0002)	(0.0002)	(0.0002)
Constant	1.9242***	1.9246***	1.9245***
	(0.0003)	(0.0003)	(0.0003)
Observations	1110746	1110746	1110746
R^2	0.480	0.480	0.480
Adjusted R^2	0.480	0.480	0.480
Pass-through rate	-3%	-5%	-4%
Station FE	Yes	Yes	Yes
Date FE	Yes	Yes	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	23,969	23,969	23,969

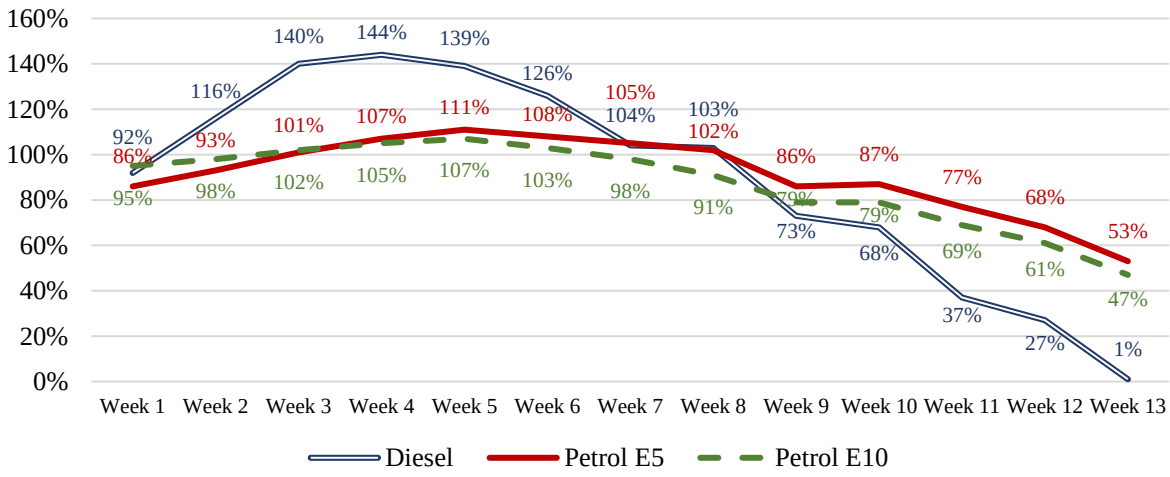
Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All coefficients are statistically significant and positive, indicating that there was a price increase before the tax discount took effect. However, the absolute change in average German gasoline prices is very small, 0.5 to 0.8 cpl. Thus, the price increase was on average below one cpl. The pass-through rate is shown as a negative number, which can be interpreted similarly to the pass-through rate of before tables. Thus, the average German price increase for the week before the tax discount took effect was 3% of the tax discount of around 16.71 cpl for diesel and even increased to 5% for the last two days of the month.

In contrast to these results for diesel, the German gasoline stations lowered the average price for petrol E5 and petrol E10 already in the week prior to the tax reduction, Appendix Tables 6 and 7. This price reduction corresponds to a pass through of 4% and 10% for petrol E5 and petrol E10, respectively. The effect disappears when focusing on the last two days of the month for petrol E5 and stays roughly the same for petrol E10. Economically, such an early price reduction (compared to the French control group) can result from decreased demand by consumers in anticipation of the tax reduction. But why can we observe this price reduction only for petrol E5, an even sharper price reduction for petrol E10, and on the other hand, a weak increase in diesel prices?

Plausibly, diesel is predominantly used for business vehicles and large cars, hence by a group that is either inelastic or unconcerned about prices. Such a lower price elasticity of demand for diesel compared to petrol in the short run is documented by Bach et al. (2019). If demand does not decrease before a tax reduction, then gasoline stations can easily maintain a high price, which I observe as a small statistically significant increase in the average diesel price before the tax reduction. Furthermore, if German gasoline stations want to pretend to pass on the entire tax reduction, then they could raise the price before the tax reduction to achieve an artificially high reference price from which to lower their prices by the amount of the tax reduction while in fact not passing on the entire tax reduction. However, this works only if demand is sufficiently inelastic.

Figure 8: Weekly Pass-through Rates of the German Gasoline Tax Reduction Over Time (France as Control Group), 2022



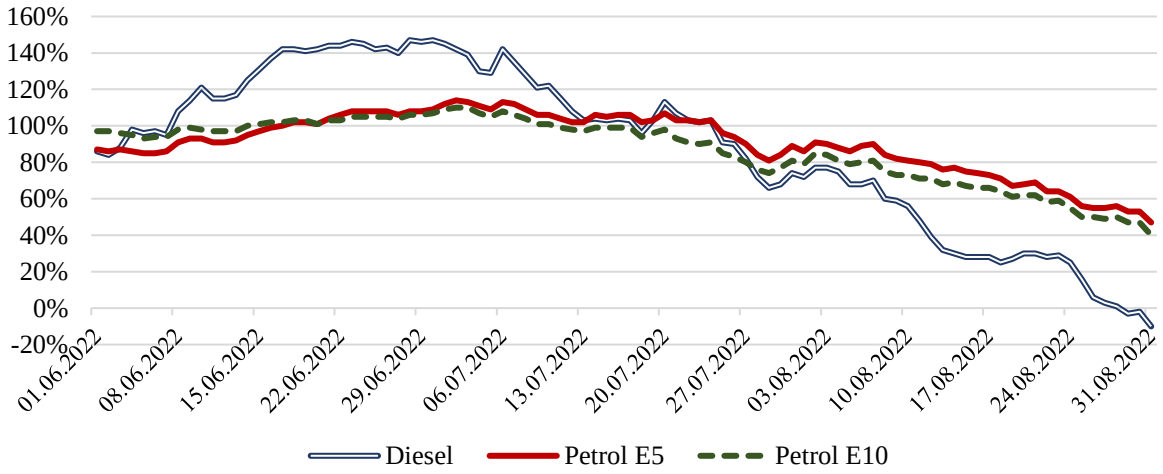
Private households in Germany predominantly use petrol cars. In 2022, a share of about 64% of German passenger cars ran on petrol E5 or E10, and about 31% on diesel, with the remaining 5% fueling liquid gas, natural gas, or being electric (Bundesministerium für Digitales und Verkehr, 2022). Petrol E5 and E10 are not taxed differently; however, petrol E10 prices are on average almost 6 cpl lower compared to those of petrol E5.[12] This may be partly driven by the relative prices of ethanol and crude oil and partly by a minimum quota of biofuels required to be sold by German gasoline stations (Montag, Sagimuldina, and Schnitzer, 2020). Thus, it is likely that price-sensitive consumers will fuel petrol E10 rather than petrol E5 and are also more likely to react with drastic decreases in gasoline demand when expecting a tax decrease. Such a reduction in demand negatively affects the market

