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New Evidence on Price Effects of Transparency Regulations in European Fuel Markets

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Abstract

This paper analyses the impact of transparency regulations on Super 95 and Diesel prices in Austria, France, and Germany to shed new light on the price effects of regulatory policies. To identify the effects of regulation, we use publicly available data from January 2005 to the end of December 2018 and estimate synthetic difference-in-difference models. In summary, our findings reveal notable differences. While prices in France did not change significantly, the results for Austria suggest that the price-reducing effect of the 2011 Price Fixing Act was offset by the transparency policy, ultimately leading to a price increase for Super 95 prices. In Germany, the Market Transparency Unit (MTU) has a price-reducing effect of two to three cents per litre, especially in the long term.

Keywords Fuel prices \cdot Regulation \cdot Market transparency \cdot Synthetic difference-indifferences \cdot Oligopoly \cdot Competition

JEL Classification $K21 \cdot K23 \cdot L13 \cdot L41 \cdot L51$

1 Introduction

In recent decades, fuel prices in Europe have experienced numerous fluctuations due to events such as the oil price crisis, the global financial crisis, and natural disasters. Beyond these event-driven fluctuations, fuel prices have been steadily increasing (Le et al. 2021; Sokhanvar et al. 2023). The volatility and upward trend in fuel prices have significant implications for consumers, businesses, and policymakers. In response to these challenges, several European

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countries have implemented transparency regulations aimed at stabilising and reducing fuel prices by increasing market transparency. Countries such as France, Austria, Germany, Belgium, and Italy have sought to counter rising fuel prices by introducing policies to enhance market transparency, thereby intensifying competition among gas stations. In Germany, a market transparency unit was established as part of the Federal Cartel Office on August 31, 2013 (Bundeskartellamt 2024). This transparency unit provides real-time data on current gasoline (Super 95) and Diesel prices from gas stations across the country. However, the effects of such price disclosures are not easily determined, as transparency regulations increase both vertical and horizontal market transparency among gas stations. On the one hand, greater vertical market transparency is expected to lead to more intense competition, as consumers gain information about current prices at the pumps. With reduced search costs, consumers can quickly react to price reductions and choose the cheapest gas stations in their vicinity. On the other hand, horizontal price transparency ensures that gas stations have more information about competitors' prices, allowing them to adjust their pricing decisions accordingly. Thus, greater transparency can lead not only to increased competition but also to coordinated effects (Kühn & Vives 1995; Møllgaard & Overgaard 2001; Stiglitz 1989; Vives 1990). Especially when automated pricing systems are used, gas stations can adjust prices more rapidly. Automated price setting can also facilitate coordinated behaviour between stations, particularly if the market structure is characterized by a tight oligopoly of large oil companies complemented by a few independent stations (Varian 2019; OECD 2017; Assad et al. 2020).

In this study, we empirically analyse the effects of market transparency policies and regulations on fuel prices in Germany, Austria, and France. We use a synthetic difference-in-differences method, introduced by Arkhangelsky et al. (2021), and apply it to a publicly available dataset for European fuel prices. Although other studies have already examined the effects of transparency regulations in European fuel markets, to the best of our knowledge, we are the first to compare these effects across Germany, Austria, and France.

Our findings vary across the countries studied. In France, we observe no statistically significant price change for fuels. This aligns with the findings for the Price Transparency Enactment in Austria. In contrast, the implementation of the MTU in Germany has a negative effect, leading to a long-term price decrease of two to three cents per litre. Similarly, the results for the Price Fixing Act Revised in Austria indicate a price decrease of two to three cents per litre, at least in the medium run. We therefore examine the different policy designs in our discussion to identify potential explanations for the varying results. Understanding these design differences could shed light on how specific implementation choices influence the effectiveness and outcomes of price transparency policies.

This paper is now organized as follows: In Sect. 2 the paper is related to the existing literature. Section 3 considers the market structure of the German, Austrian, and French fuel markets. Section 4 provides an overview of the regulations in these countries. Section 5 presents the method used. Section 6 introduces the dataset and provides descriptive statistics. Section 7 presents the results of the empirical analysis. Section 8 discusses the results and the policy implications. Finally, Sect. 9 concludes.

2 Related Research

Previous studies have reported contrasting evidence regarding the effects of transparency regulations. Dewenter et al. (2017) found that the MTU did not result in a decrease in fuel prices. Using a difference-in-differences approach to analyse the effects of the MTU

introduction in Germany, they discovered evidence suggesting an increase in gasoline prices by 1.2 to 3.4 cents per litre and Diesel prices by about 2 cents per litre (see Table 1).

In contrast, Haucap et al. (2017) observed a price-cutting effect when examining German fuel prices. Comparing the average gasoline prices of gas stations in four German cities between 2012 and 2015, they noted that average prices in 2015 were lower than those in 2012.

In more recent studies, Horvath (2019) explored the relationship between the MTU and fuel prices in Germany, employing fixed effects regression and a difference-in-differences approach with a control group of 18 other European countries. The findings revealed a price decrease of one to two cents following the implementation of the MTU.

Martin (2022) examined the effects of market transparency on competition and consumer welfare in German gas station markets. The results indicate an inverse U-shaped relationship between market transparency and consumer welfare. While full market transparency makes it easier for consumers to compare prices, it also makes it easier for gas stations to adjust their prices, which in turn leads to increasing prices. On the other hand, if there is little market transparency – only the cheapest prices are visible – this leads to falling prices, but consumer welfare is also reduced as the likelihood of inefficient purchase decisions increases. In case of Germany, consumer welfare is maximized if only the cheapest 20% of gas station prices are displayed.

Also, Montag et al. (2024) examined under which conditions the MTU has an effect on fuel prices. They compared the fuel prices of Germany with those of France by using the synthetic difference-in-differences approach by Arkhangelsky et al. (2021). The results showed that if consumers are less informed before the introduction of price disclosure, this increases the effect of MTU. In addition, the price-reducing effect of MTU is greater if there are more gas stations in an area. Additional campaigns to raise consumer awareness of price differences can also increase the price-reducing effect. On average, fuel prices fell by 2.7% and diesel prices by 1.8%.

Similarly, Becker et al. (2021) utilized a synthetic control method to examine the effects of the amendment of the Price Fixing Act in 2009 on fuel prices in Austria. Their base model included a control group consisting of eleven other European countries. The results indicated that shortly after the implementation of the regulation, the net prices of gasoline

Authors	Country	Effect
Rossi & Chintagunta (2016)	Italy	Price-reducing: 1 cent per litre
Dewenter et al. (2017)	Germany	Price-increasing: gasoline 1.2–3.4 cents per litre; Diesel 2 cents per litre
Haucap et al. (2017)	Germany	Price-reducing
Horvath (2019)	Germany	Price-reducing: 1-2 cents per litre
Luco (2019)	Chile	Price-increasing; if consumers have sufficient access to price information, it could be a price-reducing effect
Martin (2022)	Germany	Maximization of consumer welfare: display cheapest 20% of gas stations
Becker et al. (2021)	Austria	Price-reducing: gasoline by 7.5%; Diesel by 5.4%
Montag et al. (2024)	Germany	Price-reducing: gasoline by 2.7%; Diesel by 1.8%

Table 1 Effects of regulatory measures

decreased by 23.4%, whereas Diesel net prices decreased by only 6.6%. Furthermore, gasoline prices dropped by 7.5%, and Diesel prices by 5.4% in the long run.

Luco (2019) examined the effects of a price transparency policy in Chile by analysing the search behaviour of consumers and the competition among gas stations.¹ The results indicate that, following the policy implementation, gas station profit margins rose by an average of 9%. However, this effect varied significantly across regions, influenced by regional income levels. Specifically, margin increases were more pronounced in lowerincome regions, whereas in certain higher-income regions, margins decreased. Additionally, in areas with high consumer search intensity – typically associated with higher-income levels – margin increases were less substantial than in areas with lower search intensity. The author concludes that price transparency policies may enhance competitive market dynamics and benefit consumers, provided they have sufficient access to price information.

