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The Pass-Through of Differential Commodity Taxes: Do Relative Taxes among Competitors Matter?

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Abstract

This paper studies the pass-through of commodity taxes that apply differentially across competing firms. We exploit regional variations in fuel taxes in Spain, which generated sharp tax differences among competitors at either sides of regional borders. Using pump-level price data covering the universe of fuel stations in Spain, we find that equivalent tax shocks generate different price effects depending on whether they place affected firms at a competitive advantage or disadvantage relative to cross-regional rivals. High-tax stations near borders only partially shift their taxes, while their neighboring low-tax competitors do not respond to rivals' tax changes. In contrast, low-tax stations fully shift their taxes, and adjacent high-tax competitors also respond by raising their prices. We show that these asymmetric responses are particularly large in the presence of nearby regional competitors. Overall, our results are consistent with a significant influence of competitive dynamics on the pass-through of differential taxes and equivalent cost shocks among competing firms.

JEL classification: D12, H22, H71, H73, Q35, Q41.
Keywords: Pass-through, Tax Incidence, Demand Curvature.

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1 Introduction

Competing products often face different commodity taxes. Prominent examples include environmental taxes that vary with products' carbon intensity, import tariffs imposed selectively on foreign goods, and localized taxes that create tax differentials across jurisdictions. Such policies generate asymmetric cost shocks among competing firms, potentially altering their relative prices and competitive positions. Understanding the pass-through of these differential taxes is therefore central to evaluating their welfare consequences. In particular, an important question is how the relative position of taxed and untaxed firms affects the pass-through of differential tax and cost shocks. However, identifying these effects empirically is challenging because taxed products often lack clearly defined untaxed substitutes and frequently enter production as intermediate inputs (Cole & Eckel, 2018).

This paper studies the pass-through of differential commodity taxes, focusing on the role of firms' tax position. We exploit regional variations in fuel excise taxation in Spain, where regional governments were allowed to set their own tax rates. This policy generated sharp tax differentials between petrol stations located on opposite sides of regional borders, creating asymmetric cost shocks among direct competitors. We estimate how stations on both sides of regional borders adjust prices in response to cross-regional tax changes as a function of their proximity to cross-border competitors. Our analysis combines daily pump-level prices and geolocations for the universe of fuel stations in Spain within a two-way fixed-effects (TWFE) framework. We further use province-level fuel purchase data to relate price adjustments to market-wide demand responses. Because fuels are largely homogeneous and product differentiation is determined primarily by geographic distance (Slade, 1998), the Spanish fuel market provides a canonical setting for studying the pass-through of differential tax and cost shocks.

Our main finding is that the pass-through of differential tax shocks generate different price effects depending on whether these shocks place affected firms at a competitive advantage or disadvantage relative to nearby cross-regional rivals. Tax shocks that put affected stations at a disadvantage are only partially shifted on to prices, while shocks inducing tax advantage are fully shifted on to prices.

Specifically, when taxes increase on the high-tax side of a border, affected stations pass through only 57% of the tax, while neighboring low-tax stations do not adjust their prices. Conversely, when taxes increase on the low-tax side, pass-through is complete, and neighboring high-tax stations raise their prices by 43% of the tax change. In addition, we find that the effects of differential taxes are highly localized near borders, with asymmetric price responses concentrated within 10 km of regional borders. Beyond this distance, the estimated pass-through is consistent with statutory incidence: stations fully pass through their own taxes and do not respond to tax changes affecting cross-regional competitors.

We provide evidence on the role of competitive pressure from symmetric competitors – facing their same tax regime – on these asymmetric price effects. We find substantial heterogeneity in the pass-through of cross-regional taxes depending on the number of nearby competitors located in the same region[1]. While the asymmetry in the pass-through is very large under numerous symmetric competitors, the asymmetry is substantially reduced under fewer competitors. The difference is driven almost entirely by stations on the low-tax side of regional borders. Low-tax stations facing many same-region competitors do not adjust their prices in response to cross-regional tax differences. In contrast, low-tax stations facing few competitors pass through 22% of these tax differentials. On the high-tax side of borders, pass-through is much more similar across competitive environments. These findings are consistent with a substantial contribution of symmetric competitors in observing such an asymmetric pass-through of differential taxes. In particular, tax-advantaged stations appear constrained from raising prices when they face intense competition from neighboring firms on their own side of the border.

Second, we examine the effect of another form of market power, driven by the prominence of station brands. This allows checking how the asymmetry relates to market power in general, compared to competitive pressure from nearby symmetric firms specifically. To do so, we differentiate the effects by station type. The three leading brands—Repsol, Cepsa, and BP—own all nine oil refineries in Spain and likely benefit from lower marginal costs and stronger brand recognition

[1] Stations are divided according to the number of same-region competitors within 10 km: (i) low pressure: 0–1 competitors (15.8% of stations) and (ii) high pressure: more than 2 competitors (84.2% of stations).

than independent stations[2]. We find that overall price responses to cross-regional tax differentials are indeed larger among smaller brands: only 45% of tax differentials are reflected in price differences for independent stations, compared with 75% for the leading brands. However, the difference arises entirely from the high-tax side of regional borders. In both cases, low-tax stations exhibit pass-through consistent with statutory incidence. The evidence is consistent with tax-advantaged stations appear constrained from raising prices relative to neighboring stations on their own side of the border, regardless of brand strength.

Third, we estimate how province-level diesel purchases respond to cross-regional tax differentials. In this manner, we investigate whether the asymmetric pass-through of differential taxes might reflect asymmetric relocation of purchases across regional borders[3]. Our results indicate that tax differentials generate sizable demand shifts, both when stations face a tax advantage or a tax disadvantage. Consequently, the absence of price responses among low-tax stations may not come from a lack of market demand adjustment. These findings suggest that within-region competitive dynamics, rather than cross-regional demand responses, could drive the asymmetric incidence of differential taxes.

Overall, our pass-through results are consistent a significant role of the curvature of demand (Bulow & Pfleiderer, 1983; Weyl & Fabinger, 2013), specifically the result can be explained by a kink-shaped demand curve (Hall & Hitch, 1939; Sweezy, 1939). Maskin and Tirole (1988) showed that in oligopoly, firms expect competitors to match price reductions more readily than price increases. This makes firm-level demand more elastic for raising prices above those of competitors than for prices below them. Thus, even when firms benefit from tax-induced demand gains, they may not find profitable to raise prices because of fears of losing their demand, while firms facing tax-induced demand losses may find price reductions optimal. These competitive dynamics have been widely documented in retail fuel markets (Noel, 2007a, 2007b; Wang, 2009). The framework rationalizes the three main observations. First, for moderate cross-regional demand shocks, a kinked

[2] The three leading brands account for 49.4% of petrol stations in Spain, while all other brands account for the remaining 50.6%.

[3] We interact cross-regional taxes with the share of stations in various distance ranges, estimating how the effects of differential taxes depend on the proximity to regional borders. We are aware of the shortcoming of using more aggregate data.

demand can explain the rigidity of prices, rationalizing the highly localized nature of the observed price effects. Second, for similarly large demand shocks, the kinked demand can generate markedly different pricing responses depending on whether they improve or worsen a firm's competitive position. Third, under fewer nearby competitors, when kinked in the demand curve is expected to be less pronounced, the asymmetric pass-through is reduced.

Our findings contribute four main strands of literature. First, we contribute to the literature on the cross-border incidence of consumption taxes, where existing studies have focused on markets for fuels (Bajo-Buenestado & Borrella-Mas, 2019; Hurtado, 2023; Stolper, 2016), alcohol (Asplund et al., 2007), and cigarettes (DeCicca et al., 2013; Harding et al., 2012). Whereas this literature primarily examines how cross-border tax differences affect pass-through, we show that the effects of tax differentials depend critically on whether firms face a tax advantage or a tax disadvantage relative to nearby competitors. To the best of our knowledge, this paper provides the first direct evidence on the heterogeneous incidence of differential taxes across the two sides of a border.

Second, our results contribute to understanding the incidence of differential taxes and cost shocks more broadly. These include the pass-through of import tariffs (Amiti et al., 2019; Cavallo et al., 2021; Fajgelbaum et al., 2020; Flaaen et al., 2020; Irwin, 2019), differential cost shocks (Muehlegger & Sweeney, 2022) and carbon-intensity taxes (Amendola, 2025), or exchange rate changes (Goldberg & Hellerstein, 2013; Nakamura & Zerom, 2010). These policies create asymmetric cost shocks among competing firms, much like the regional fuel taxes studied in this paper. Our findings show how the pass-through of these differential shocks depends on firms' competitive positions, as well as competition with symmetric substitutes.

Third, we contribute to the tax incidence literature. Previous studies have shown that tax incidence depends on factors such as supply-side conditions (Marion & Muehlegger, 2011), market power (Alm et al., 2009; Genakos & Pagliero, 2022; Moral & González, 2025), vertical relationships (Bajo-Buenestado & Borrella-Mas, 2022), temporary tax changes (Doyle Jr & Samphantharak, 2008), tax remittance and evasion (Kopczuk et al., 2016), price rigidities (Conlon & Rao, 2020), tax change direction (Benzarti et al., 2020) and local demand conditions (Harju et al., 2022; Stolper, 2021, 2024). We contribute to this literature by examining the incidence of differential taxes among competing firms. Our results show that pass-through depends not only on market structure and firm characteristics, but also on whether tax changes place firms at a competitive advantage or disadvantage relative to nearby rivals. We also illustrate how the pass-through asymmetry arises through competitive interactions.