[12] See descriptive statistics in Appendix Tables 1 and 2.

price, which I observe as an economically relevant reduction in the average petrol E10 price before the tax reduction actually took effect. However, the overall price changes before the tax reduction came into effect were rather small.

How did the pass-through rates of the German gasoline tax reduction evolve over time? I conducted DID regressions to estimate the pass-through rates for each week and day in the treatment period (June, July, and August) compared to the entire pre-treatment time (April 14 to the end of May). The results of DID estimates for each single week in the treatment period, which I compare separately to the entire period before the tax reduction, are presented in Appendix Tables 8 to 10 for diesel, petrol E5, and petrol E10, respectively. The first week runs from Wednesday, June 1, to Tuesday, June 7; the second week begins on Wednesday, June 8, and so on. The last week extends from Wednesday, August 24, to Wednesday, August 31, that is, for eight days. I use station and date fixed effects and control for public and school holidays. Results for weekly pass-through rates for all fuel types are summarized in Figure 8.

Figure 9: Daily Pass-through Rates of the German Gasoline Tax Reduction Over Time (France as Control Group), 2022



Similar to the weekly analysis, I conducted DID regressions to estimate pass-through rates for each single day. These results are summarized in Figure 9.[13] Pass-through rates for petrol E5 and petrol E10 evolve very similarly over time. The pass-through rates are below 100% for the first two weeks of June and rise slightly above afterwards, peaking at 114% and 110%, respectively, on July 2. The rate for petrol E5 falls below 100% on July 25 and reaches its trough of 47% on August 31. Already on July 11, the rate for petrol E10 fell below 100%,

[13] It is one DID regression with station and date-fixed effects, controlling for public and school holidays for each day and fuel type, hence 276 regressions overall that underlie Figure 9. Results tables are provided on demand.

also reaching its trough of 40% on August 31. The pass-through rate was at least 100% on 38 and 27 days out of 92 days for petrol E5 and petrol E10, respectively.

However, for diesel, the deviations from complete pass-through are more extreme. The rate starts at 86% on June 1 and increases subsequently, reaching full pass-through on June 8. The rate increases further and reaches its peak of 147% on June 28 and June 30. It decreases subsequently with stronger fluctuations, reaching its trough of -10% on August 31. The pass-through rate of 100% was reached or exceeded on 48 out of 92 days.

Overall, there were rather small price changes before the gasoline tax reduction took effect. However, pass-through rates vary substantially over time, and full pass-on of the tax reduction was reached on about half the days for diesel, substantially fewer days for petrol E5, and even fewer days for petrol E10. It can be concluded that on average, German petrol stations passed on the full tax discount on about 52% of the days for diesel, 41% of the days for petrol E5, and 29% of the days for petrol E10. The gasoline tax reduction was on average not passed on fully, with rates of 89%, 91% and 87% for diesel, petrol E5 and petrol E10 respectively. All results are statistically significant at the 0.1% confidence level.

4.2 Results with Countries in the European Union as a Control Group

The results above are based on DID estimates with high-frequency data from all French gasoline stations as a control group. Even though France is commonly used as a control group, as discussed in the introduction, and the common trend assumption seems to be fulfilled, as discussed in Section 3.2, I use weekly data for all countries in the EU for further analysis. Also for Germany and France, I stick to data from the European Commission (2022). First, I look at the average pass-through rate; second, I focus on the question of whether German gasoline stations increased their prices before the tax reduction took effect; and third, I focus on the evolution of pass-through rates over time.

In Table 7, I show the results of DID estimation for diesel and petrol E5 with station and date fixed effects. I use data for all countries in the EU that did not change taxes during the relevant time period from April 14 to August 31, 2022. Recall that it is not controlled for public and school holidays, as discussed in Section 3.3. Furthermore, there are no data available for petrol E10. The coefficients are statistically significant at the 0.1 confidence level. The pass-through rates are close to the ones estimated with France as the control group. Namely, the average pass-through rate for diesel is about 85% and about 94% for petrol.