Unlike the price transparency policies in Germany, France, Austria and Chile, where current prices are transmitted to a central platform, Italy implemented a different transparency policy. By 2011, electronic price displays, providing real-time prices for the next four gas stations, were installed primarily along high-traffic highways in Italy.² The impact of this price transparency measure was analysed by Rossi and Chintagunta (2016). Their findings indicated an average reduction in gasoline prices by one cent per litre. However, price dispersion among gas stations remained largely unchanged, and fewer than 10% of drivers actively used the electronic price displays.

3 Fuel Market Structure

In May 2008 the German Federal Cartel Office initiated a sector investigation into the fuel market. Triggered by indications for antitrust concerns in the fuel sector as well as by complaints of independent gas station operators and consumers.

From an antitrust perspective, the road gas station market is segmented into Diesel and gasoline markets, each with regional limitations. BP (Aral), ConocoPhillips (Jet), ExxonMobil (Esso), Shell, and Total collectively form a dominant oligopoly in these regional gas station markets. The big five oil companies have significant market power, being the sole entities with access to refinery capacities in Germany and maintaining a nationwide network of gas stations. The market shares of these oil companies vary from one regional market to another. A nationwide sales share analysis reveals that the Big Five account for approximately 65% of annual fuel sales in Germany: BP (Aral) and Shell hold the largest shares, each around 20%, followed by ConocoPhillips (Jet) and Total, each with around 10%, and ExxonMobil (Esso) with over 5%. The remaining market share is distributed among a few larger companies such as Orlen, Hem-Tamoil, OMV, Eni, and Avia and the respective independent gas stations. In Germany, there were more than 15,000 gas stations in 2012. However, the number

¹ In February 2012, the Chilean government enacted a regulation requiring gas stations to publish their fuel prices on a government-operated website as soon as they are updated at the pump. The website launched on March 1, 2012, initially displaying prices only from selected regions. Since July 2012, fuel prices from across the entire country have been available on the website.

² The law was passed in 2007. After the first price displays were activated in July 2007, the gradual installation of additional displays followed in the subsequent years. By 2011, all the planned price displays were fully operational. Like other transparency policies, the law aimed to strengthen competition between gas stations and increase price transparency for drivers.

has decreased in recent years to approximately 14,800 gas stations (Bundeskartellamt 2011, pp. 7ff.; Doetsch 2023).

With the introduction of the transparency unit, market transparency has significantly increased. Even before the implementation of the MTS, oil companies had a comprehensive overview of their competitors' pricing through the prices displayed on the price boards. High transparency facilitates possible parallel behaviour in pricing strategies. Furthermore, coordination among the oligopolists can also be facilitated by product homogeneity, as competition parameters are primarily narrowed down to fuel prices. Market transparency also implies that deviant behaviour by the oligopolists can be promptly identified and penalized accordingly. In addition to examining the market structure, a price analysis revealed that the oligopolistic market structure results in higher sales prices compared to those in a competitive market (Bundeskartellamt 2011, pp. 12ff.).

The Austrian fuel market is similarly dominated by several major oil companies, including OMV, BP (Aral), Shell, Eni (Agip), and ConocoPhillips (Jet). The country has approximately 3,000 gas stations, although some of them exclusively sell diesel fuel. Both the number of gas stations and the market shares of these groups have remained relatively stable over the past few years. This stability can be attributed to various factors. On the supply side, there are barriers to market entry and exit, as companies must obtain official approval for gas station construction and have their own refineries or contracts with refineries. On the demand side, the market is relatively saturated, requiring new gas stations to compete regionally with well-established and strategically positioned counterparts (Bundeswettbewerbsbehörde 2022, pp. 25ff.).

In Austria, Eni and Jet petrol stations primarily source their fuel from refineries in which they have no ownership stake. Conversely, OMV primarily obtains its fuel from its own refineries. BP sources approximately a third of its diesel fuel from its own production. Shell acquires roughly equal amounts from both its internal sources and external suppliers. Gas station operators outside the five main companies lack their own refineries and thus rely on the mineral oil companies. Therefore, it can be inferred that Austria also has an oligopolistic market structure (Bundeswettbewerbsbehörde 2022, pp. 27f.).

In France, an oligopolistic market structure is also assumed (Si et al. 2023). The market is dominated by a few major gas station operators such as TotalEnergies, BP (Aral), Shell, Eni (Agip), Avia, and ExxonMobil (Esso). TotalEnergies stands out as one of the largest traditional players in the fuel market in France. In addition to the major gas stations also supermarket chains such as Carrefour, Leclerc, Auchan and Intermarché operate gas stations located adjacent to their stores play an important role in French fuel markets. Moreover, also smaller, independently owned gas stations are scattered throughout France, particularly in rural and less densely populated areas. As of 2024, there are about 11,000 gas stations in France, with a significant number located in urban areas and along major highways (Statista 2024).

4 Regulations in European fuel markets

4.1 France

The first regulation on market transparency was introduced in France. On December 12, 2006, the law on "Informing Consumers about the Retail Prices of Fuels" (JORF 2006, No. 291, Text No. 17) was enacted. According to this law, every fuel retailer is required to publish its sales prices on the website operated by the Ministry of Economics, Finance and

Industrial and Digital Sovereignty.³ Changes in the sales price must be reported immediately, either through the Internet or voice services. Retailers can also indicate price changes in advance, provided they specify the date and time when the price change will take effect.

4.2 Germany

Since August 31, 2013, operators of German gas stations have been required to promptly report fuel price changes to the relevant agency of the German Federal Competition Authority (Bundeskartellamt) in real-time. This enables consumers to access the most up-to-date prices online or through apps at any given time. On December 1, 2013, the MTU for fuels in Germany (Markttransparenzstelle für Kraftstoffe) officially commenced operation following a three-month trial period. The MTU is jointly operated by the German Federal Competition Authority and the Federal Network Agency (Bundeskartellamt 2024).

4.3 Austria

In contrast to Germany and France, Austria has not only introduced market transparency regulations, but also regulations that restrict the pricing of gas stations.

On July 1, 2009, the "Price Labelling Act" (BGBI 1992a, b, No. 146; BGBI 1992a, b, No. 813) was extended by the enactment of the "Code of Conduct for Petrol Station Operators on the Timing of Fuel Price Indication at Petrol Stations" (BGBI 2009, II, No. 190).⁴ This regulation stipulated that gas stations were only permitted to increase their prices once a day in the morning. For gas stations operating 24 h a day, this meant setting their maximum price at 12:00 a.m. Gas stations with limited opening hours were required to set their maximum price at opening, while self-service stations had to set their maximum price by 8:30 a.m. Price reductions were allowed at any time.

In January 2011, the enactment was revised (BGBI 2010, II, No. 484), specifying that gasoline and diesel prices could only be increased once a day at 12:00 p.m. Price reductions remained permissible at any time.

Additionally, in August 2011, the "Price Transparency Enactment" (BGBI 2011, I, No. 54) came into force, amending the "Price Transparency Act." According to this amendment, gas station operators in Austria are obligated to report current prices to the price transparency database of E-Control within half an hour of any price change. Consumers can view fuel prices via the *spritpreisrechner.at* website. The website lists the ten nearest gas stations from a given starting point. However, only the prices of the five cheapest gas stations are displayed. The revision made at the beginning of 2011 remained unaffected (Bundesministerium für Arbeit und Wirtschaft 2024).

Furthermore, in 2012, gas station operators were prohibited from changing their prices between 6 June 2012, 11:00 a.m., and 10 June 2012,12:00 p.m.; between 28 June 2012, 11:00 a.m., and 1 July 2012, 12:00 p.m.; as well as between 5 July 2012, 11:00 a.m., and 8 July 2012, 12:00 p.m. (BGBI 2012, II, No. 186). Since 2012, the Price Fixing Act, as well as the Price Transparency Enactment, have been consistently renewed without major changes.

³ Ministère de l'économie, des finances et des la souveraineté industrielle et numérique. Available at: www. prix-carburants.gouv.fr.(June 7, 2024).

⁴ We will call this code of conduct in the following "Price Fixing Act".