Fourth, we contribute to the literature on the pass-through of cost shocks, more focused on the role of competitive environment. Studied phenomenon include the direction of cost changes (Borenstein et al., 1997), competitors' costs (Muehlegger & Sweeney, 2022), mark-up adjustments (Fabra & Reguant, 2014), nominal price rigidities (Goldberg & Hellerstein, 2008). We provide evidence of how the competitive environment can influence the pass-through of differential cost shocks among competitors, consistent with a significant role of curvature of demand in pass-through (Bulow & Pfleiderer, 1983; Maskin & Tirole, 1988; Weyl & Fabinger, 2013).

The remainder of this paper is structured as follows. Section 2 presents a simple framework to illustrate the effects of differential commodity taxation. Section 3 provides background on Spain's fuel tax system. Section 4 describes the data sources. Section 5 outlines the empirical strategy. Section 6 presents the main results. Section 7 discusses how demand curvature can explain our results. Section 8 concludes.

2 Conceptual framework

We present a simple partial equilibrium model to illustrate the price responses to differential commodity taxes predicted by the canonical model of tax incidence.

2.1 Model setup

We represent geographical locations as different markets that sell a homogeneous product, each geographic market being a substitute for one another. We consider two products, A and B, each located in different jurisdictions with distinct per-unit taxes τ_A and τ_B, respectively. Both markets sell a homogeneous product to consumers who can choose between the two suppliers. Firms set their retail prices simultaneously, expressed as p_A and p_B. We assume that retailers participate in a competitive market with barriers to entry and exit. We describe how market demand and marginal costs may be affected by unilateral taxes.

Marginal costs. The effective marginal cost in each market includes the jurisdiction-specific tax $MC_i(Q_i) = c(Q_i) + \tau_i$ for $i = \{A, B\}$, where $c(Q_i)$ represents the marginal cost of producing and distributing fuel, excluding taxes. Thus, differential taxes create exogenous variations in marginal costs among competing firms.

Retailer demand. We describe how spatial differentiation affects demand in markets A and B. We decompose the substitution patterns affecting a retailer's demand as coming from within-region symmetric competitors and cross-regional asymmetric competitors:

$$\underbrace{D_A(p_A, p_B, d_{AB})}_{\text{Retailer demand}} = \underbrace{D_A^w(p_A)}_{\text{Within-market}} + \underbrace{D_A^c(p_A - p_B, d_{AB})}_{\text{Cross-market shift}} \tag{1}$$

where $D_A^w()$ represents the within-market demand in market A under no shift between markets, and $D_A^c()$ represents the cross-market demand-shift between A and B, which depends on price differences $p_A - p_B$ and distance between markets d_{AB}, which measures product differentiation.

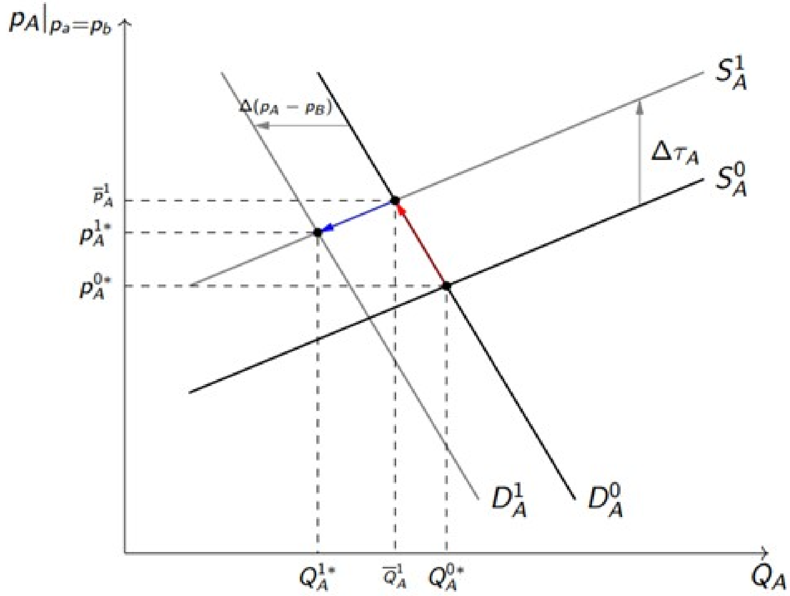
This framework is well suited to retail fuel markets, where geographic differentiation plays a central role (Slade, 1998), but the model could also be applied to markets with other forms of product differentiation. More formal price competition models under geographical differentiation can be found in Anderson et al. (2001) or Bajo-Buenestado and Borrella-Mas (2019).

2.2 Price effects of unilateral tax changes

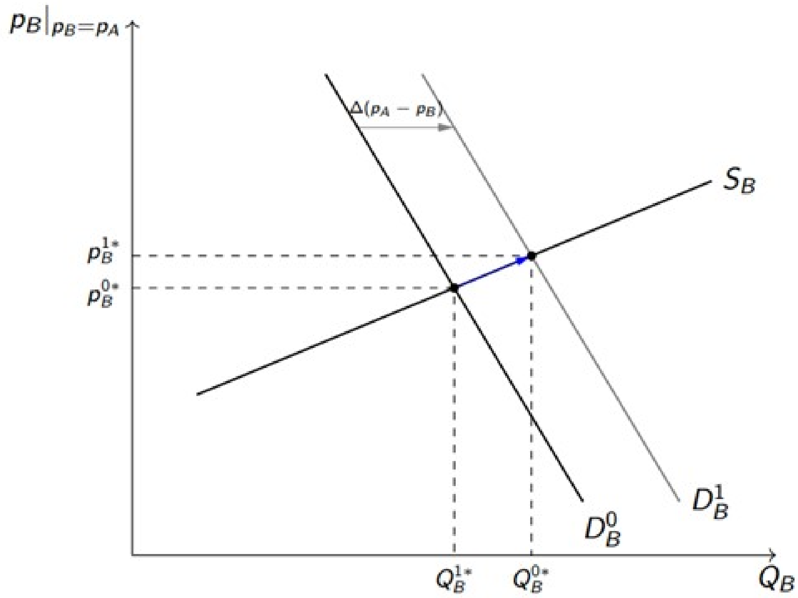
Figure 1 illustrates the predicted price effect of a unilateral tax change under the canonical model with linear demand. The y-axis plots the price under $p_A = p_B$, reflecting the demand curve when prices in all substitutable markets adjust simultaneously. An increase in market A's tax τ_A raises its marginal cost MC_A, shifting the supply curve upward. The resulting change in prices and quantities can be decomposed into two key effects: the within-market price effect and the cross-market substitution effect.

Figure 1: Effect of an increase in τ_A: Canonical model

(a) Market A



(b) Market B



Notes: The figure illustrates the effect of a tax change applied to market A on market A (panel a) and on market B (panel b). The red arrow represents the movements along the demand curve following a tax change. The blue arrows represent the substitution effect, capturing the demand shifts because of changes relative prices. The y-axis plots the price under $p_A = p_B$, reflecting the demand curve when prices in all substitutable markets adjust simultaneously.
Source: Own illustration.

Direct price effect. The effect of a change in tax on market A results in a movement along the demand curve $D_A^w()$, holding the price difference between markets $(p_A - p_B)$ constant. The effect, illustrated through the red arrow in panel (a), captures the price response to changes in local fuel taxes, abstracting any substitution between markets A and B.

Demand-shift effects. The unilateral tax change also affects relative prices $p_A - p_B$, which induces consumers to reallocate demand from market A to market B. This is expected to cause a leftward shift in the demand curve of market A, and an equivalent rightward shift in the demand curve of market B. These are expressed through blue arrows. As suggested in Equation (1), the extent of substitution will depend on d_{AB}, the distance between markets.

3 Institutional design

This section outlines the institutional context for our analysis. We first describe the structure of fuel markets in Spain. We then discuss the fuel taxation system in Spain, with particular emphasis on regional fuel tax variations that provide key quasi-experimental variation for our study.

3.1 Fuel markets in Spain

The Spanish fuel market was liberalized in the mid-1980s, ending the state monopoly previously operated by Campsa (now Repsol) (Perdiguero, 2010, 2012; Perdiguero & Borrell, 2007). Although all segments of the oil supply chain—refining, transportation, distribution, and retail—are now fully liberalized, the market remains highly concentrated. Three firms (Repsol, BP, and Cepsa) own all nine oil refineries producing automotive fuel in Spain, and nearly half of all retail petrol stations in peninsular Spain operate under their brands, reflecting significant forward integration. Spanish competition authorities monitor fuel market competition through regular data collection. Since 2007, the Ministry for Ecological Transition and Demographic Challenge has published daily station-level fuel prices for all retail stations in Spain.

3.2 Fuel taxation in Spain

Fuel taxation in Spain consists of value-added tax (VAT) and excise taxes, levied at both the national and regional levels. The retail price of fuel at station i in region r at time t can be expressed as:

$$P_{irt} = (P_{irt}^{pre} + \overline{\tau}_t + \tau_{rt}) \times (1 + VAT_t(\%)) \tag{2}$$

where P_{irt}^{pre} denotes the pre-tax price, $\overline{\tau}_t$ is the central government excise tax, τ_{rt} is the regional excise tax, and VAT_t is the national VAT rate. Between 2007 and 2020, central excise taxes were fixed at 38 cents/liter for diesel and 47 cents/liter for gasoline. The VAT rate increased from 16% (2007–2010) to 18% (2010–2012), and then to 21% from 2012 onward. In 2021, taxes accounted for 49% of the retail price of diesel and 53% for gasoline in Spain, both below the Eurozone averages of 56% and 61%, respectively[4]. Historically, diesel has been taxed less heavily than gasoline, making it the dominant fuel in Spain. In 2019, diesel accounted for 82.4% of total automotive fuel purchases. As a result, our empirical analysis focuses primarily on diesel.