Table 7: Difference-in-Differences Regressions (EU), Diesel and E5

	Diesel	E5
Discount Period # Treated Stations	-0.1412***	-0.3310***
	(0.0065)	(0.0106)
Constant	1.8330***	1.7914***
	(0.0069)	(0.0059)
Observations	360	360
R^2	0.783	0.855
Adjusted R^2	0.771	0.847
Pass-through rate	85%	94%
Station FE	Yes	Yes
Date FE	Yes	Yes
VCE	cluster	cluster
VCE Type	Robust	Robust
No. Clusters	19	19

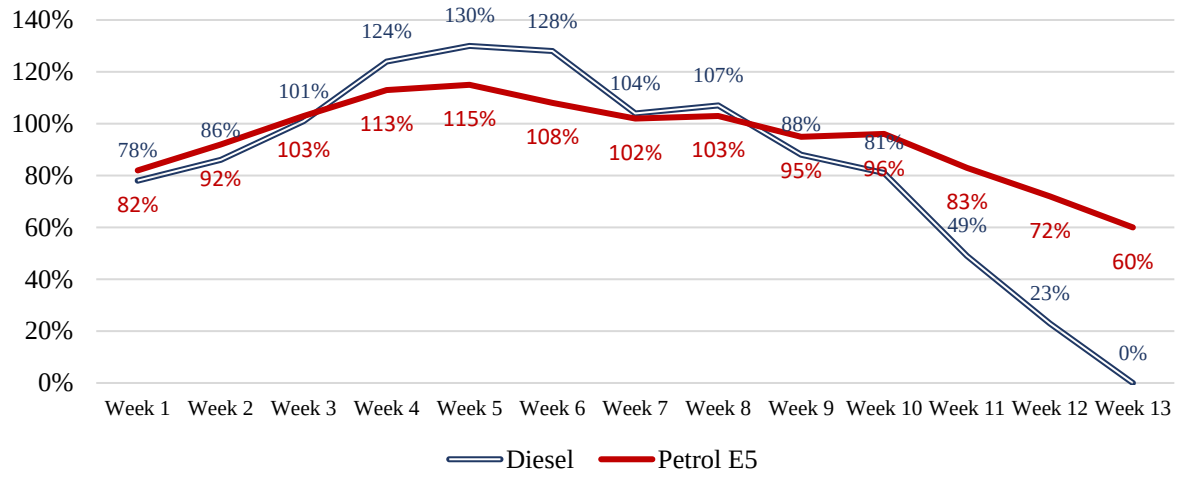
Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Again, the next question I must answer is whether gasoline stations increased their prices prior to the tax reduction. I compare the last week before the tax reduction (the last week of May) to the weeks before. In contrast to the case where I used France as the control group, I cannot present daily results here because there are only weekly data. I cannot find any price increase or decrease in the week before the tax reduction, as shown in Appendix Table 11. The coefficients are not statistically significant, and they are positive for both diesel and petrol E5, and the pass-through rate is 2% and 3%, respectively. The last week of May corresponds to one observation in the weekly data for countries in the EU and is therefore not as well suited for analysis of short time periods as the larger data source with high-frequency data for Germany and France.

Finally, I show how the pass-through rate changes over time when using countries in the EU as a control group instead of French gasoline stations. The pass-through rates are summarized in Figure 10, which is based on EU-countries as a control group and very similar to Figure 8, which was based on France as a control group. I present the regression output that underlies Figure 10 in Appendix Tables 12 and 13 for diesel and petrol E5, respectively.

The pattern of the evolution of pass-through rates of the German tax reduction over time, which is based on the analysis of weekly data from 19 countries in the EU, matches the results that are based on high-frequency data for Germany and France. The pattern appears to be less pronounced when using all countries in the EU, which did not change taxes. But the rates for diesel appear to be systematically lower (than in the case with France as the control group), starting at 78% and peaking at 130% in Week 5 (in contrast to 92% and 144%, respectively, in the France case). Then, the rate decreases, very similar to the case with France, to about 0% pass-through at the end of August.

Figure 10: Weekly Pass-through Rates of the German Gasoline Tax Reduction Over Time (EU as Control Group), 2022



The evolution of pass-through rates for petrol E5, when using countries in the EU as a control group, is very similar to the results when using France as a control group. They start at 82% and 86%, peak at 115% and 111% in week 5, and decrease to 60% and 53% for the Eu and France cases, respectively.

The average weekly pass-through rates for diesel and petrol E5 were six weeks above and seven weeks below full pass-through for EU data. When using solely France as a control group, the average weekly pass-through rate for diesel was seven weeks above full pass-through. However, diesel rates dropped very far below full pass-through toward the end of August in this latter case.

Overall, the results are insensitive to changing the control group from French gasoline stations to weekly data on gasoline prices for countries in the EU. On average, pass-through rates were below 100% for all gasoline types. The average estimates are pass-through rates of 89% and 85% for diesel and 91% and 94% for petrol E5 for the control groups France and the EU, respectively.

5 Discussion of Threats to Validity and Robustness Checks

In this section, I look at typical robustness checks and discuss possible threats to the validity. I start with a placebo test, and I present results for control groups consisting of countries in the EU that have a similar gasoline price level as Germany and for neighboring countries afterwards. I end with a discussion of the external validity.

For the placebo test, I take the month of May and split it in half, treating the second half as if it were the policy period. Thus, I take the data from May 1 to May 31 and set May 15 to be the first treatment day. I include station- and date-fixed effects. Additionally, I control for public and school holidays in the case of French gasoline stations as the control group. The results for the case with French stations as the control group are presented in Appendix Table 14. There is a slightly negative pass-through rate of -3% for diesel and small positive rates of 3% for petrol E5 and 8% for petrol E10. This could still be biased by what happens in the last week. Excluding the last week of May and setting the first treatment day to May 13 decreases all pass-through rates, namely to 0%, 1%, and 6%, respectively (Appendix Table 15). It appears that there was a minor decrease in petrol E10 prices.[14] Overall, the placebo test yields the expected results, namely that there is no effect, and therefore supports the common-trend assumption.

I present two robustness checks with respect to varying the control group, which consists of countries in the EU. Firstly, I exclude the three countries with the lowest price levels, and secondly, I use only German neighbor countries.

For simplicity, I exclude the three countries with the lowest price levels. I look at the mean price from the descriptive statistics tables, Table 3 and Appendix Table 3 for diesel and petrol E5, respectively. Namely, I exclude Bulgaria, Poland, and Romania and present results analogous to Table 7 in Appendix Table 16. Results are robust with respect to this selection. Only the pass-through rate for diesel increases by about one percentage point.