4.4 Costs

While precise information on actual costs of transparency regulations for each country are not publicly available, some general considerations can be made. It can be assumed that establishing a market transparency unit involves substantial initial investments. This encompasses the development, setup, and implementation of technical infrastructure (such as software, hardware, databases, network security, interfaces with gas station operators and the Federal Cartel Office, etc.). Ongoing costs would include operational and administrative expenses (such as data preparation, analysis, maintenance, building rental, supervision, human resources, etc.). Additionally, monitoring costs will arise to ensure enforcement of the regulation. These include verifying that gas stations comply with the requirements and implementing measures to sanction any violations. The real-time transmission of prices may also incur costs for the service station operators.

In February 2013, the Federal Ministry of Economic Affairs and Technology of Germany estimated that the reporting system would incur one-off costs of around EUR 7.1 million and annual bureaucratic costs of around EUR 2.8 million for the economy. In addition, the costs for the Market Transparency Unit itself are estimated at EUR 2.2 million one-off and EUR 1.3 million annually. No costs were expected for consumers.⁵

A report from August 2018 on the results of the Market Transparency Unit indicates that the annual costs for the economy amount to only around EUR 1.5 million, with the ongoing costs of the MTU also being below EUR 1 million. Additionally, a significant portion of the initially planned one-time setup costs for the MTU was saved. As a result, both the costs for establishing and operating the fuel market transparency unit and the economic burden on businesses were lower than originally anticipated. Consumers can continue to access the information free of charge as expected.⁶

However, it is difficult to find and measure the exact costs, which is why this only provides a rough overview of the possible costs that may incur for such an implementation, especially for France and Austria.

5 Method

We analyse the effects of transparency regulations using the synthetic difference-in-differences (SDID) approach introduced by Arkhangelsky et al. (2021). It combines different aspects of the Synthetic Control (SC) and difference-in-differences (DID) method.

In our model, a balanced panel with *T* time periods (weekly from January 2005 to the end of December 2019) and *N* countries is assumed. The fuel price for country *i* in week *t* is denoted by Y_{it} . $W_{it} \in \{0, 1\}$ denotes when the regulation of the regulated countries occurred. Furthermore, it will be assumed that the control countries N_{co} (countries without regulations), are never regulated, while the regulated countries $N_{tr} = N - N_{co}$, are regulated after time T_{pre} . Weights which align the pre-regulation trends in the outcome of

⁵ See Deutscher Bundestag, Verordnung zur Markttransparenzstelle für Kraftstoffe (MTS-Kraftstoff-Verordnung) as of February 2013: https://dserver.bundestag.de/btd/17/123/1712390.pdfdserver.bundestag.de/ btd/17/123/1712390.pdf (access on June 1, 2024).

⁶ See Evaluierungsbericht des Bundeswirtschaftsministeriums zur Markttransparenzstelle für Kraftstoffe as of August 2018:

https://www.bundeskartellamt.de/SharedDocs/Publikation/DE/Berichte/Evaluierungsbericht_MTS-K_. html (access on November 22, 2024).

unregulated countries with those for the regulated countries, denoted by $\hat{\omega}^{sdid}$, are also included, as well as time weights $\hat{\lambda}_t^{sdid}$ which balance the pre-regulation with the post-regulation time periods. α_i denotes the country fixed effects, β_t the time fixed effects and μ is an intercept. This results in the following two-way fixed effects regression τ , to estimate the average causal effect of the regulation:

$$\left(\hat{\tau}^{sdid}, \hat{\mu}, \hat{\alpha}, \hat{\beta}\right) = \underset{\tau, \mu, \alpha, \beta}{\operatorname{argmin}} \left\{ \sum_{i=1}^{N} \sum_{t=1}^{T} \left(Y_{it} - \mu - \alpha_i - \beta_t - W_{it} \tau \right)^2 \hat{\omega}_i^{sdid} \hat{\lambda}_i^{sdid} \right\}$$
(1)

Comparatively, the DID method does not include country or time period weights.

$$\left(\hat{\tau}^{did},\hat{\mu},\hat{\alpha},\hat{\beta}\right) = \operatorname*{argmin}_{\tau,\,\mu,\,\alpha,\,\beta} \left\{ \sum_{i=1}^{N} \sum_{t=1}^{T} \left(Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau \right)^2 \right\}$$
(2)

For the SDID estimator $\hat{\tau}^{sdid}$, time and country weights are used, giving more weight to time periods and countries that are on average similar to the treated periods to reduce potential violations of the parallel trend assumption. Furthermore, the localisation of the regression increases the robustness of the estimator by including similar countries and time periods, compared to the DID method. By removing the systematic parts of the outcome, weights may improve the precision of the estimator.

Given that our model examines a single regulated country at a time, we implement the placebo method. The primary concept behind placebo evaluations is to analyse the behaviour of synthetic control estimation by replacing the regulated country with various countries that were not regulated. Therefore, we use placebo standard errors, with 500 simulation replications for valid results.

6 Data

The dataset consists of the publicly available fuel price database Weekly Oil Bulletin provided by the European Commission and covers the period from January 2005 to the end of December 2018 (European Commission 2024). The observation period varies for each country due to changes in EU membership over time. In our analysis, we use the pump prices of Euro-Super 95 and Automotive Gas Oil (Diesel), as posted by the gas stations. Member states report the prices most frequently charged, calculated as a weighted average. Prices are reported as weekly fuel prices per 1000 L in Euro. As prices are not weighted by actual quantities sold for most countries, using this data could result in an underestimation of the effects. However, since the quantities are unknown, we are unable to address this potential bias.

As the aim of our analysis is to examine the effect of regulations on fuel prices—not the effects of tax changes—and to make the effects of regulations more comparable, we use tax-free prices. This approach is necessary because tax rates differ between countries and can also change over time.

Country	Period	Fuel	N	Mean	Std. Dev	Min	1st Qu	Median	3rd Qu	Max
FR	01/2005 - 12/2011	Super 95	344	48	10	26	42	48	54	68
		Diesel	344	52	11	35	45	50	59	79
DE	01/2008 - 12/2018	Super 95	543	56	11	25	48	56	65	84
		Diesel	543	60	12	33	49	58	70	85
AT	01/2009 - 12/2016	Super 95	394	55	11	25	45	57	64	76
		Diesel	394	59	12	36	48	59	70	79

 Table 2
 Descriptive statistics of fuel prices

Note: Prices in Cent per litre excluding taxes

In addition to the data for Germany, Austria, and France, we include information from 18 other EU countries for our control group.⁷ Prices from Bulgaria, Croatia, Malta, and Romania are not included due to missing data. In addition to Germany, Austria, and France, Italy, Belgium, and Luxembourg have also introduced regulations concerning their fuel prices. Which has led us to exclude these countries as well to ensure comparability.

Table 2 gives an overview of the descriptive statistics of the fuel prices (Euros per 1000 L) without taxes for France, Austria and Germany. While the dataset for France includes 344 weekly observations from January 2005 to December 2011, the data for Austria comprises 394 weekly observations from January 2009 to December 2016. The German dataset consists of 543 weekly observations spanning from January 2008 to December 2018.

For France, the average price for Super 95 is 48 cents per litre, while Diesel averages 52 cents per litre. Austria and Germany have higher average prices. For Austria, the average Super 95 prices are 55 cents per litre and 59 cents per litre for Diesel. In Germany the average value for Super 95 is 56 cents per litre and for Diesel 60 cents per litre. While an earlier period is examined for France, we consider a later period for Austria and Germany. The observation that prices in Germany and Austria are higher compared to France aligns with the literature, showing an increase in fuel prices over the years (Le et al. 2021; Sokhanvar et al. 2023). Moreover, average prices of Super 95 are consistently lower than those of Diesel across all countries. The standard deviation for Diesel is higher than for Super 95, ranging between 10 and 12 cents per litre. To understand these price differences, it is important to consider the specific factors influencing fuel demand and pricing in each country. In Germany and Austria, most commercial vehicles such as trucks, company cars, and agricultural vehicles are equipped with Diesel engines, resulting in relatively high demand. Additionally, Diesel prices are more affected by seasonal fluctuations. For instance, in winter, the demand for heating oil—which is refined similarly to Diesel—increases, driving up prices. These factors contribute to higher Diesel prices, explaining why the average value for Diesel is higher than that for gasoline (Sterner 2012).