3.3 Regional fuel excise taxes

In 2002, the Spanish government introduced a regional fuel excise tax band[5], which allowed Autonomous Communities to levy a supplementary fuel excise tax of up to 4.8 cents per liter[6]. Due to the application of VAT, the effective burden of the regional tax could reach up to 5.808 cents per liter. The tax became popularly known as the health cent, as revenues were earmarked for regional healthcare spending.

Between 2002 and 2019, there were 40 changes to regional fuel excise taxes. Figure 2 illustrates the geographic and temporal evolution of the tax band across provinces. By 2007, regions on the center and on the east had increased their regional taxes. Additional regions on the south increased

[4] Excise duties (europa.eu)

[5] The legal name of the tax was the Tax on Retail Sales of Certain Mineral Oils (*Impuesto sobre las Ventas Minoristas de determinados Hidrocarburos*, IVMDH), established by Law 24/2001 of 27 December on Fiscal, Administrative, and Social Order Policies.

[6] The cap on the regional excise tax increased over time: 1.7 cents per liter in 2002–2003, 2.4 cents in 2004–2007, and 4.8 cents from 2008 onward.

their regional diesel excise taxes by 2012. In 2012, several additional regions raised their rates, with eight reaching the maximum allowable level by early 2013. Between 2013 and 2018, some regions reduced their tax rates, while others, such as Galicia and Aragón, implemented further increases. In 2019, the regional tax was standardized at the maximum rate of 4.8 cents per liter. This reform affected eight regions, five of which had previously levied no regional excise tax.

4 Data

We describe the data used in our empirical study. First, we describe the data sources. Second, we describe our measurement of distance to nearest cross-regional competitors. Third, we describe the selection of our sample and the summary statistics.

4.1 Data sources

Our analysis draws on two primary data sources. First, we use daily fuel price data at the station level to examine the incidence of fuel taxes. Second, we use monthly province-level fuel purchases data to analyze how fuel purchases respond to cross-border variations in fuel taxes. Both datasets are derived from information submitted by fuel retail station brands to the Ministry for the Ecological Transition and the Demographic Challenge.

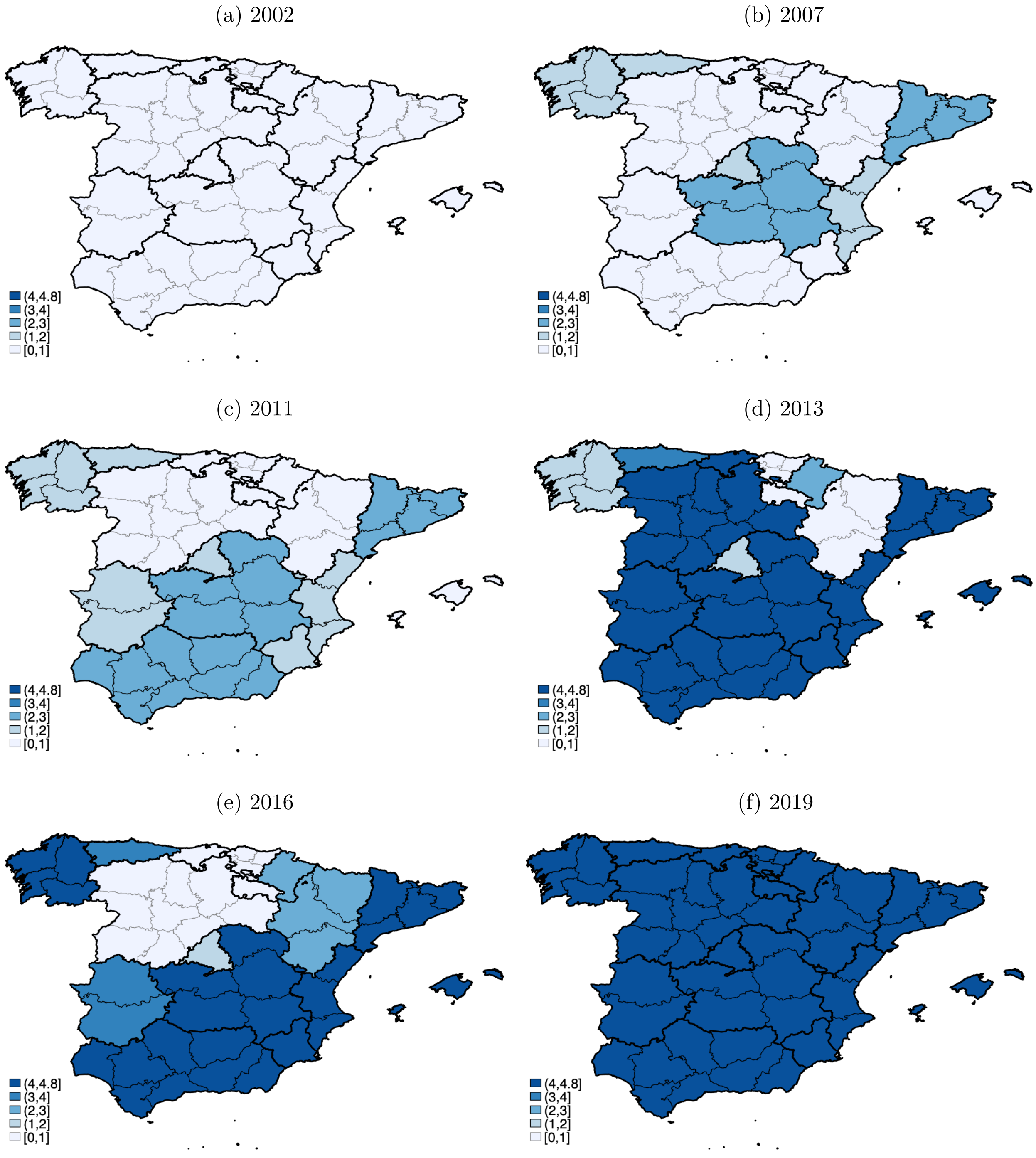
***Geoportal* data.** We use daily retail fuel price data for the universe of petrol stations covering the period July 2014 to December 2019[7]. The dataset includes daily prices for various diesel and gasoline products, as well as brand name and geographic information.

CNMC data. We use monthly province-level data on average fuel prices and total purchased volumes (in liters) for each of the 52 Spanish provinces[8]. The data coverage starts in 2002 for fuel purchases, and from 2007 for fuel prices. Despite the aggregate nature of the data, the availability of fuel price and purchases with such a time and geographic disaggregation remains an exception

[7]The Ministry collects real time price data from all petrol stations, which are published online in real-time. Figure B.1 illustrates the real-time interface of the *Geoportal* platform.

[8]The dataset is med publicly available by the Spanish National Markets and Competition Commission (*Comisión Nacional de los Mercados y la Competencia*, CNMC).

Figure 2: Regional excise tax for automotive diesel between 2002-2019.



Notes: The figure displays the regional band of automotive diesel excise taxes for Spanish provinces on the 1st January in years 2002 (panel a), 2007 (panel b), 2011 (panel c), 2013 (panel d), 2016 (panel e) and 2019 (panel f). The automotive taxes for gasoline correspond almost identically.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

in Europe[9].

4.2 Calculation of distance to rival stations

The geographic coordinates of the petrol stations allow us to calculate the distance from each station to its nearest cross-regional competitor.

Station-level distance. For each station, we compute the driving distance and travel time to its nearest cross-regional competitor. We first identify the nearest cross-regional competitor, and then compute road distances and travel times for each station pair using OpenStreetMap data[10]. To account for international arbitrage, we additionally compute geodesic distances from each station to the nearest border with France or Portugal. Figure 3 illustrates the distribution of petrol stations, highlighting those that are around regional and international borders. Panel (a) highlights the stations within 50km from international borders, which are dropped from our main sample. Panels (b)-(e) highlight the stations entering 10km-distance bins from regional competitors, once the stations within 50kms are excluded.

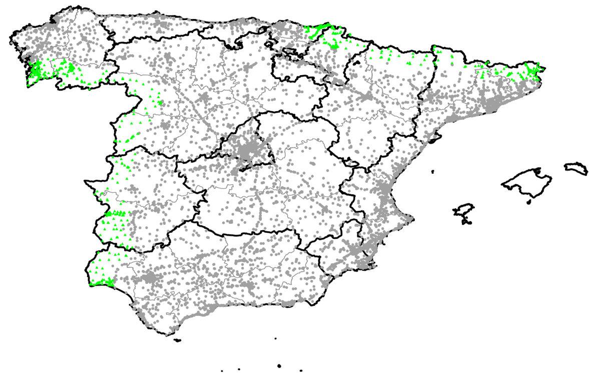
Province-level distance. For our analysis based on diesel purchases, we aggregate station-level measures to the province level. We compute province-level distance shares $\pi_p^d = \Pr(d_{i_p} \leq d)$, defined as the share of stations in province p whose nearest cross-regional competitor lies within distance d. These measures capture the intensity of relocation opportunities as a function of travel distance or time. Figure C.1 shows the distribution of these shares across provinces, separately for 10km bins. The figure also shows the analog measure with respect to international borders, which are used as controls for cross-border demand substitution.

[9] To the best of our knowledge, Italy is the only other European country providing monthly fuel data at a similar level of disaggregation, but this is only available from 2015. While state-level data are available for the US, the data for Spain remains more granular.