Next, I look at pass-through rates when the control group is limited to German neighboring countries in the EU that did not change their taxes in the relevant time period. I present the results in Appendix Table 17. The pass-through rate for diesel is three percentage points below the one in Table 7, and the pass-through rate for petrol E5 is five percentage points lower. Overall, the weekly analysis using different countries in the EU is very similar.

Pass-through rates may be slightly overestimated because, at the same time as the tax reduction on gasoline, the German government introduced a monthly 9-Euro-Ticket for local public transport, which could have affected demand during the gasoline tax reduction negatively. This negative demand shock could have led to lower gasoline prices compared to the counterfactual. Hence, the estimates presented here, which already suggest an under-

[14] Results for the very same placebo test based on data with countries of the EU as a control group are not statistically significant at the 0.1% level.

proportional pass through, are high in the sense that they may already capture price-lowering effects from the negative demand shock caused by the 9-Euro-Ticket. In other words, pass-through estimates might have been lower in the absence of the 9-Euro-Ticket because demand might have been higher. The external validity is therefore limited when looking at exact pass-through rates; however, the mechanisms are likely to occur as observed here in similar gasoline markets, such as the evolution of the pass-through rate over time.

6 Conclusion

Governments of western economies throughout the world introduced relief packages to mitigate the effects of rocketing energy prices in the course of the global post-pandemic economic recovery and the Russian aggression towards the Ukraine. Germany reduced the gasoline tax from the beginning of June to the end of August. The German gasoline market is being intensively researched, and all price data are collected by federal authorities in order to be able to intervene in cases of market power abuse. First results on pass-through rates of the gasoline tax reduction based on such high-frequency data for Germany and France were provided by Fuest, Neumeier, and Stöhlker (2022). Results based on weekly data from the European Commission (2022) were provided by Freitas and Syga (2022), Drolsbach, Gail, and Klotz (2022), and Dovern et al. (2022).

I am the first to present results based on high-frequency data for Germany and France as well as results based on weekly data for all countries in the EU for the entire period in which the tax reduction was in effect. Moreover, I am the first to control for public and school holidays when using high-frequency data for Germany and France. In addition to providing precise estimates of the average pass-through of the tax reduction, I present results on the evolution of pass-through rates over time.

Recent research on pass-through rates for value-added tax changes in Germany, based on high-frequency data for Germany and France, was conducted by Montag, Sagimuldina, and Schnitzer (2020). They find pass-through rates far below full pass-through and argue that differences in pass-through rates for different gasoline types may be explained by differences in competitive pressure from different customer groups. However, the dimension of price changes in absolute values is rather small. In contrast to the value-added tax change in 2020, the German tax reduction in 2022 was considerably larger and had infinitely greater political and economic implications, along with corresponding attention in the public debate.

In this article, I analyze the question of the pass-through of this tax reduction based on high-frequency data for Germany and France as well as weekly price data for all countries of the European Union. My main results are that, firstly, average pass-through is high but incomplete, with rates of 85% to 89% for diesel, 91% to 94% for petrol E5, and 87% for petrol E10. Secondly, in contrast to public opinion, there was no price increase before the tax reduction came into effect.

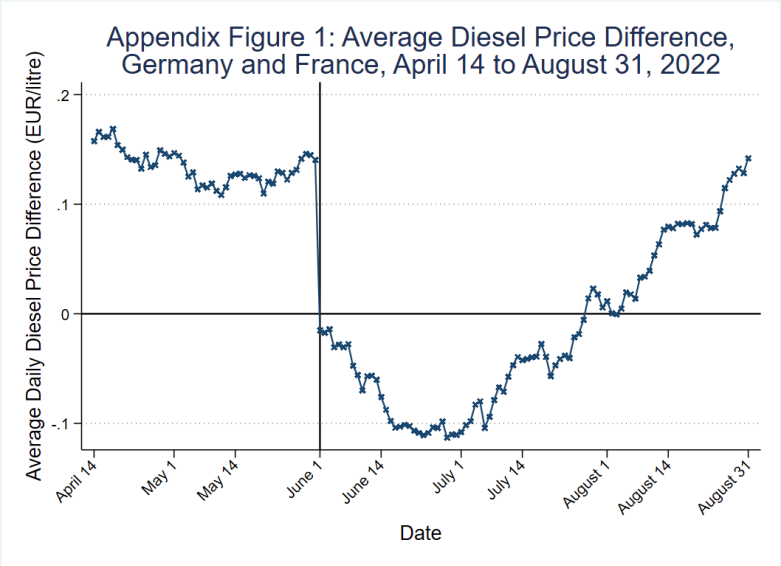
Furthermore, the high-frequency data yielded interesting insights on the evolution of pass-through rates over time. Pass-through was incomplete at the beginning of the tax reduction and decreased to zero for diesel and about 45% to 60% for petrol by the end of August, just before the end of the tax reduction. Thus, pass-through rates vary substantially over time, which could be explained by falling media attention and decreasing presence in the public debate.