⁷ The control group consists of Cyprus, Czechia, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Latvia, Lithuania, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

Country	Transparency Regulation	Model	Period
France	12/12/2006: Law on Informing Consumers about	FR.I	01/01/2005 - 31/12/2008
	the Retail Prices of Fuels	FR.II	01/01/2005 - 31/12/2010
		FR.III	01/01/2005 - 31/12/2011
Germany	31/08/2013: Market Transparency Unit	DE.I	01/09/2011 - 31/08/2015
		DE.II	01/09/2009 - 31/08/2017
		DE.III	01/09/2008 - 31/08/2018
Austria	01/08/2011: Price Transparency Enactment	AT.I	01/08/2009 - 31/07/2013
		AT.II	01/07/2009 - 31/07/2015
		AT.III	01/07/2009 - 31/07/2016

 Table 3
 Overview model periods

Table 4 Overview model periods for the Price Fixing Act Austria

Transparency Regulation	Model	Period
01/07/2009: Price Fixing Act	AT.IV	01/01/2008 - 31/12/2010
01/01/2011: Price Fixing Act Revised	AT.V	01/06/2010 - 31/07/2011
	AT.VI	01/07/2009 - 31/07/2011

7 Results

In our analysis, we examine three time periods for the respective transparency regulation: a short-term, a medium-term, and a long-term period.⁸

Table 3 gives an overview of the observation periods of France, Germany and Austria. For France we assume periods from January 2005 to the end of 2008 (FR.I), from January 2005 to the end of 2010 (FR.II) and from January 2005 to the end of 2011 (FR.III). For Germany we assume periods from September 2011 until August 2015 (DE.I), from September 2009 until August 2017 (DE.II) and from September 2008 until August 2018 (DE.III). For Austria we assume periods from August 2011 until July 2013 (AT.I), from July 2011 until July 2015 (AT.II) and from July 2011 until July 2016 (AT.III). Apart from Germany, we cannot consider a symmetric period around the introduction of the regulation for the other countries due to data limitations and other regulations.

As outlined in chapter 4, Austria has not only implemented a transparency regulation but also a regulation on price-setting. Since these regulations were introduced around the same time as the transparency regulation, we also examine the potential impact of these price restrictions (see Table 4 for the respective time periods).

7.1 France

We begin our analysis with France, which has already introduced the "Law on Informing Consumers about the Retail Prices of Fuels" in the end of 2006 and thus has the longest

⁸ We have also tested other time periods that have led to similar results. These can be made available upon request.

experience with transparency regulations in fuel markets. The short-term period covers four years, from January 2005 to December 2008, encompassing two years before and two years after the implementation. The medium-term period covers six years, from January 2005 to December 2010 (two years before and four years after the implementation). Finally, the long-term period covers seven years, from January 2005 to December 2011 (two years before and five years after the implementation). As the data on fuel prices from the Weekly Oil Bulletin are only available since 2005, it is not possible to consider a symmetric period for the medium- and long-term periods.

Table 5 shows the weighting of the individual countries within the control groups. In model FR.I all countries, except of Ireland, are included in the control groups for Super95 and Diesel. In particular, Super 95 prices from Lithuania (9.1%), Denmark (8.7%), Greece (8.5%), Sweden (8.4%), the Netherlands (8.3%) and Estonia (8.2%) are weighted to a greater extent, whereas Czechia (1.7%) and Poland (1.7%) play only minor roles in the control group. Considering the Diesel prices, the control group is particularly built on Sweden (10.9%), Spain (9.3%), the Netherlands (9.2%) and Denmark (8.5%). In contrast, Czechia (1.8%) is barely included.

In model FR.II und FR.III, Ireland is included, but it accounts only for 0.3 to 0.6%. In both models for Super 95, Lithuania, Denmark, and Sweden were largely included in the control groups. Sweden, the Netherlands, and Spain were largely included in the control groups for Diesel.

Our results in Table 6 show hardly any significant average treatment effect (ATT). While the price of Super 95 has increased by about 0.6 cents, the price of Diesel has increased by

	<u> </u>					
	FR.I		FR.II		FR.III	
Country	Super 95	Diesel	Super 95	Diesel	Super 95	Diesel
Cyprus	0.055	0.040	0.055	0.044	0.055	0.045
Czechia	0.017	0.018	0.025	0.027	0.027	0.029
Denmark	0.087	0.085	0.082	0.080	0.080	0.079
Estonia	0.082	0.078	0.077	0.074	0.076	0.072
Finland	0.043	0.059	0.046	0.060	0.047	0.059
Greece	0.085	0.076	0.079	0.072	0.077	0.070
Hungary	0.052	0.053	0.054	0.054	0.054	0.054
Ireland	0.000	0.000	0.003	0.004	0.004	0.006
Latvia	0.056	0.043	0.056	0.046	0.057	0.047
Lithuania	0.091	0.077	0.083	0.073	0.081	0.072
Netherlands	0.083	0.092	0.079	0.085	0.078	0.083
Poland	0.017	0.028	0.025	0.034	0.027	0.036
Portugal	0.043	0.034	0.045	0.039	0.046	0.040
Slovakia	0.056	0.025	0.056	0.033	0.056	0.035
Slovenia	0.028	0.038	0.033	0.041	0.035	0.043
Spain	0.068	0.093	0.066	0.085	0.065	0.082
Sweden	0.084	0.109	0.081	0.098	0.079	0.094
United Kingdom	0.055	0.051	0.055	0.052	0.056	0.053

Table 5 Country weights of models for France

FR.I: 01/01/2005 - 31/12/2008; FR.II: 01/01/2005 - 31/12/2010; FR.III: 01/01/2005 - 31/12/2011

Table 6	Average treatment	
effects of	of models for France	;

		ATT	Std. Err	t	P> t	[95% Co Interval]	onf.
F.I	Super 95	0.617	1.242	0.50	0.619	-1.817	3.051
	Diesel	0.275	1.223	0.22	0.822	-2.121	2.671
F.II	Super 95	1.029	8.865	1.18	0.238	-0.675	2.714
	Diesel	0.035	1.931	0.02	0.985	-3.749	3.819
F.III	Super 95	1.193	1.099	1.09	0.278	-0.961	3.347
	Diesel	-0.157	2.258	-0.07	0.945	-4.583	4.269

Note: The control group consists of a weighted average of all available countries. We use placebo standard errors, with 500 simulation replications



Fig. 1 Model F.I: Fuel prices for France and the synthetic control group. Note: Prices of Super 95 (left) and Diesel (right) in Euro from January 2005 until the end of December 2008. The grey vertical line indicates the first day of regulation on December 12, 2006. The red line shows the prices for France and the blue line shows the prices for the control group. The dark-grey area at the bottom of the graph indicates the time weights used for the calculations per week

about 0.28 cents in the short term. In the mid-term, the effect on Super 95 prices increases, so that the price increase is approximately one cent in both the medium and long term. In contrast, the effect on Diesel prices decreases with the extension of the observation period. In the long term, this effect becomes negative, resulting in a price reduction of approximately 0.16 cents. However, all effects are statistically insignificant. The graphical analysis also reveals no anomalies across the three time periods (see Fig. 1 for model F.I).⁹ At first glance, this transparency regulation has no obvious effect on fuel prices in France.

7.2 Germany

Even though the German Market Transparency Unit only went into regular operation on December 1, 2013, we assume the start of the trial run as implementation date, August 31, 2013.¹⁰ For different model specifications we use a symmetric sample.

⁹ The figures for the other models are available upon request.

¹⁰ We have also tested the effects with the regular implementation in December 2013. The results remain mainly unaffected.