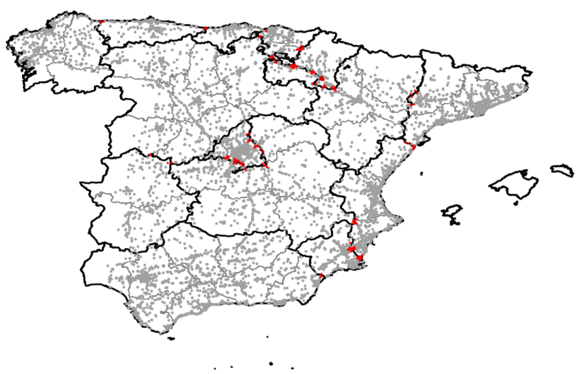
[10] For each station, we identify the five nearest stations by geodesic distance, separated by within and cross-regional competitors, using Picard (2010). Then, we calculate the distances by road to each of them using Huber and Rust (2016), which helps identify both the nearest station and the distance to this.

Figure 3: Location of petrol stations by distance to regional and international borders

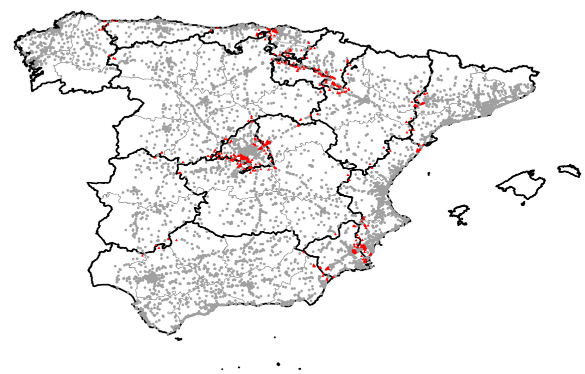
(a) International borders (0-50km)



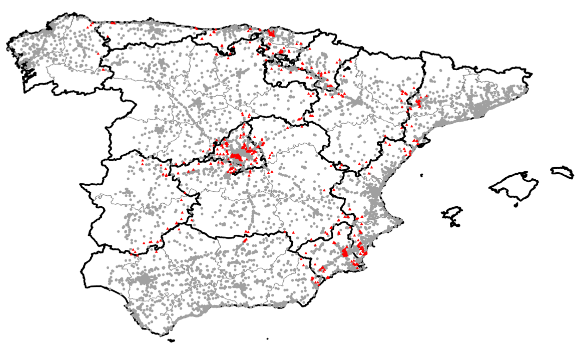
(b) Regional borders (0-10km)



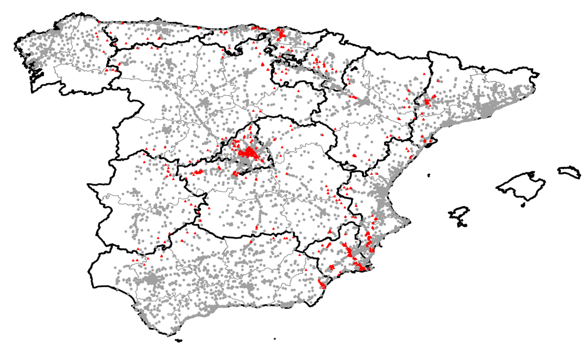
(c) Regional borders (10-20km)



(d) Regional borders (20-30km)



(e) Regional borders (30-40km)



Notes: The figure shows the map of all petrol stations in Spain in January 2015. The figure highlights stations within 50km of geometric distance to international borders (panel a), and in driving distance to regional borders, separated in ranges 0-10km (panel b), 10-20km (panel c), 20-30km (panel d), and 30-40km (panel e). Panels (b)–(e) do not include stations within 50km of geometric distance to international borders highlighted in panel (a). The green dots refer to stations in distances with respect to international borders and red dots to regional borders. Gray dots refer to any other petrol station.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

4.3 Sample selection

We use a number for sample restrictions for our analysis. First, we focus our analysis on petrol stations located in peninsular Spain, where regional borders are present. Second, we exclude petrol stations that are situated within 50 kilometers of the French and Portuguese borders to avoid confounding effects from international cross-border traffic. After applying these restrictions, the final analysis sample comprises 9,504 petrol stations, and 2,429,387 station-week observations. Table 1 presents summary statistics for the main variables used in our analysis based on *Geoportal* data.

As with station-level data, our analysis on fuel purchases focus on the 47 provinces in peninsular Spain. We use the available data spanning from January 2002 to February 2020, just before the onset of the Covid pandemic. This results in 9,682 observations. Table 2 reports summary statistics of the variables used in the CNMC dataset.

5 Empirical strategy

This section describes our empirical strategy to estimate the effects of regional variation in diesel taxes in Spain. We first present our TWFE specification to estimate the pass-through of diesel taxes across regional borders. Second, we present our analog TWFE specification to estimate the effects of diesel taxes on fuel purchases across regional borders. Finally, we introduce a panel event study design to estimate the dynamic effects of regional diesel tax changes on prices and purchases.

5.1 Pass-through of differential taxes

We estimate the pass-through of own and cross-border diesel taxes as a function of the distance to the closest competitor located across the regional border. The regression specification is as follows:

$$P_{it} = \alpha_i + \gamma_t + \sum_{d=1}^{8} \rho_d (b_i^d \times \tau_{it}) + \sum_{d=1}^{8} \rho_d^c (b_i^d \times \tau_{it}^c) + \sum_{d2=1}^{8} \phi_d^{c_2} (b_i^{d2} \times \tau_{it}^{c_2}) + \mathbf{x_{it}}\theta + \varepsilon_{it} \tag{3}$$

where P_{it} denotes the diesel price at petrol station i in week t, α_i are petrol station fixed effects

Table 1: Summary statistics on the Geoportal dataset

	Mean (1)	S.D. (2)	Min (3)	Max (4)	N(obs) (5)
Diesel products (c/liter)					
Retail price	115.03	10.51	75.91	146.90	2,429,387
Pre-tax price	58.04	8.50	24.84	83.50	2,429,387
Tax component	56.98	2.70	46.33	63.40	2,429,387
Own regional tax	4.74	2.00	0.00	5.81	2,429,387
Competitor's tax 1	4.34	2.13	0.00	5.81	2,428,919
Competitor's tax 2	4.28	2.30	0.00	5.81	2,428,919
Gasoline products (c/liter)					
Retail price	125.53	9.07	87.90	158.50	2,334,609
Pre-tax price	57.33	7.28	28.91	83.72	2,334,609
Tax component	68.20	2.54	57.72	74.78	2,334,609
Own regional tax	4.76	2.00	0.00	5.81	2,429,387
Competitor's tax 1	4.39	2.15	0.00	5.81	2,428,919
Competitor's tax 2	4.30	2.31	0.00	5.81	2,428,919
Distance to closest cross-border comp. (%)					
0-10km	2.47	15.51	0.00	100.00	2,429,387
10-20km	6.61	24.85	0.00	100.00	2,429,387
20-30km	7.68	26.63	0.00	100.00	2,429,387
30-40km	8.77	28.28	0.00	100.00	2,429,387
40-50km	6.15	24.02	0.00	100.00	2,429,387
50-60km	5.58	22.95	0.00	100.00	2,429,387
60-70km	5.60	23.00	0.00	100.00	2,429,387
Travel time to closest cross-border comp. (%)					
0-10min	2.34	15.12	0.00	100.00	2,429,387
10-20min	7.40	26.17	0.00	100.00	2,429,387
20-30min	10.19	30.25	0.00	100.00	2,429,387
30-40min	9.64	29.52	0.00	100.00	2,429,387
40-50min	7.25	25.93	0.00	100.00	2,429,387
50-60min	8.87	28.43	0.00	100.00	2,429,387
60-70min	6.81	25.20	0.00	100.00	2,429,387
Additional variables					
Brent (c/liter)	33.29	6.63	16.46	51.63	2,429,387
Real province GDP (2016€)	23,091.90	5,118.70	17016.25	34,902.26	2,429,387
Petrol station type (%)					
Top station	49.31	50.00	0.00	100.00	2,429,387
Rest of stations	50.69	50.00	0.00	100.00	2,429,387

Notes: The table describes the summary statistics for the main variables of the petrol station price dataset, which covers the period between July 2014 and December 2019. The sample excludes the Canary Islands, Ceuta, Melilla and the Balearic Islands. Observations within 50 km to the borders with Portugal and France are dropped. Diesel regional excise tax represents the tax variation induced by regional excise taxes, including the 21% VAT. Top stations are comprised of top petrol station brands (Repsol, Campsa, BP, Cepsa and Galp).
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

and γ_t are week fixed effects. The indicator b_i^d takes value 1 if distance between petrol station i and its nearest cross-border competitor falls within 10km bin d, where $d = 8$ captures all distances above 70km. τ_{it} is the diesel tax rate in the region of station i, τ_{it}^c is the diesel tax rate faced by the closest cross-regional station i, and $\tau_{it}^{c_2}$ is the diesel tax rate faced by the second closest cross-