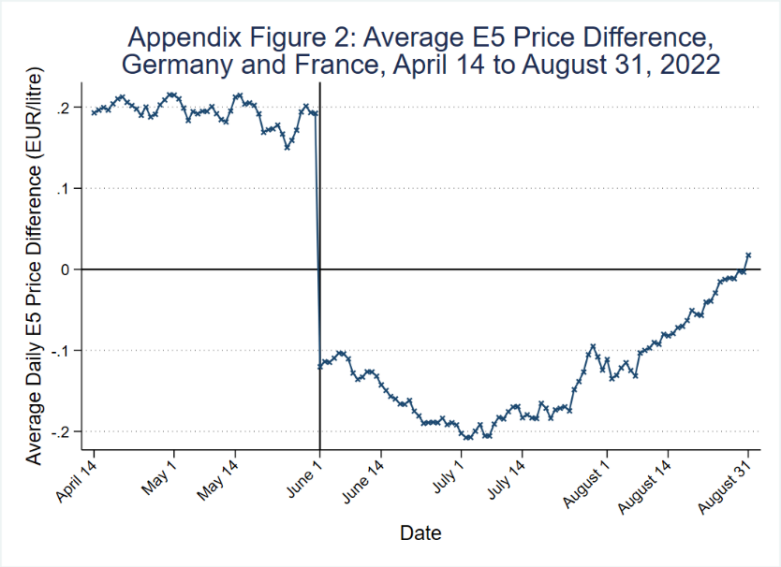
Generally, results are confirmed when using weekly data for all countries in the EU as a control group, which did not change their taxes during the relevant time period, compared to using all French gasoline stations as a control group. Not surprising, the peaks are more moderate when looking at the evolution of pass-through rates over time using countries in the EU as a control group because weekly averages instead of daily data are used. Results are robust to changes in the composition of the control group.

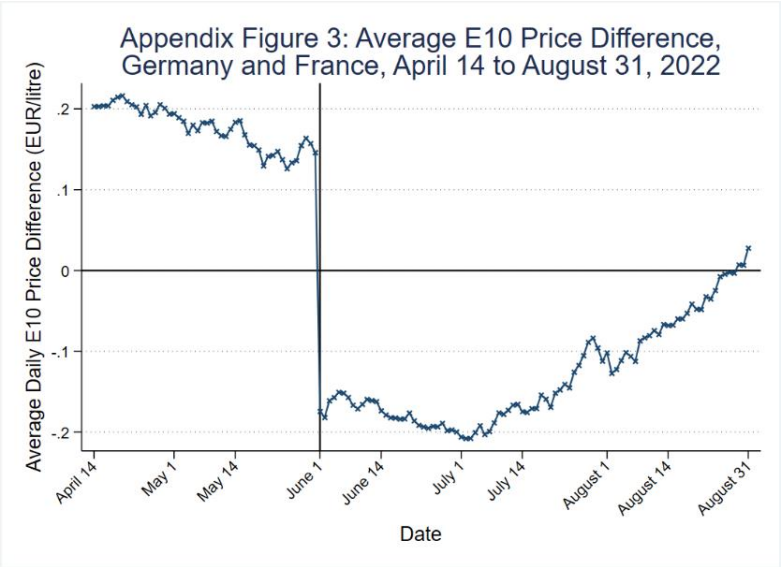
The key results are that pass-through was high but incomplete on average, and that pass-through rates of tax reductions varied substantially over time. Further research may focus on the determinants of these anomalies in pass-through rates over time and space.

Appendix

Appendix Figures







Appendix Tables

Appendix Table 1: Descriptive Statistics for France and Germany, E5, April 14 to August 31

Descriptive Statistics Before Tax Reduction, E5

	Mean	Median	SD	N
Non-Treatment-Group:				
Daily Average E5 Price, EUR/l	1.892	1.883	.098	178640
Crude Oil Closing Price, EUR/l	.668	.67	.023	115525
Public or School Holiday	.37	0	.483	172688
Treatment-Group:				
Daily Average E5 Price, EUR/l	2.086	2.076	.077	669333
Crude Oil Closing Price, EUR/l	.668	.67	.023	432386
Public or School Holiday	.226	0	.418	669333

Descriptive Statistics After Tax Reduction, E5

	Mean	Median	SD	N
Non-Treatment-Group:				
Daily Average E5 Price, EUR/l	1.991	2.002	.156	347341
Crude Oil Closing Price, EUR/l	.699	.7	.022	112500
Public or School Holiday	.611	1	.487	335695
Treatment-Group:				
Daily Average E5 Price, EUR/l	1.866	1.864	.101	1288883
Crude Oil Closing Price, EUR/l	.699	.7	.022	419067
Public or School Holiday	.482	0	.5	1288883

Appendix Table 2: Descriptive Statistics for France and Germany, E10, April 14 to August 31

Descriptive Statistics Before Tax Reduction, E10

	Mean	Median	SD	N
Non-Treatment-Group:				
Daily Average E10 Price, EUR/l	1.847	1.834	.107	321716
Crude Oil Closing Price, EUR/l	.668	.67	.023	207990
Public or School Holiday	.367	0	.482	321668
Treatment-Group:				
Daily Average E10 Price, EUR/l	2.029	2.018	.078	643065
Crude Oil Closing Price, EUR/l	.668	.67	.023	415341
Public or School Holiday	.227	0	.419	643065

Descriptive Statistics After Tax Reduction, E10

	Mean	Median	SD	N
Non-Treatment-Group:				
Daily Average E10 Price, EUR/l	1.933	1.949	.158	622282
Crude Oil Closing Price, EUR/l	.699	.7	.022	202069
Public or School Holiday	.61	1	.488	622190
Treatment-Group:				
Daily Average E10 Price, EUR/l	1.808	1.806	.102	1238262
Crude Oil Closing Price, EUR/l	.699	.7	.022	402587
Public or School Holiday	.482	0	.5	1238262