	DE.I		DE.II		DE.III	
Country	Super 95	Diesel	Super 95	Diesel	Super 95	Diesel
Cyprus	0.024	0.026	0.036	0.043	0.046	0.049
Czechia	0.021	0.056	0.000	0.021	0.018	0.035
Denmark	0.119	0.124	0.120	0.099	0.129	0.101
Estonia	0.048	0.060	0.076	0.072	0.068	0.061
Finland	0.057	0.000	0.048	0.012	0.045	0.029
Greece	0.029	0.041	0.038	0.053	0.043	0.052
Hungary	0.062	0.060	0.063	0.061	0.063	0.059
Ireland	0.000	0.000	0.000	0.009	0.000	0.000
Latvia	0.070	0.063	0.063	0.046	0.041	0.045
Lithuania	0.062	0.052	0.059	0.057	0.065	0.071
Netherlands	0.076	0.073	0.080	0.091	0.066	0.077
Poland	0.078	0.039	0.062	0.033	0.047	0.037
Portugal	0.071	0.075	0.069	0.068	0.060	0.066
Slovakia	0.021	0.034	0.020	0.043	0.021	0.041
Slovenia	0.007	0.014	0.027	0.026	0.027	0.031
Spain	0.082	0.075	0.075	0.073	0.081	0.073
Sweden	0.161	0.160	0.156	0.141	0.148	0.124
United Kingdom	0.010	0.049	0.019	0.050	0.034	0.047

Table 7 Country weights of models for Germany

DE.I: 01/09/2011 - 31/08/2015; DE.II:01/09/2009 - 31/08/2017; DE.III: 01/09/2008 - 31/08/2018

	U			5			
		ATT	Std. Err	t	P> t	[95% Conf val]	. Inter-
DE.I	Super 95	-0.419	0.584	-0.72	0.473	-1.564	0.725
	Diesel	-1.859	1.049	-1.77	0.076	-3.915	0.196
DE.II	Super 95	-1.508	1.134	-1.33	0.184	-3.731	0.715
	Diesel	-1.359	1.105	-1.23	0.218	-3.524	0.806
DE.III	Super 95	-2.243	1.171	-1.92	0.055	-4.538	0.053
	Diesel	-2.936	1.266	-2.32	0.020	-5.418	-0.454

Table 8 Average treatment effects of models for Germany

The control group consists of a weighted average of all available countries. We use placebo standard errors, with 500 simulation replications

Table 7 summarizes the weights for each model specification of Super 95 and Diesel. The results are relatively consistent across the observations. In all models, Sweden (12-16%) and Denmark (10-12%) are weighted the most. Ireland is not included in any model, except of the medium-term of Diesel, with less than 1%. Finland is also assigned a relatively lower weight in the Diesel models (less than 3%) and is not included at all in the short run. In the medium-run analysis of Super 95, Czechia is not included.

The average treatment effects are negative, indicating a price-reducing effect (see Table 8). For Super 95, this price-reducing effect increases by extending the observation



Fig. 2 Model DE.I: Fuel prices for Germany and the synthetic control group. Note: Prices of Super 95 (left) and Diesel (right) in Euro from September2011 until the end of August 2015. The grey vertical line indicates the first day of regulation on August 31, 2013. The red line shows the prices for Germany and the blue line shows the prices for the control group. The dark-grey area at the bottom of the graph indicates the time weights used for the calculations per week

period. In the short-run there is a price-reducing effect on Super 95 prices of only 0.4 cents per litre. In the medium-run 1.5 cents per litre. However, both effects are not statistically significant. The situation differs in the long run, where we observe a price-reducing effect of 2.2 cents per litre, which is statistically significant at the 5% level. In the medium-run specification for Diesel there is a price-reducing effect of 1.4 cents per litre, but not statistically significant. This effect is stronger in the short run, at 1.9 cents per litre, and is even statistically significant at the 10% level. The highest price-reducing effect is observed in the long-run Diesel specification, amounting to approximately three cents per litre. This effect is statistically significant at the 5% level.

Interestingly, a price-reducing effect of the regulation does not appear to have occurred immediately but only after some time. This could be due to the fact that consumers initially made little use of the websites and apps providing current prices, resulting in the increased competitive pressure building up gradually. Similarly, it may have taken some time for the increased transparency to influence pricing behaviour on the part of gas stations.

For model DE.I, the graphical analysis indicates no statistically significant effect on Super 95 prices. In contrast, Fig. 2 suggests a slight price-reducing effect on diesel prices following the implementation of the MTU.¹¹

As we can see, compared to France, the results from Germany indicate a price-reducing effect of around two to three cents per litre.

7.3 Austria

Next, we analyse the effect of the Price Transparency Enactment of August 2011 in Austria. As described in Chapter 4, regulation was also introduced in Austria to restrict the pricing of gas stations. As this runs in parallel with the Price Transparency Enactment, was amended only two years before its introduction, and was also revised in 2011, it is impossible to separate the potential effects from 2011 onward. However, we attempt to account

¹¹ The figures for the other models are available upon request.

-	AT.I		AT.II		AT.III	
Country	Super 95	Diesel	Super 95	Diesel	Super 95	Diesel
Cyprus	0.031	0.022	0.039	0.030	0.041	0.032
Czechia	0.061	0.071	0.059	0.070	0.059	0.068
Denmark	0.045	0.079	0.048	0.067	0.049	0.066
Estonia	0.068	0.102	0.067	0.089	0.066	0.087
Finland	0.074	0.044	0.066	0.048	0.065	0.049
Greece	0.031	0.030	0.039	0.039	0.041	0.040
Hungary	0.037	0.049	0.043	0.055	0.044	0.055
Ireland	0.016	0.022	0.025	0.029	0.028	0.031
Latvia	0.043	0.049	0.047	0.050	0.048	0.051
Lithuania	0.061	0.041	0.061	0.043	0.060	0.044
Netherlands	0.069	0.054	0.065	0.053	0.064	0.053
Poland	0.081	0.095	0.070	0.086	0.069	0.083
Portugal	0.061	0.049	0.060	0.051	0.060	0.051
Slovakia	0.102	0.038	0.088	0.044	0.084	0.045
Slovenia	0.041	0.061	0.045	0.061	0.046	0.061
Spain	0.062	0.080	0.061	0.072	0.060	0.071
Sweden	0.045	0.053	0.048	0.051	0.048	0.051
United Kingdom	0.073	0.063	0.069	0.063	0.068	0.062

Table 9 Country weights of transparency models for Austria

AT.I: 01/08/2009 - 31/07/2013; AT.II: 01/07/2009 - 31/07/2015; AT.III: 01/07/2009 - 31/07/2016

for the overlap in determining the observation periods. Therefore, we cannot assume symmetric time periods around the introduction date of the Price Transparency Enactment.

Even though the Price Fixing Act in Austria, which came into force in July 2009 and was revised in January 2011, is not a price transparency regulation, we also analyse it in chapter 7.3.2 in order to be able to separate and at the same time compare the possible effects.

7.3.1 Price Transparency Enactment

In model AT.I, we consider the period from August 2009 to July 2013, encompassing two years before and after implementation. Model AT.II extends the observation period from July 2009 to July 2015, while model AT.III further extends it to July 2016.

Table 9 presents the weights assigned to the control groups for each model. Ireland receives the lowest weight for both Super 95 and Diesel prices (approximately 2-3%). While Slovakia carries the highest weight for Super 95 prices (8–10%), Estonia is the most weighted for Diesel prices (9–10%).

Table 10 presents the average treatment effects of the Price Transparency Enactment on Super 95 and Diesel prices in Austria (see also Fig. 3). Notably, the average treatment effect on Super 95 prices is positive across all model specifications, indicating a priceincreasing effect. This effect grows with an extension of the observation period. In contrast,

Table 10 Average treatment effects of transparency models for Austria			ATT	Std. Err	t	P>ltl	[95% Co Interval]	onf.
	AT.I	Super 95	0.804	1.156	0.70	0.487	-1.461	3.069
		Diesel	-0.436	1.476	-0.30	0.768	-3.329	2.457
	AT.II	Super 95	1.682	1.074	1.57	0.117	-0.428	3.787
		Diesel	-0.284	1.553	-0.18	0.855	-3.328	2.761
	AT.III	Super 95	1.841	1.185	1.55	0.120	-0.481	4.162
		Diesel	-0.380	1.680	-0.23	0.821	-3.672	2.912

The control group consists of a weighted average of all available countries. We use placebo standard errors, with 500 simulation replications



Fig.3 Model AT.I: Fuel prices for Austria and the synthetic control group. Note: Prices of Super 95 (left) and Diesel (right) in Euro from August 2009 until the end of July 2013. The grey vertical line indicates the first day of regulation on August 1, 2011. The red line shows the prices for Austria and the blue line shows the prices for the control group. The dark-grey area at the bottom of the graph indicates the time weights used for the calculations per week

the results for Diesel prices suggest a price-decreasing effect of less than 1 cent per litre across all model specifications. However, none of the results are statistically significant.¹²

The results indicate that, if there is any significant effect of the transparency regulation in Austria, it would lead to an increase in Super 95 prices up to two cents per litre and to a decrease in Diesel prices by less than one cent per litre.