Table 2: Summary statistics on main variables using CNMC data

	Mean (1)	S.D. (2)	Min (3)	Max (4)	N(obs) (5)
Diesel products					
Retail price (c/litre)	116.21	15.13	82.18	145.68	7,426
Pre-tax price (c/litre)	55.64	10.84	30.16	77.52	7,426
Tax component (c/litre)	60.58	7.01	46.37	71.14	7,426
Regional excise tax (c/litre)	2.37	2.51	0.00	5.81	9,682
Tax differential (c/litre)	0.36	2.03	-5.81	5.81	9,682
Price differential (c/litre)	0.20	2.24	-8.02	7.87	7,426
Total purchases (l)	38,403.90	34,577.76	3,955.61	218,952.81	9,682
Gasoline products					
Retail price (c/litre)	124.02	14.59	84.25	152.23	7,426
Pre-tax price (c/litre)	50.88	9.44	25.64	74.16	7,426
Tax component (c/litre)	73.14	7.41	57.52	83.60	7,426
Regional excise tax (c/litre)	2.49	2.51	0.00	5.81	9,682
Tax differential (c/litre)	0.11	1.95	-5.81	5.81	9,682
Price differential (c/litre)	0.18	2.36	-8.74	7.82	7,426
Total purchases (l)	7,980.69	9,874.06	532.70	74,290.48	9,682
Distance range to competitors (%)					
$Pr(d_{i_p} \leq 10km)$	2.91	6.31	0.00	38.89	9,682
$Pr(d_{i_p} \leq 20km)$	10.17	14.73	0.00	75.00	9,682
$Pr(d_{i_p} \leq 30km)$	18.17	22.09	0.00	88.89	9,682
$Pr(d_{i_p} \leq 40km)$	25.88	27.40	0.00	100.00	9,682
$Pr(d_{i_p} \leq 50km)$	31.91	30.57	0.00	100.00	9,682
$Pr(d_{i_p} \leq 60km)$	39.28	33.63	0.00	100.00	9,682
$Pr(d_{i_p} \leq 70km)$	45.88	35.78	0.00	100.00	9,682
Additional variables					
Petrol stations	183.72	136.86	37.00	704.00	9,682
Population	901,865.65	1,158,462.43	89,415.00	6,747,068.00	9,682
Real GDP (2016€)	22,813.62	4,989.98	14,525.44	40,748.40	9,682
Employment rate (%)	47.51	5.53	32.78	62.90	9,682
Diesel cars	229,295.78	297,462.85	14,264.00	2,150,688.00	9,682
Diesel trucks	82,874.80	94,947.43	9,824.00	616,718.00	9,682
Other diesel vehicles	10,930.31	10,100.85	1,726.00	68,811.00	9,682
Gasoline cars	201,034.76	284,898.78	18,263.00	1,803,658.00	9,682
Other gasoline vehicles	66,267.30	100,063.36	5,243.00	735,426.00	9,682
Tourists	123,294.47	175,929.56	6,105.00	1,328,095.00	9,635
New mortgages	1,024.97	1,778.14	13.00	17,175.00	9,682
New firms	151.47	290.67	2.00	2,262.00	6,862

Notes: The table describes the summary statistics for the main variables of the CNMC dataset. The relevant variables include diesel price, taxes and purchases from the CNMC, distance shares to closest cross-regional competitors calculated using *Geoportal* data, we well as additional control variables from the Spanish Office of National Statistics. The data covers the period between January 2002 and February 2020. This considers monthly data for all Spanish provinces, excluding the Canary Islands, Ceuta and Melilla.
Source: Spanish National Markets and Competition Commission (CNMC).

regional station i, located in a different region than the first[11]. The vector $\mathbf{x_{it}}$ includes calendar month effects per province to account for seasonality and province-specific time trends. Standard

[11]The second nearest station is included as a control, rather than explicitly focusing on its effect.

errors are clustered at the petrol station level.

There are two coefficients of interest: the parameter ρ_d captures the pass-through of own-region diesel taxes for stations located within distance bin d, holding constant the competitor's tax. The parameter ρ_d^c captures the pass-through of the competitor's diesel taxes onto station i's prices, conditional on own-region taxes.

Heterogeneity by side of tax changes. Given the symmetry of cross-border effects, the coefficient estimates ρ_d and ρ_d^c illustrate how unilateral tax changes affect prices on both sides of borders[12]. In addition, both sides of borders are observed: when one side is the high-tax side, the other side is the low-tax side. We examine how the price and quantity effects depend on whether taxes change on the low- or the high tax side of borders. To implement this, Equation (3) is re-estimated separately for two subsamples of stations:

1. **Changes on high-tax side.** To illustrate the effect of tax changes that occur on the high-tax side of borders, we use ρ_d estimated on the subsample of petrol stations on the high-tax side ($\tau_{it} \geq \tau_{it}^c$), while ρ_d^c is comes from the sample on the low-tax side ($\tau_{it} \leq \tau_{it}^c$). This case considers the effect of a tax increase in a region where both sides were initially applying the same tax level.

2. **Changes on low-tax side.** We use the analogue case to illustrate the effect of tax changes on the low-tax side of borders, where ρ_d estimated on the subsample of petrol stations on the low-tax side ($\tau_{it} \leq \tau_{it}^c$) and ρ_d^c on the high-tax side ($\tau_{it} \geq \tau_{it}^c$). This case considers the effect of a tax increase in a region that had lower taxes, which leads to leveling up the tax on both sides of the border.

[12] The effect of a competitor's tax on own prices is equal to the effect of own taxes on competitor prices. Formally, $\rho_d^c = \frac{\partial P_{it}^d}{\partial \tau_{it}^c} = \frac{\partial P_{jt}^d}{\partial \tau_{it}}$.

5.2 Fuel purchases across borders

We estimate the effects of cross-border diesel taxes on purchases, using the closest analog specification to Equation (3) under the available province-level disaggregation:

$$\ln S_{pt} = \alpha_p + \gamma_t + \sum_{s=1}^{2} \beta_{s,d}(\tau_{pt} \times \pi_s^d) + \sum_{s=1}^{2} \beta_{s,d}^c(\overline{\tau^c}_{pt} \times \pi_s^d) + \mathbf{x_{pt}}\theta + \varepsilon_{pt} \tag{4}$$

where $\ln S_{it}$ is the log of diesel purchases in province p and month t, α_p are province fixed effects, γ_t represents month fixed effects, τ_{pt} is the diesel taxes in province p and $\overline{\tau^c}_{pt}$ is a weighted average of diesel tax rates in the nearest cross-border provinces to p. The weights reflect the share of petrol stations in p whose closest cross-border competitor lies in each neighboring province. The variables π_s^d denote the share of petrol in province p whose nearest cross-border competitor lies either within d km ($s = 1$) or beyond d km ($s = 2$). These distance bins are constructed using station-level data from the *Geoportal*, as illustrated in Figure C.1. The control vector $\mathbf{x_{pt}}$ includes province-level variables such as the employment rate, the logarithm of population, and the logarithm of real GDP per capita, vehicle fleets (cars, trucks and other). We also include indicators for province seasonality and time trends, accounting for differential effects of the financial crisis. Finally, we include interactions between year and country fixed effects and the share of stations within 50 km of the French and Portuguese borders, controlling for exposure to international demand shocks. Standard errors are clustered at the province level.

The coefficients β_s^d captures the effect of own tax changes when petrol stations are either closer ($s = 1$) or farther ($s = 2$) than distance d from the closest competitor. $\beta_{s,d}^c$ captures the corresponding effect of the competitor's diesel tax. We also distinguish between tax changes that happen under tax advantages and disadvantages.

5.3 Event study regressions

We estimate linear panel event study regressions to provide graphical evidence on the exogeneity of regional excise tax changes with respect to pre-existing time trends in diesel prices and purchases in Spain. Our event study framework allows us to assess the dynamic response of outcomes around tax changes and to test for the presence of differential pretrends. The implementation of our event study approach follows Freyaldenhoven et al. (2025). We estimate two event studies to assess the exogeneity of own and cross-regional provinces' tax changes:

$$y_{pt} = \alpha_p + \gamma_t + \sum_{m=-G}^{M} \beta_m \tau_{p,t-m} + \pi \overline{\tau^c}_{p,t-m} + \mathbf{x_{pt}}\theta + \varepsilon_{pt} \tag{5}$$

$$y_{pt} = \alpha_p + \gamma_t + \sum_{m=-G}^{M} \beta_m \overline{\tau^c}_{p,t-m} + \pi \tau_{p,t-m} + \mathbf{x_{pt}}\theta + \varepsilon_{pt} \tag{6}$$

where y_{pt} denotes the outcome variable of interest, namely diesel prices, P_{pt}, and the log of diesel purchases, $\ln S_{pt}$, for province p and month t. The specification includes province fixed effects α_p and fixed time effects γ_t. $\tau_{p,t-m}$ and $\overline{\tau}_{j,t-m}$ stand for own province and adjacent province's regional diesel taxes m periods prior to time t for province p. The vector $\mathbf{x_{pt}}$ includes control variables, as described before. We normalize coefficients relative to period $m = 1$ when estimating fuel price responses, and to $m = 2$ when estimating responses in fuel purchases, addressing the possibility of anticipation to the reform (Coglianese et al., 2017).

6 Results

This section presents our empirical findings on the effects of fuel excise taxes in markets segmented by regional borders. We begin by reporting event study estimates that illustrate the dynamic impact of diesel excise tax changes on retail prices and purchases. Second, we provide evidence on the pass-through of diesel taxes near regional borders and quantify the associated responses in diesel purchases. Third, we conduct a series of robustness checks to validate our findings. Finally, we replicate the analysis for gasoline, allowing for a comparative assessment across fuel types[13].