Appendix Table 3: Germany and EU Control Group Countries: Descriptive Statistics Before and After Tax Reduction in Germany, E5

a) Before Tax Reduction

	Mean	Median	SD	N
AT diesel with tax	1.769	1.765	.042	6
BE diesel with tax	1.884	1.901	.079	6
BG diesel with tax	1.536	1.53	.044	6
CY diesel with tax	1.599	1.585	.082	6
DE diesel with tax	2.11	2.112	.061	6
DK diesel with tax	2.238	2.215	.112	6
EE diesel with tax	1.931	1.925	.068	6
ES diesel with tax	1.89	1.888	.058	6
FI diesel with tax	2.258	2.237	.093	6
FR diesel with tax	1.881	1.879	.077	6
GR diesel with tax	2.183	2.188	.083	6
IE diesel with tax	1.877	1.849	.071	6
IT diesel with tax	1.822	1.816	.049	6
LT diesel with tax	1.782	1.774	.091	6
LV diesel with tax	1.858	1.851	.064	6
NL diesel with tax	2.168	2.166	.063	6
PL diesel with tax	1.506	1.496	.094	6
RO diesel with tax	1.594	1.599	.046	6
SK diesel with tax	1.766	1.776	.048	6
Crude Oil Closing Price, EUR/l	.657	.656	.04	6

b) After Tax Reduction

AT diesel with tax	1.966	1.996	.134	13
BE diesel with tax	1.914	1.91	.142	13
BG diesel with tax	1.654	1.665	.057	13
CY diesel with tax	1.741	1.784	.093	13
DE diesel with tax	1.873	1.864	.085	13
DK diesel with tax	2.285	2.246	.16	13
EE diesel with tax	2.029	2.025	.111	12
ES diesel with tax	1.98	2.026	.137	13
FI diesel with tax	2.318	2.307	.172	13
FR diesel with tax	1.961	2.001	.143	13
GR diesel with tax	2.244	2.279	.154	13
IE diesel with tax	2.034	2.049	.123	13
IT diesel with tax	1.931	1.941	.121	13
LT diesel with tax	1.908	1.905	.122	13
LV diesel with tax	1.957	1.947	.113	13
NL diesel with tax	2.206	2.19	.13	13
PL diesel with tax	1.562	1.556	.121	13
RO diesel with tax	1.694	1.681	.031	13
SK diesel with tax	1.844	1.852	.078	13
Crude Oil Closing Price, EUR/l	.657	.661	.044	13

Appendix Table 4: Difference-in-Differences Regressions, E5

	OLS	Station FE	Station & Date FE
Treated Stations	0.1841***	0.0000	
	(0.0010)	(.)	
Discount Period	0.1192***	0.1191***	
	(0.0009)	(0.0009)	
Treated Stations # Discount Period	-0.3178***	-0.3174***	-0.3189***
	(0.0009)	(0.0009)	(0.0009)
Public or School Holiday	-0.0843***	-0.0844***	-0.0006**
	(0.0004)	(0.0004)	(0.0002)
Constant	1.9213***	2.0673***	1.9680***
	(0.0010)	(0.0002)	(0.0003)
Observations	2466599	2466599	2466599
R^2	0.537	0.618	0.886
Adjusted R^2	0.537	0.618	0.886
Pass-through rate	90%	90%	91%
Station FE	No	Yes	Yes
Date FE	No	No	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	18,492	18,492	18,492

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 5: Difference-in-Differences Regressions, E10

	OLS	Station FE	Station & Date FE
Treated Stations	0.1671***	0.0000	
	(0.0008)	(.)	
Discount Period	0.1107***	0.1105***	
	(0.0005)	(0.0005)	
Treated Stations # Discount Period	-0.3046***	-0.3041***	-0.3056***
	(0.0006)	(0.0006)	(0.0006)
Public or School Holiday	-0.1034***	-0.1035***	-0.0081***
	(0.0004)	(0.0004)	(0.0002)
Constant	1.8851***	1.9963***	1.8868***
	(0.0008)	(0.0002)	(0.0003)
Observations	2825185	2825185	2825185
R^2	0.502	0.585	0.884
Adjusted R^2	0.502	0.585	0.884
Pass-through rate	87%	86%	87%
Station FE	No	Yes	Yes
Date FE	No	No	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	20,946	20,946	20,946

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 6: Was There a Price Increase in Last Week/Last Two Days/Last Day Before Tax Reduction? Difference-in-Differences Regressions, E5

	Last Week of May	Last Two Days of May	Last Day of May
One Day before tax reduction # Treated Stations	-0.0135***	0.0007	-0.0003
	(0.0009)	(0.0011)	(0.0012)
Public or School Holiday	0.0006**	0.0017***	0.0017***
	(0.0002)	(0.0002)	(0.0002)
Constant	1.9676***	1.9668***	1.9668***
	(0.0003)	(0.0003)	(0.0003)
Observations	842021	842021	842021
R^2	0.834	0.833	0.833
Adjusted R^2	0.834	0.833	0.833
Pass-through rate	4%	0%	0%
Station FE	Yes	Yes	Yes
Date FE	Yes	Yes	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	18,326	18,326	18,326

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 7: Was There a Price Increase in Last Week/Last Two Days/Last Day Before Tax Reduction? Difference-in-Differences Regressions, E10

	Last Week of May	Last Two Days of May	Last Day of May
One Day before tax reduction # Treated Stations	-0.0366***	-0.0282***	-0.0318***
	(0.0006)	(0.0007)	(0.0008)
Public or School Holiday	-0.0016***	0.0023***	0.0020***
	(0.0002)	(0.0002)	(0.0002)
Constant	1.8824***	1.8797***	1.8799***
	(0.0002)	(0.0002)	(0.0002)
Observations	964733	964733	964733
R^2	0.850	0.844	0.844
Adjusted R^2	0.850	0.844	0.844
Pass-through rate	10%	8%	9%
Station FE	Yes	Yes	Yes
Date FE	Yes	Yes	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	20,759	20,759	20,759

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 8: Difference-in-Differences Regressions for Single Weeks, Diesel