7.3.2 Price Fixing Act

In model AT.IV we analyse the effect of the Price Fixing Act in July 2009. The model covers a period of three years, one and half years before and after the implementation,

¹² We also conducted the analysis using observation periods beginning in January 2011 to account for the revision of the Price Fixing Act. The results indicate a price-increasing effect for both Super 95 and Diesel prices. Notably, for Super 95 prices, this effect is statistically significant in the long run (see Table 15, Table 16 and Table 17 in the appendix).

	AT.IV		AT.V		AT.VI	
Country	Super 95	Diesel	Super 95	Diesel	Super 95	Diesel
Cyprus	0.048	0.048	0.038	0.039	0.026	0.058
Czechia	0.060	0.057	0.041	0.026	0.070	0.058
Denmark	0.075	0.093	0.075	0.090	0.088	0.080
Estonia	0.059	0.065	0.063	0.081	0.032	0.020
Finland	0.034	0.034	0.066	0.043	0.058	0.043
Greece	0.064	0.053	0.054	0.055	0.028	0.035
Hungary	0.041	0.060	0.047	0.049	0.060	0.078
Ireland	0.015	0.000	0.055	0.048	0.008	0.016
Latvia	0.061	0.049	0.072	0.066	0.071	0.039
Lithuania	0.066	0.072	0.059	0.045	0.066	0.020
Netherlands	0.108	0.080	0.081	0.098	0.078	0.109
Poland	0.043	0.054	0.040	0.034	0.006	0.058
Portugal	0.048	0.057	0.062	0.061	0.062	0.077
Slovakia	0.039	0.024	0.034	0.042	0.068	0.039
Slovenia	0.030	0.045	0.012	0.007	0.035	0.054
Spain	0.067	0.077	0.090	0.088	0.079	0.092
Sweden	0.080	0.087	0.082	0.082	0.071	0.063
United Kingdom	0.062	0.048	0.028	0.045	0.092	0.061

Table 11 Country weights of Price Fixing Act models for Austria

AT.IV: 01/01/2008 - 31/12/2010; AT.V: 01/06/2010 - 31/07/2011; AT.VI: 01/07/2009 - 31/07/2011

Table 12Average treatmenteffects of Price Fixing Actmodels for Austria			ATT	Std. Err	t	P>ltl	[95% Co Interval]	onf.
	AT.IV	Super 95	0.921	1.415	0.65	0.515	-1.853	3.695
		Diesel	-1.021	1.512	-0.68	0.499	-3.984	1.942
	AT.V	Super 95	-2.841	1.497	-1.90	0.058	-5.775	0.093
		Diesel	-2.245	1.281	-1.75	0.080	-4.755	0.264
	AT.VI	Super 95	-2.158	1.766	-1.22	0.222	-5.619	1.303
		Diesel	-2.338	1.408	-1.65	0.098	-5.086	0.431

The control group consists of a weighted average of all available countries. We use placebo standard errors, with 500 simulation replications

from January 2008 until December 2010. An extension of the time period after the implementation is not possible, because of the revision of the law in January 2011.¹³

To analyse the effect of the Price Fixing Act Revised in January 2011 we consider two observation periods. Model AT.V covers a period of 14 months, with seven months before and after the revision, from June 2010 until July 2011. Model AT.VI covers a period of two years and one month, with one and a half year before revision and seven months after

¹³ We have also analysed a two-year period (one year before and one year after the implementation) as well as a four-year period (two and half years before and one and a half years after the implementation). However, the results did not change significantly.



Fig. 4 Model AT.V: Fuel prices for Austria and the synthetic control group. Note: Prices of Super 95 (left) and Diesel (right) in Euro from June 2010 until the end of July 2011. The grey vertical line indicates the first day of regulation on January 1, 2011. The red line shows the prices for Austria and the blue line shows the prices for the control group. The dark-grey area at the bottom of the graph indicates the time weights used for the calculations per week

revision, from July 2009 until July 2011. We did not extend the period after revision due to the introduction of the transparency regulation in August 2011. Therefore, we only analyse the short-term effects of the Price Fixing Act.

Table 11 shows the weights for each model specification of Super 95 and Diesel. In model AT.IV for Super 95, the Netherlands are weighted most (10.8%), while Ireland contributes only 1.5%. For Diesel, Ireland is excluded, and Denmark holds the largest weight (9.3%). In contrast, model AT.V for Diesel, the Netherlands contributes 9.8% of the control group and United Kingdom least, with less than 1%. For the Super 95 control group, Spain (9%) was weighted the most and Slovenia (1.2%) the least. Lastly, in model specification AT.VI, Poland and Ireland contribute less than 1% of the Super 95 control group, while the United Kingdom has the highest weight with 9.2%. Also for Diesel, Ireland is weighted least (1.6%) and the Netherlands most (10.9%).

Table 12 presents the average treatment effect of the Price Fixing Act in Austria. The effect of the original Price Fixing Act in 2009 is a price-increasing effect of less than one cent per litre for Super 95 prices. In contrast, there is a price-decreasing effect of one cent per litre on Diesel prices. However, the effects are not statistically significant. In the models for the Price Fixing Act Revised in 2011 there is in all model specifications a price-reducing effect of two to three cents per litre. In model AT.V so the 14 months period (seven months before and after revision) there is a price-reducing effect of 2.8 cents per litre on Super 95 prices and of 2.2 cents per litre on Diesel prices. Both effects are statistically significant, at least at 10% level. In model AT.VI with the more extended observation period of one and a half years before the revision, the price-reducing effect on Super 95 prices is 2.2 cents per litre and on Diesel prices 2.3 cents per litre. Only the effect on Diesel prices is statistically significant at 10% level.

Figure 4 shows the effect of the revised Price Fixing Act in January 2011 (model AT.V). The graphical analysis reveals that approximately two weeks before the revision, the fuel prices decrease compared to the control group. Following the introduction of the revision, Super 95 prices briefly increase but stabilize at a lower level compared to the control group. After approximately 10 weeks, prices begin to converge with the control group. However, they remain lower than before the revision. Diesel prices also increase following the revision but drop sharply after approximately two weeks. Similarly, prices only align with the

Model	Period	Fuel	ATT	Std. Err	P>ltl
F.I	01/01/2005 - 31/12/2008	Super 95	0.617	1.242	0.619
		Diesel	0.275	1.223	0.822
F.II	01/01/2005 - 31/12/2010	Super 95	1.020	0.865	0.238
		Diesel	0.035	1.931	0.985
F.III	01/01/2005 - 31/12/2011	Super 95	1.193	1.099	0.278
		Diesel	-0.157	2.258	0.945
DE.I	01/09/2011 - 31/08/2015	Super 95	-0.419	0.584	0.473
		Diesel	-1.859	1.049	0.076
DE.II	01/09/2009 - 31/08/2017	Super 95	-1.508	1.134	0.184
		Diesel	-1.359	1.105	0.218
DE.III	01/09/2008 - 31/08/2018	Super 95	-2.243	1.171	0.055
		Diesel	-2.936	1.266	0.020
AT.I	01/08/2009 - 31/07/2013	Super 95	0.804	1.156	0.487
		Diesel	-0.436	1.476	0.768
AT.II	01/07/2009 - 31/07/2015	Super 95	1.682	1.074	0.117
		Diesel	-0.284	1.553	0.855
AT.III	01/07/2009 - 31/07/2016	Super 95	1.841	1.185	0.120
		Diesel	-0.380	1.680	0.821

Table 13 Overview of the obtained ATT for transparency regulations

The control group consists of a weighted average of all available countries. We use placebo standard errors, with 500 simulation replications

control group after about 10 weeks, but stabilize at a comparatively lower level than those of the control group.¹⁴

While the results of the Price Fixing Act in 2009 do not indicate any significant effect, the revision of the Price Fixing Act suggests a price-reducing effect of two to three cents per litre. This could indicate that the adaption of the Price Fixing Act in 2011, by changing the time for setting the maximum daily price from 12 a.m. to 12 p.m. had an impact on the pricing strategy of gas station operators. In contrast, the findings for the transparency regulation in Austria indicate that, if there is any effect of the transparency regulation, it is likely to be a price-increasing one for Super 95 prices and a decreasing one for Diesel prices.