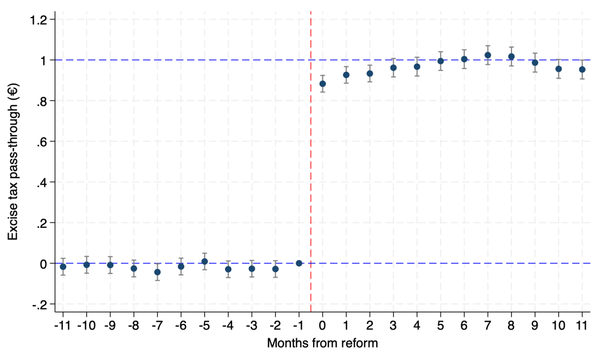
[13]While both fuels are traded in highly comparable retail environments and exhibit similar degrees of product homogeneity, demand may differ across fuel types. Diesel is disproportionately used by commercial vehicles and high-mileage users, whereas gasoline consumption is more concentrated among private passenger vehicles.

6.1 Event study evidence

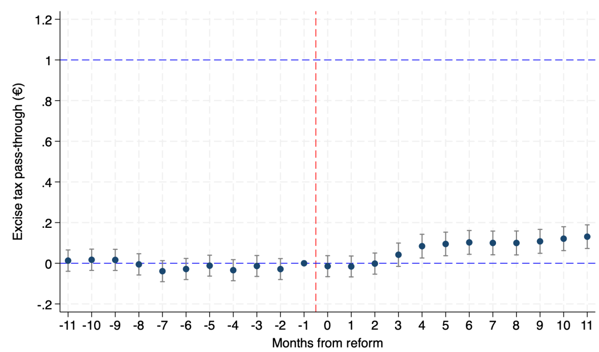
Our identification strategy relies on the assumption that regional diesel tax changes are uncorrelated with pre-existing regional trends in diesel prices and purchases. To assess the plausibility of this assumption, we estimate dynamic event study specifications around diesel tax changes. Figure 4 displays event study estimates for diesel prices and purchases. These event study graphs allow us to assess whether there are differential pre-trends before tax changes, and whether dynamic patterns post-treatment align with theoretical predictions. The event study evidence is also discussed in Iraizoz and Labeaga (2026).

Figure 4: Event study evidence on responses to regional diesel excise taxes

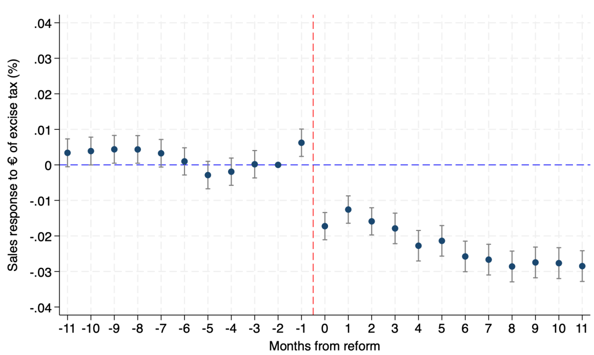
(a) Diesel prices: Own province tax



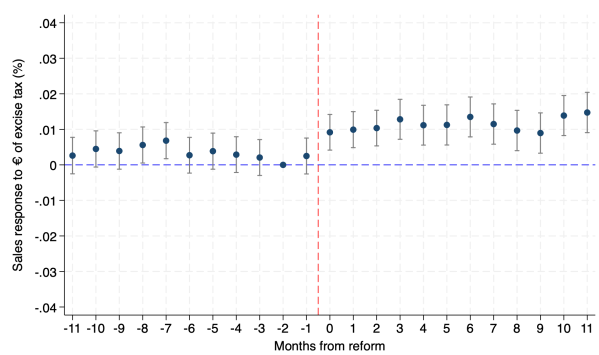
(b) Diesel prices: Cross-province tax



(c) Diesel purchases: Own province tax



(d) Diesel purchases: Cross-province tax



Notes: The figure shows the event study graph on the dynamic effect of the diesel excise taxes on diesel prices using *Geoportal* daily data (panel a) and CNMC monthly data (panel b), as well as the dynamic effects of fuel taxes on purchases (panel c). The vertical dashed red line refers to the period prior to the reform.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge and Spanish National Markets and Competition Commission (CNMC).

Diesel prices. We find no evidence of differential pre-trends in diesel prices, indicating that treated and untreated regions followed parallel price trajectories prior to the tax changes. This supports the credibility of our identification strategy. Furthermore, diesel excise taxes are passed through to consumer prices rapidly and to a large extent. Within 12 months of a tax increase, between 90% and 95% of the tax is reflected in retail diesel prices. These pass-through rates are consistent with existing evidence on the high responsiveness of fuel prices to tax changes (Alm et al., 2009; Chouinard & Perloff, 2004; Marion & Muehlegger, 2011; Poterba, 1996; Stolper, 2021). Moreover, we document that province-level prices respond to adjacent province's taxes, shifting 10% of these taxes, consistent with substantial spatial substitution of fuels.

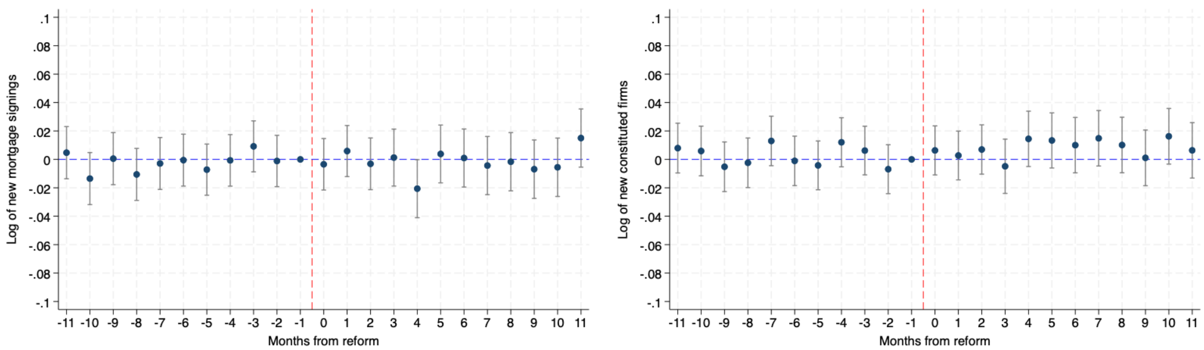
Diesel purchases. We first detect anticipatory behavior: consumers increase diesel purchases in the month preceding the implementation of excise tax hikes[14] (Coglianese et al., 2017). Beyond this anticipatory effect, we find no evidence of differential pre-trends in fuel consumption across regions, reinforcing the credibility of our identification strategy and the plausibility of treating tax reforms as exogenous shocks. Second, our estimates indicate that a one percentage point increase in diesel excise taxes leads to an average relative decline in diesel purchases of approximately 2.7% in regions experiencing a tax increase compared to those that do not. This effect is immediate and persistent following the reform. Finally, we also estimate that a one percentage point increase in the adjacent provinces diesel excise tax leads to an increase in diesel purchases of approximately 1.6%.

Placebo tests. We conduct placebo tests to examine whether regional fuel tax changes are correlated with business cycle factors that might also influence regional fuel consumption. To this end, we use pro-cyclical variables also available at the province-month level, such as new mortgage signings and firm creations. As shown in Figure 5, we find no discernible effects before or after regional fuel tax reforms, supporting a causal interpretation of our estimates.

[14] To account for this behavior, our TWFE regressions exclude observations from the month before and after the excise tax changes.

Figure 5: Placebo test on the relation of diesel taxes on economic cycle

(a) New mortgages (b) New constituted firms



Notes: The figure shows the event study graph on the dynamic effect of the diesel excise taxes on the log of mortgages (panel a) and new firms (panel b). The vertical dashed red line refers to the period of the reform.
Source: Spanish National Markets and Competition Commission (CNMC).

6.2 Pass-through across regional borders

We present our results of diesel excise tax pass-through using high-frequency station-level data from the *Geoportal*. First, we present the results on the pass-through rates of diesel taxes for petrol stations located near regional borders. Second, we examine the heterogeneity in pass-through to investigate the determinants of these responses.

6.2.1 Main results

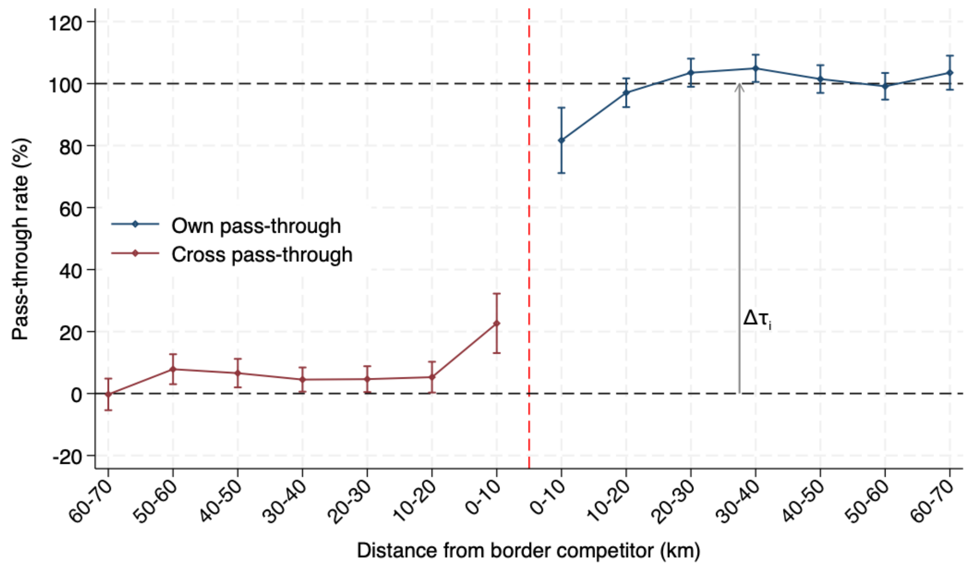
We present our main results on the pass-through of diesel taxes. We first examine the pass-through of diesel taxes across all tax changes. Then, we examine how spatial pass-through varies when the tax changes occur on the high- or the low-tax side of regional borders.