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Week before tax reduction # Treated Stations	-0.1536***	-0.1935***	-0.2334***	-0.2404***	-0.2326***	-0.2099***	-0.1732***	-0.1715***	-0.1219***	-0.1138***	-0.0618***	-0.0456***	-0.0015
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0006)	(0.0006)	(0.0007)	(0.0008)	(0.0008)	(0.0008)
Public or School Holiday	0.0005***	0.0001	-0.0002	0.0010***	-0.0003*	-0.0032***	-0.0047***	-0.0097***	-0.0069***	0.0014***	0.0084***	0.0124***	0.0215***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Constant	1.9252***	1.9254***	1.9256***	1.9248***	1.9257***	1.9277***	1.9288***	1.9323***	1.9304***	1.9247***	1.9198***	1.9172***	1.9108***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Observations	1273703	1273071	1272464	1272814	1273007	1273311	1273591	1273601	1273609	1273717	1273320	1274268	1297979
R^2	0.598	0.709	0.790	0.795	0.734	0.660	0.617	0.615	0.562	0.625	0.613	0.483	0.404
Adjusted R^2	0.598	0.709	0.790	0.795	0.734	0.660	0.617	0.615	0.562	0.625	0.613	0.483	0.404
Pass-through rate	92%	116%	140%	144%	139%	126%	104%	103%	73%	68%	37%	27%	1%
Station FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VCE	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust
No. Clusters	23,974	23,983	23,989	23,995	24,014	24,027	24,043	24,071	24,083	24,090	24,103	24,107	24,112

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 9: Difference-in-Differences Regressions for Single Weeks, E5

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Week before tax reduction # Treated Stations	-0.3027***	-0.3260***	-0.3550***	-0.3779***	-0.3888***	-0.3802***	-0.3692***	-0.3575***	-0.3038***	-0.3061***	-0.2711***	-0.2379***	-0.1861***
	(0.0014)	(0.0014)	(0.0013)	(0.0012)	(0.0011)	(0.0011)	(0.0011)	(0.0013)	(0.0013)	(0.0013)	(0.0014)	(0.0013)	(0.0013)
Public or School Holiday	0.0014***	0.0036***	0.0040***	-0.0001	-0.0005*	-0.0038***	-0.0053***	-0.0094***	-0.0123***	0.0015***	0.0139***	0.0146***	0.0192***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0004)
Constant	1.9670***	1.9652***	1.9649***	1.9679***	1.9682***	1.9707***	1.9719***	1.9750***	1.9772***	1.9669***	1.9576***	1.9572***	1.9538***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)
Observations	965739	965190	964596	964948	965121	965401	965705	965753	965807	965921	965570	966491	984609
R^2	0.853	0.857	0.870	0.887	0.896	0.899	0.901	0.909	0.907	0.916	0.919	0.913	0.896
Adjusted R^2	0.853	0.857	0.869	0.887	0.896	0.899	0.901	0.909	0.907	0.916	0.919	0.913	0.896
Pass-through rate	86%	93%	101%	107%	111%	108%	105%	102%	86%	87%	77%	68%	53%
Station FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VCE	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust
No. Clusters	18,338	18,348	18,354	18,360	18,377	18,388	18,409	18,441	18,455	18,467	18,482	18,487	18,492

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 10: Difference-in-Differences Regressions for Single Weeks, E10

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Week before tax reduction # Treated Stations	-0.3356***	-0.3443***	-0.3589***	-0.3690***	-0.3779***	-0.3617***	-0.3448***	-0.3190***	-0.2770***	-0.2779***	-0.2429***	-0.2158***	-0.1667***
	(0.0008)	(0.0008)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0009)
Public or School Holiday	0.0019***	0.0032***	0.0032***	0.0005***	0.0002	-0.0026***	-0.0033***	-0.0062***	-0.0080***	0.0018***	0.0108***	0.0114***	0.0148***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)
Constant	1.8800***	1.8790***	1.8789***	1.8808***	1.8810***	1.8830***	1.8836***	1.8856***	1.8870***	1.8801***	1.8737***	1.8734***	1.8709***
	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Observations	1106280	1105814	1105311	1105645	1105818	1106014	1106381	1106434	1106530	1106655	1106327	1107129	1127643
R^2	0.875	0.883	0.889	0.894	0.899	0.896	0.895	0.899	0.899	0.909	0.913	0.908	0.891
Adjusted R^2	0.875	0.883	0.889	0.894	0.899	0.896	0.895	0.899	0.899	0.909	0.913	0.908	0.891
Pass-through rate	95%	98%	102%	105%	107%	103%	98%	91%	79%	79%	69%	61%	47%
Station FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VCE	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust
No. Clusters	20,771	20,789	20,797	20,802	20,816	20,833	20,854	20,882	20,899	20,914	20,932	20,937	20,944

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 11: Was There a Price Increase in Last Week/Last Two Days/Last Day Before Tax Reduction? Difference-in-Differences Regressions (EU), Diesel and E5

	Diesel	E5
Discount Period # Treated Stations	-0.0039	-0.0090
	(0.0076)	(0.0092)
Constant	1.8329***	1.7916***
	(0.0044)	(0.0062)
Observations	114	114
R^2	0.406	0.898
Adjusted R^2	0.373	0.892
Pass-through rate	2%	3%
Station FE	Yes	Yes
Date FE	Yes	Yes
VCE	cluster	cluster
VCE Type	Robust	Robust
No. Clusters	19	19

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 12: Difference-in-Differences Regressions for Single Weeks- (EU), Diesel