8 Discussion

Table 13 provides an overview of the average effects of the transparency regulations for each model to compare the results of the different periods for Austria, Germany and France. For France, there is a price-increasing effect on Super 95, amounting to approximately one cent or less per litre. For Diesel prices, the short- and medium-term effects show an increase of up to 0.3 cents per litre. In the long term, there is a price-reducing

¹⁴ The figures for the other models are available upon request.

Model	Regulation	Period	Fuel	ATT	Std. Err	P>ltl
AT.I	Price Transparency Enactment	01/08/2009 - 31/07/2013	Super 95	0.804	1.156	0.487
	2011		Diesel	-0.436	1.476	0.768
AT.II		01/07/2009 - 31/07/2015	Super 95	1.682	1.074	0.117
			Diesel	-0.284	1.553	0.855
AT.III		01/07/2009 - 31/07/2016	Super 95	1.841	1.185	0.120
			Diesel	-0.380	1.680	0.821
AT.I Price Fix	Price Fixing Act 2009	01/01/2008 - 31/12/2010	Super 95	0.921	1.415	0.515
			Diesel	-1.021	1.512	0.499
AT.II	Price Fixing Act Revised 2011	01/06/2010 - 31/07/2011	Super 95	-2.841	1.497	0.058
			Diesel	-2.245	1.281	0.080
AT.III		01/07/2009 - 31/07/2011	Super 95	-2.158	1.766	0.222
			Diesel	-2.338	1.408	0.098

Table 14 Overview of the obtained ATT for regulations in Austria

The control group consists of a weighted average of all available countries. We use placebo standard errors, with 500 simulation replications

effect of 0.2 cents per litre. However, the results are statistically insignificant for both Super 95 and Diesel in all model specifications.

In case of Austria, for Super 95 there are consistently price-increasing effects. The effect lies between one and two cents per litre. In contrast, there are consistently price-decreasing effects for Diesel of less than one cent per litre. However, all effects are statistically insignificant.

The results of Germany indicate a price-cutting effect. For Super 95, this effect intensifies by extending the observation period. In the short and medium term there is a pricereducing effect of up to 1.5 cents per litre. However, both effects are not statistically significant. In the long-term period there is a price-reducing effect of more than two cents per litre, which is statistically significant. Aside from the medium-term period, the pricereducing effect of two to three cents per litre in the short and long run for Diesel prices are statistically significant.

By comparing our results with previous research, our results for Germany align with most of the previous studies. Like Haucap et al. (2017), Horvath (2019), Martin (2022) and Montag et al. (2024), we find a price-reducing effect of the MTU in Germany. While Horvath (2019) find a price decrease by one to two cents per litre, our results indicate that this effect might be even higher with up to three cents per litre. However, we also consider the long-term effects, whereas Horvath (2019) examines only a ten-month period. In addition, our analyses are based on different datasets.

Similar to our analysis, Montag et al. (2024) use the SDID method to compare gas stations in Germany and France. As a robustness check, they apply a DiD method using the same dataset as ours. However, they do not narrow the control group and instead include 26 member states, some of which are subject to fuel market regulations. Despite the differences, our findings align closely, underscoring the robustness of the results.

Our findings diverge from those reported by Dewenter et al. (2017), which could be due to differences in methodology, such as their use of a DiD approach incorporating additional explanatory variables. Furthermore, their analysis includes a broader control group. Variations in observation periods may also play a role, as their study examines a pre-treatment

period from 2005 to December 2013, followed by a comparatively brief post-treatment period ending in 2015. Martin (2022) examined what level of transparency maximizes the consumer welfare. He has based this on the model in Austria, where only the prices of the five cheapest gas stations within this area are displayed. His results show that if only 20% of the prices are shown, would maximizes the consumer welfare. However, while our results indicate that the Austrian regulation leads to a decrease in Diesel prices but has no impact on Super 95 prices, German transparency regulation leads to overall price decreases. The question arises as to what extent the combined regulation in Austria is responsible for this circumstance.

Table 14 compares the different regulations in Austria. As already mentioned, the results indicate that the Price Transparency Enactment in 2011 has no significant effect on the prices. The results suggest at most a potential increase in Super 95 prices, while Diesel prices may experience a slight decline. The Price Fixing Act in 2009 led to no significant results. While there is a price-increasing effect on Super 95 prices of one cent per litre, Diesel prices exhibit a price-decreasing effect of one cent per litre. In contrast, the revision of the Price Fixing Act in 2011 led to consistently price-decreasing effects of two to three cents per litre. Nonetheless, only the effect on Diesel prices is statistically significant.

It is noteworthy that the Price Fixing Act of 2009 and its revision in 2011 had different effects on prices, despite the only change being the reporting time for the maximum price. This could be related to the fact that a maximum price set at 12:00 p.m. is noticed more by consumers than a change at 12:00 a.m. (respectively 8:30 a.m.). As a result, gas stations may not be able to raise their maximum price as significantly.

Sine the revision of the Pirce Fixing Act was implemented shortly before the transparency regulation, the results may suggest that the price-reducing effect of the revision is reduced by the transparency regulation and in case of Super 95, even results in a price increase.

Concerning the effects of the Price Fixing Act in 2009, we have different results compared to Becker et al. (2021). Becker et al. (2021) found a price-reducing effect on Super 95 and Diesel prices. Our results indicate no significant effects and for Diesel prices it tends to a price-increasing effect. This could be related to the fact that Becker et al. (2021) extended the post-treatment period, irrespective of the subsequent regulations. As a result, they examine the long-term effect of the first Price Fixing Act in 2009. If we include our results concerning the revision of the Price Fixing Act in 2011, we align with the results of Becker et al. (2021) that the Price Fixing Act led to a price decrease.

In chapter 4, we pointed out the potential costs associated with implementing price transparency regulations. For Germany, detailed information is available regarding the costs of the MTU. According to the report, one-off costs for the reporting system amount to EUR 7.1 million and for the MTU itself amount to EUR 2.2 million. A significant portion of the latter costs was saved, though no precise details were provided. Ongoing costs for the economy total EUR 1.5 million, while the ongoing costs of the MTU are approximately EUR 1 million annually. Based on this, we can estimate that the one-off costs for implementing the MTU are approximately EUR 9 million or less, with ongoing costs around EUR 2.5 million per year.

According to the Federal Statistical Office, annual sales of Diesel and gasoline fuel between 2014 and 2020 amounted to approximately 25.7 billion litres and 24.7 billion litres, respectively (Statistisches Bundesamt 2022). As our results suggest, Diesel prices are expected to decrease by three cents per litre, and Super 95 prices by two cents per litre as a result of the MTU. Consequently, consumers could save up to EUR 1.3 billion per year. Given these figures, the potential savings resulting from the MTU, estimated at approximately EUR 1.3 billion per year, significantly exceed the implementation and

ongoing costs. This suggests that the MTU would be a cost-effective measure, delivering substantial net savings for consumers.

As we do not have exact cost data for France and Austria, we cannot make a precise statement of the costs for the transparency regulation in these countries. However, our results for both France and Austria suggest that the transparency regulation either has no impact on prices or tends to have a price-increasing effect. Therefore, the costs of implementing price transparency regulations in these countries may outweigh the benefits, as the potential for price reductions appears limited or non-existent.