All tax changes. Figure 6 illustrates how one-sided diesel tax changes are shifted on to the prices of taxed and untaxed stations, stratified by distance to the nearest cross-border competitor[15]. The figure shows that stations located within 10 km of a regional border shift approximately 81.7% of their own diesel tax onto prices, significantly below full pass-through. Near competitors also shift these taxes, as stations within 10 km of a cross-border competitor incorporate 22.7% of their competitor's diesel tax into their own prices. Thus, cross-border tax differences lead to price

[15]Table 3 reports these coefficients on how own and competitor diesel taxes affect station-level prices.

differences of 59%. Beyond the 10 km threshold, pass-through converges to statutory pass-through, suggesting that spatial differentiation effectively attenuates the price effects of tax asymmetries.

Figure 6: Spatial pass-through of a one-sided change among all tax changes



Notes: The figure shows the spatial pass-through of diesel taxes by the distance to the nearest cross-border competitor, provided in 10 km bins. Panel (a) displays the results for all tax changes, reporting the results in columns (1) and (2) in Table 3. The blue line represents the pass-through of own taxes and the red line represents the effect on competitor prices.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

Low vs. high-tax side changes. Figure 7 distinguishes the pass-through of tax changes occurring on the high and low-tax sides of regional borders, based on columns (3)–(6) in Table 3. Panel (a) illustrates cases where the tax changes on the high-tax side. Pass-through near borders is partial, only 56.8%, while stations on the low-tax side do not adjust their prices. Conversely, panel (b) shows that when taxes rise on the low-tax side, pass-through is complete, while bordering high-tax competitors exhibit partial price adjustments of around 43.3%. The differences from statutory pass-through decrease with distance and are statistically negligible beyond 30 km.

Thus, differential taxes across borders are translated into price differences by 60% of tax changes on either side of borders. However, the deviations from statutory pass-through fully arise from high-taxed stations near borders, leading to important asymmetry of price effects depending on whether the tax change occurs on the high- or the low-tax side of borders.

Table 3: Effects of diesel excise taxes on prices

	All observations		High-tax side ($\tau_{it} \geq \tau^c_{it}$)		Low-tax side ($\tau_{it} \leq \tau^c_{it}$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ^c_{it}) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ^c_{it}) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ^c_{it}) (6)
0-10km	81.68***	22.65***	56.80***	43.34***	99.43	1.94
	(5.38)	(4.90)	(7.15)	(6.47)	(6.46)	(6.39)
10-20km	97.06	5.27*	87.80**	10.19*	99.65	0.98
	(2.36)	(2.53)	(4.49)	(3.99)	(2.93)	(3.45)
20-30km	103.52	4.64*	89.92*	13.35***	108.10**	-3.56
	(2.31)	(2.12)	(4.37)	(3.52)	(2.82)	(3.07)
30-40km	104.92*	4.50*	95.58	9.15**	108.03**	-2.52
	(2.24)	(1.99)	(4.34)	(2.88)	(2.61)	(3.38)
40-50km	101.47	6.57**	96.23	9.87**	104.36	0.50
	(2.28)	(2.34)	(5.80)	(3.63)	(2.36)	(3.82)
50-60km	99.13	7.84**	100.78	6.19	95.43	13.23***
	(2.19)	(2.47)	(4.08)	(3.21)	(2.81)	(3.84)
60-70km	103.51	-0.28	108.17	-2.99	99.80	6.13
	(2.80)	(2.60)	(4.77)	(3.20)	(4.30)	(5.64)
70+km	98.15*	6.49***	97.28	6.17***	98.29	5.44*
	(0.89)	(0.96)	(1.73)	(1.07)	(1.51)	(2.53)
N(obs)	2,428,915		2,046,801		1,704,495	

Notes: This table provides spatial pass-through using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis. The stars on point estimates indicate deviation from complete statutory pass-through. * p<0.05, ** p<0.01, *** p<0.001.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

6.2.2 Heterogeneity: Symmetric competitors

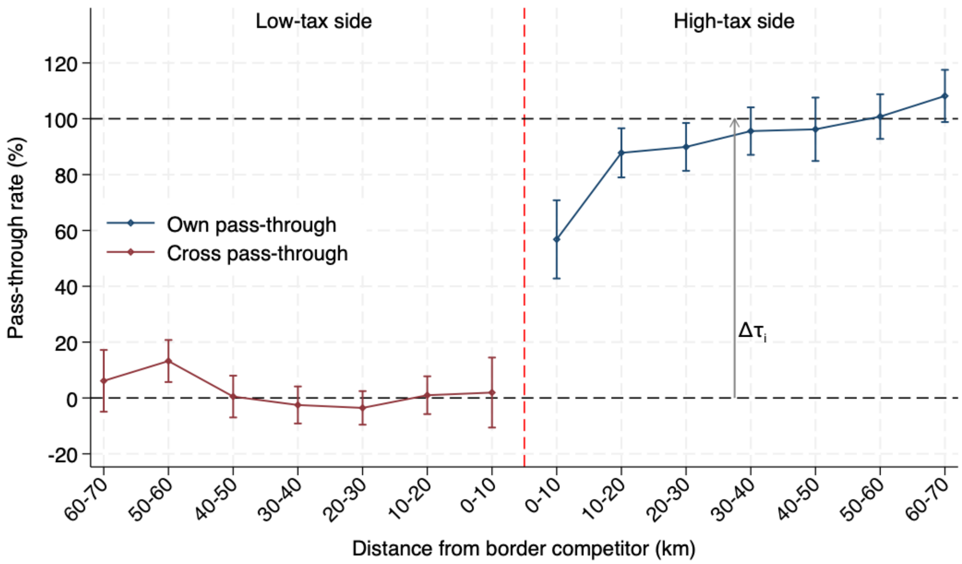
We further examine how the pass-through of differential taxes varies with the number of competitors on the same side of the border. This heterogeneity aims to assess the effect of the competitive pressure induced by competitors facing the same costs. To do so, we divide stations into two groups depending on the number of same-region competitors within 10km: (i) 0-1 competitors, (ii) more than 2 competitors.

Figure 8 graphically displays the pass-through of diesel taxes across borders, separated by the intensity of competitive pressure[16]. The figure shows a relevant heterogeneity of the effects of differential taxes: the difference is only 26% under low competitive pressure, while this is 77% under high-competitive pressure. The primary difference comes from the low-tax side of borders. While those facing many competitors shift taxes according to statutory incidence, those with few competitors significantly deviate from statutory incidence, shifting shift 22% of cross-regional taxes.

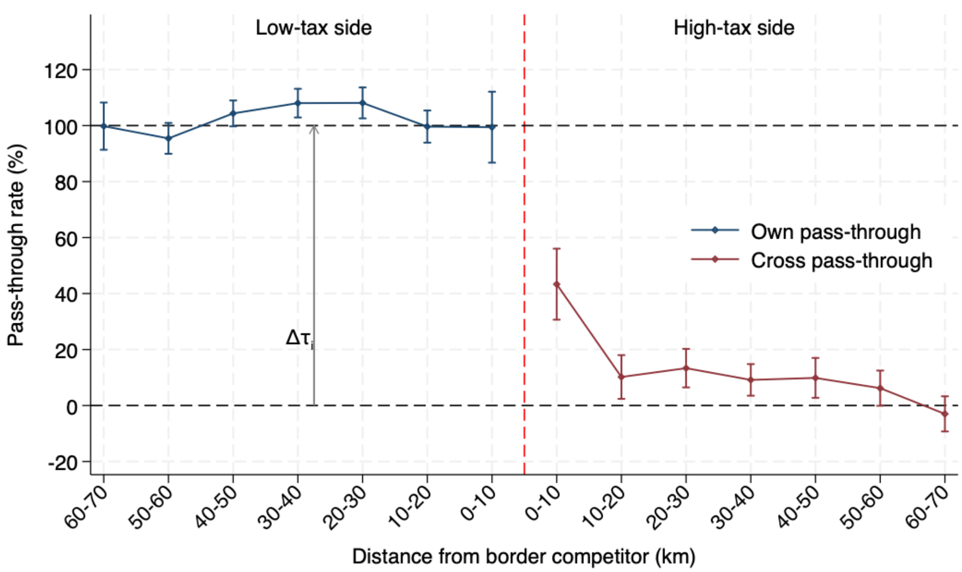
[16]Table D.3 provides the regression estimates for the heterogeneity by the number of symmetric stations.