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Discount Period # Treated Stations	-0.1296***	-0.1430***	-0.1693***	-0.2072***	-0.2171***	-0.2143***	-0.1741***	-0.1792***	-0.1475***	-0.1346***	-0.0821***	-0.0383**	-0.0003
	(0.0080)	(0.0113)	(0.0145)	(0.0115)	(0.0109)	(0.0134)	(0.0117)	(0.0129)	(0.0121)	(0.0126)	(0.0138)	(0.0125)	(0.0120)
Constant	1.8329***	1.8329***	1.8329***	1.8329***	1.8329***	1.8329***	1.8329***	1.8331***	1.8329***	1.8329***	1.8329***	1.8329***	1.8329***
	(0.0043)	(0.0038)	(0.0040)	(0.0045)	(0.0049)	(0.0052)	(0.0053)	(0.0054)	(0.0053)	(0.0055)	(0.0056)	(0.0053)	(0.0046)
Observations	133	133	133	133	133	133	133	132	133	133	133	133	133
R^2	0.591	0.789	0.838	0.888	0.851	0.758	0.701	0.571	0.457	0.367	0.421	0.383	0.373
Adjusted R^2	0.568	0.778	0.829	0.882	0.842	0.744	0.684	0.547	0.427	0.332	0.388	0.349	0.338
Pass-through rate	78%	86%	101%	124%	130%	128%	104%	107%	88%	81%	49%	23%	0%
Station FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VCE	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust
No. Clusters	19	19	19	19	19	19	19	19	19	19	19	19	19

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 13: Difference-in-Differences Regressions for Single Weeks (EU), E5

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13
Discount Period	-	-	-	-	-	-	-	-	-	-	-	-	-
# Treated Stations	0.2887***	0.3222***	0.3636***	0.3971***	0.4051***	0.3814***	0.3589***	0.3619***	0.3323***	0.3369***	0.2928***	0.2523***	0.2097***
	(0.0147)	(0.0126)	(0.0124)	(0.0128)	(0.0132)	(0.0166)	(0.0170)	(0.0194)	(0.0171)	(0.0180)	(0.0161)	(0.0163)	(0.0148)
Constant	1.7916***	1.7916***	1.7916***	1.7916***	1.7916***	1.7916***	1.7916***	1.7911***	1.7916***	1.7916***	1.7916***	1.7916***	1.7916***
	(0.0076)	(0.0069)	(0.0064)	(0.0060)	(0.0056)	(0.0053)	(0.0049)	(0.0050)	(0.0053)	(0.0047)	(0.0052)	(0.0052)	(0.0052)
Observations	133	133	133	133	133	133	133	132	133	133	133	133	133
R^2	0.900	0.930	0.934	0.929	0.919	0.878	0.850	0.815	0.814	0.808	0.835	0.836	0.845
Adjusted R^2	0.895	0.926	0.930	0.925	0.915	0.872	0.842	0.804	0.803	0.798	0.826	0.827	0.836
Pass-through rate	82%	92%	103%	113%	115%	108%	102%	103%	95%	96%	83%	72%	60%
Station FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VCE	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust
No. Clusters	19	19	19	19	19	19	19	19	19	19	19	19	19

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 14: Difference-in-Differences Regressions, Diesel, E5 & E10, May 2022

	Diesel	E5	E10
Discount Period # Treated Stations	0.0054***	-0.0098***	-0.0294***
	(0.0005)	(0.0008)	(0.0005)
Public or School Holiday	-0.0059***	-0.0001	-0.0016***
	(0.0003)	(0.0004)	(0.0004)
Constant	2.0091***	2.0059***	1.9271***
	(0.0003)	(0.0004)	(0.0004)
Observations	717731	544067	623300
R^2	0.555	0.773	0.788
Adjusted R^2	0.555	0.773	0.788
Pass-through rate	-3%	3%	8%
Station FE	Yes	Yes	Yes
Date FE	Yes	Yes	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	23,959	18,317	20,747

French gasoline stations as control group. Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 15: Difference-in-Differences Regressions, Diesel, E5 & E10, May 2022 Without Last Week

	Diesel	E5	E10
Discount Period # Treated Stations	0.0004	-0.0039***	-0.0214***
	(0.0004)	(0.0007)	(0.0005)
Public or School Holiday	0.0041***	0.0051***	0.0007
	(0.0006)	(0.0009)	(0.0006)
Constant	2.0009***	2.0011***	1.9250***
	(0.0005)	(0.0008)	(0.0006)
Observations	555014	420610	481973
R^2	0.555	0.743	0.753
Adjusted R^2	0.555	0.743	0.753
Pass-through rate	0%	1%	6%
Station FE	Yes	Yes	Yes
Date FE	Yes	Yes	Yes
VCE	cluster	cluster	cluster
VCE Type	Robust	Robust	Robust
No. Clusters	23,942	18,296	20,730

French gasoline stations as control group. Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 16: Difference-in-Differences Regressions (EU-countries with no Tax Changes as Control Group), Excluding BG, PL, and RO

	Diesel	E5
Discount Period # Treated Stations	-0.1433***	-0.3314***
	(0.0067)	(0.0124)
Constant	1.8765***	1.8511***
	(0.0065)	(0.0068)
Observations	303	303
R^2	0.820	0.888
Adjusted R^2	0.808	0.881
Pass-through rate	86%	94%
Station FE	Yes	Yes
Date FE	Yes	Yes
VCE	cluster	cluster
VCE Type	Robust	Robust
No. Clusters	16	16

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 17: Difference-in-Differences Regressions (EU-countries with no Tax Changes as Control Group), Only German Neighbor Countries

	Diesel	E5
Discount Period # Treated Stations	-0.1372***	-0.3124***
	(0.0138)	(0.0270)
Constant	1.8930***	1.8395***
	(0.0097)	(0.0113)
Observations	133	133
R^2	0.827	0.886
Adjusted R^2	0.797	0.867
Pass-through rate	82%	89%
Station FE	Yes	Yes
Date FE	Yes	Yes
VCE	cluster	cluster
VCE Type	Robust	Robust
No. Clusters	7	7

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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