In summary, no universally valid conclusion can be drawn regarding the impact of transparency regulations in European fuel markets. While in France there are no insights for any significant effects, we find for Germany a price-reducing effect of two cents on Super 95 prices and of three cents for Diesel prices in the long run. As in France, there are hardly any significant results for the transparency regulation in Austria. Only in the long term, the results indicate that there is a price-increasing effect of around 3 cents per litre for Super 95 prices. In case of France, the results could indicate that the law has increased not only vertical but also horizontal market transparency. In fact, it seems like the effect of the horizontal transparency may be greater than the vertical one, whereas the results of Germany indicate the opposite. The results from Austria are inconclusive. However, the revision of the Price Fixing Act in Austria, which restricts gas stations in their pricing decisions, indicates a price-reducing effect.

These different results could be related to the different policy designs. In Germany, the real-time prices of gas stations can be viewed via various channels, such as websites and apps (the MTU itself does not operate a consumer information service). In contrast, in France and Austria the fuel prices are only published on the official website. This may restrict consumers' access to price information, as they cannot access via different channels. Moreover, in Austria, the website displays only the prices of the five cheapest gas stations, as well as the ten nearest gas stations. That is, not all gas stations are displayed, which reduces the information available to consumers, but also to gas station operators. In addition, Austria has the Price Fixing Act, which may affect the effect of the transparency regulation.

The dissemination of price information via various channels can make it easier for consumers to access this data, as they can choose the channel that best suits their preferences and offers the most convenient service from their perspective. In contrast, if the data is only available on an official website, this might result in fewer consumer utilizing the price information. Even when such websites are optimized for smartphones, some consumers may prefer apps, which they might use more frequently if such alternatives were available.

From the gas station operators' perspective, however, this limitation is unlikely to pose a significant problem in monitoring prices, as companies typically rely on professional tools or platforms for price analysis.

This insight highlights the importance of offering multiple, user-friendly channels for price information to maximize the optimal utilization of consumers, thereby the effectiveness of the transparency policies. If consumers make less use of the price information due to limited channels, vertical transparency may increase less than horizontal price transparency, potentially leading to higher prices (see Montag et al 2024).

Since Austria has implemented the Price Fixing Act in addition to the transparency policy, this could make it easier for gas station operators to adjust their maximum prices to the competitors, whereby the effectiveness of the Price Fixing Act is reduced. This could explain why the results for Austria indicate a price-increasing effect on Super 95 prices or why the price-reducing effect on Diesel prices following the transparency regulation is less pronounced compared to the period before the revision was introduced.

9 Conclusion

This paper analyses the impact of transparency regulations on fuel prices in Austria, Germany and France, utilizing a synthetic difference-in-differences approach (SDID) as an identification strategy.

Using data from the Weekly Oil Bulletin which provides information on fuel prices for all member states of the European Union, our results are inconclusive. While results for France indicate a mostly price-increasing effect on fuel prices, results for Germany suggest that prices have fallen by two to three cents per litre due to the introduction of the MTU. However, while price effects in France are statistically insignificant, results for Germany are statistically significant, at least in the long run.

In addition to the transparency regulation, Austria also introduced a regulation that specifically affects the pricing of the gas stations. Gas station operators are only allowed to increase prices once a day at a fixed time. While the 2009 regulation, which required gas station operators to set their maximum price at 12:00 a.m., had no significant effect, the revision in 2011, which required them to set their maximum price at 12:00 p.m., suggests a price-reducing effect of two to three cents per litre. Like for France, the analysis of the Austrian transparency regulation suggests a price-increasing effect on Super 95 but also a price-reducing effect on Diesel. However, none of the effects are statistically significant.

Due to our divergent results, no generally valid statement about the effectiveness of transparency policies in European fuel markets can be made. The results indicate that the impact depends on the design of the policy as well as on other regulations in the fuel markets.

In the case of France, the results suggest that horizontal transparency outweighs vertical transparency, leading to an increase in prices. Becker et al. (2021) suggest that restricting the disclosure of prices should have a price-reducing effect. Austria displays the prices of only the five cheapest gas stations, yet our findings indicate a price-increasing effect, at least for Super 95 prices. This may be attributed to the additional regulation of price setting in Austria or the accessibility of price information. In Austria and France, price information is exclusively available on the official website, whereas in Germany, consumers can access this information through various channels. As a result, consumers may not use the provided information effectively, allowing gas station operators to benefit more from the price transparency.

Comparing costs and benefits of the regulatory interventions, the MTU appears to have led to lower prices in Germany, which overall outweigh the operating costs of the MTU. When compared to the margins of the gas stations, price effects also seem to be non-negligible. Following Frondel et al. (2020) this corresponds to a reduction of about 20% and more in margins.¹⁵ In contrast, the findings for France and Austria do not support maintaining the existing transparency policies, at least not in their current form. However, one must also bear in mind that, as prices are posted prices and not weighted by actual quantities sold (which holds at least for most of the countries), using this data could result in an underestimation of the effects of regulation,¹⁶ at least in the short run. In the long run, one would expect prices to adjust accordingly. However, since the quantities are unavailable to us, we are unable to address this potential issue.

¹⁵ See also Scope Investor Services (2021), which promotes margins of 10 to 12 euro cents.

¹⁶ We are grateful to an anonymous referee indicating this issue.

Appendix

Country	Transparency Regulation	Model	Period
Austria	01/08/2011: Price Transparency Enactment	AT.AI AT.AII AT.AIII	01/01/2011 – 31/07/2013 01/01/2011 – 31/07/2015 01/01/2011 – 31/07/2016

 Table 15
 Austria model periods – restricted

	AT.I		AT.II		AT.III	AT.III	
Country	Super 95	Diesel	Super 95	Diesel	Super 95	Diesel	
Cyprus	0.030	0.054	0.036	0.052	0.038	0.052	
Czechia	0.045	0.037	0.048	0.041	0.048	0.042	
Denmark	0.090	0.087	0.082	0.080	0.080	0.078	
Estonia	0.010	0.062	0.020	0.064	0.023	0.064	
Finland	0.061	0.053	0.059	0.053	0.059	0.053	
Greece	0.055	0.050	0.055	0.051	0.055	0.051	
Hungary	0.051	0.052	0.052	0.053	0.053	0.054	
Ireland	0.071	0.021	0.069	0.027	0.068	0.028	
Latvia	0.059	0.065	0.058	0.064	0.058	0.063	
Lithuania	0.060	0.067	0.059	0.064	0.058	0.064	
Netherlands	0.072	0.073	0.068	0.070	0.067	0.069	
Poland	0.048	0.044	0.050	0.046	0.050	0.047	
Portugal	0.069	0.072	0.065	0.069	0.065	0.068	
Slovakia	0.043	0.036	0.046	0.039	0.047	0.041	
Slovenia	0.048	0.044	0.049	0.046	0.050	0.047	
Spain	0.059	0.076	0.059	0.072	0.058	0.071	
Sweden	0.077	0.072	0.073	0.069	0.071	0.068	
United Kingdom	0.052	0.033	0.052	0.038	0.052	0.039	

 Table 16
 Country weights of transparency models for Austria—restricted

AT.I: 01/01/2011 – 31/07/2013; AT.II: 01/01/2011 – 31/07/2015; AT.III: 01/01/2011 – 31/07/2016

Table 17Average treatmenteffects of transparency modelsfor Austria – restricted

		ATT	Std. Err	t	P>ltl	[95% C Interval	onf.]
AT.I	Super 95	1.373	1.353	1.02	0.310	-1.278	4.025
	Diesel	0.204	1.487	0.14	0.891	-2.710	3.117
AT.II	Super 95	2.515	1.540	1.63	0.103	-0.504	5.534
	Diesel	0.787	1.792	0.44	0.660	-2.725	4.299
AT.III	Super 95	2.784	1.654	1.68	0.092	-0.458	6.025
	Diesel	1.031	1.927	0.54	0.593	-2.745	4.807

The control group consists of a weighted average of all available countries. We use placebo standard errors, with 500 simulation replications Author Contribution While Lea Bernhardt have equally contributed, Xenia Breiderhoff has the largest share in the data analysis of the paper.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Conflict of Interest The authors declare no competing interests.

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