Figure 7: Spatial pass-through of a one-sided tax change depending on relative taxes

(a) Change in high-tax side



(b) Change in low-tax side



Notes: The figure shows the spatial pass-through of diesel taxes by the distance to the nearest cross-border competitor, provided in 10 km bins. Panel (a) displays the results when tax changes happen in the disadvantaged side, reporting the results in columns (3) and (6) in Table 3, respectively for blue and red lines. Panel (b) displays the results when tax changes happen in the advantaged side, reporting the results in columns (4) and (5) in Table 3, respectively for red and blue lines. The blue line represents the pass-through of own taxes and the red line represents the effect on competitor prices.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

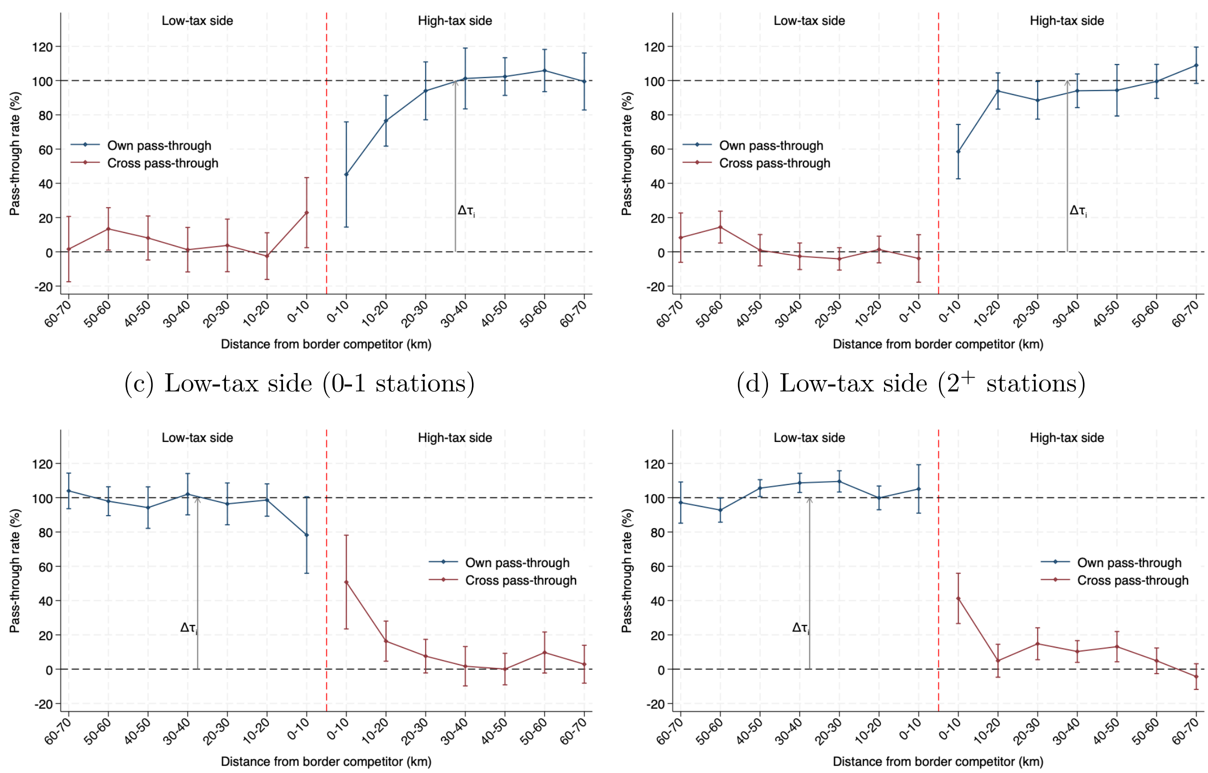
In contrast, on high tax side of borders, pass-through is more similar for stations facing few and many same-side competitor stations: 50% vs 40%.

This suggests that the number of competitors is more relevant for the price effects of low-tax stations than high-tax stations. This is consistent with interpreting the lack of pass-through on the low-tax side coming from the competitive pressure exercised by nearby stations. Tax advantaged stations only increase their prices under low competitive pressure. Thus, competitive pressure from same-side competitors may be preventing stations from raising their prices.

Figure 8: Spatial pass-through by same-side stations within 10km

(a) High-tax side (0-1 stations) (b) High-tax side (2$^+$ stations)

(c) Low-tax side (0-1 stations) (d) Low-tax side (2$^+$ stations)



Notes: The figure illustrates the spatial pass-through of diesel taxes depending on the distance to the nearest cross-border competitor, separately for petrol stations with a high and low number of symmetric stations – on the same region – and the region's relative tax position. Panel (a) and (c) display the pass-through on stations facing only 0-1 stations of the same region with 10km, respectively for tax changes happening on the high-tax and low-tax side of regional borders. Panel (b) and (d) display the pass-through on the rest of petrol stations facing 2 at least 2 stations of the same region with 10km, respectively for tax changes happening on the high-tax and low-tax side of regional borders. In each panel, the blue line indicates own-region diesel taxes, and the red line indicates the diesel tax level in the region of the nearest competitor.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

6.2.3 Heterogeneity: Station prominence

We next examine how tax pass-through varies by the prominence of petrol station brands, focusing on differences in vertical integration and market power. We divide the sample into two groups: (i) top brand stations, Repsol, BP, and Cepsa, which are largely vertically integrated with domestic refineries and represent approximately 49.3% of stations in Spain; and (ii) smaller brands, which include independent or less-integrated retailers. Top brands are generally considered to benefit from greater supply chain flexibility and market power, which may shape their response to tax changes (Bajo-Buenestado and Borrella-Mas, 2022). This heterogeneity allows us to assess whether cost structures and competitive advantages influence the extent to which excise taxes are passed on to consumers.

Figure 9 graphically displays the pass-through of diesel taxes across borders, separated by petrol station brands[17]. The figure shows that deviations from statutory incidence are primarily driven by smaller brands. Smaller brands on the high-tax side only shift 45.9% of their own tax, compared to 75.5% for top brands. Conversely, in response to competitor taxes, smaller brands on the high-side adjust prices by 55.4%, while top brands shift only 25.7%. These findings are consistent with our prior evidence pointing to the fact that deviations from statutory incidence are driven by the competitors with large marginal costs (or tax), and low differentiation (either spatial or brand name).

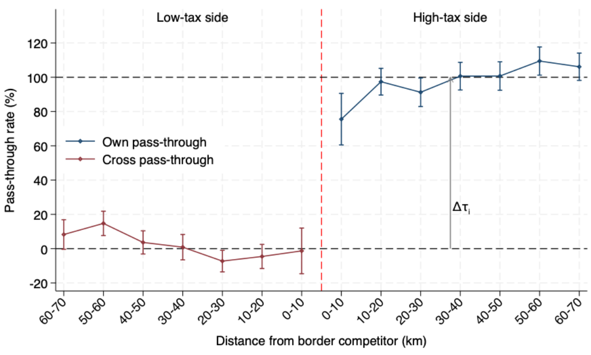
6.3 Effects on diesel purchases

This subsection examines how diesel purchases respond to cross-border excise tax differences. Given the more aggregate nature of our province-level fuel purchase data, this exercise serves as complementary evidence to interpret the pass-through estimates. Specifically, we investigate whether market-wide responses in fuel purchases to cross-regional taxes can explain the observed price responses. Table 4 reports the estimated effects of cross-regional diesel taxes on diesel purchases, distinguishing the results by distance to the nearest cross-regional station and by whether the

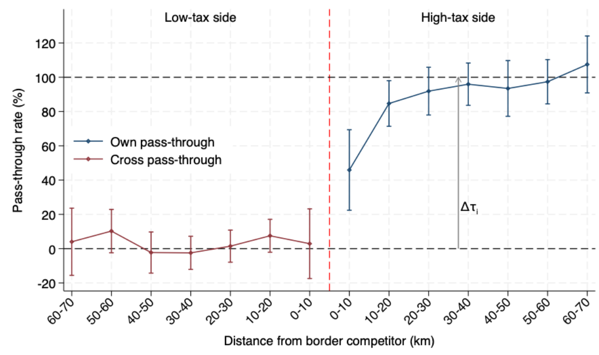
[17] Table D.2 provides the regression estimates.

Figure 9: Spatial pass-through by type of petrol station

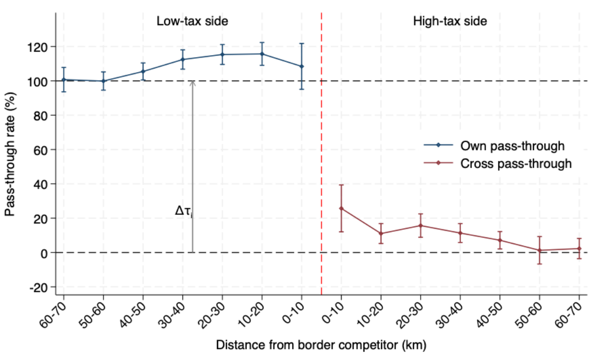
(a) High-tax side (top brands)



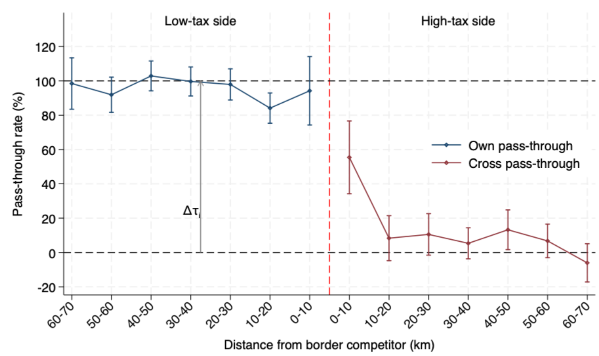
(b) High-tax side (smaller brands)



(c) Low-tax side (top brands)



(d) Low-tax side (smaller brands)



Notes: The figure illustrates the spatial pass-through of diesel taxes as a function of the distance to the nearest cross-border competitor, separately by petrol station brand group and the region's relative tax position. Panel (a) and (c) display the pass-through on top petrol station brands (Cepsa, Repsol, and BP), respectively for tax changes happening on the high-tax and low-tax side of regional borders. Panel (b) and (d) display the pass-through on the rest of the smaller petrol station brands, respectively for tax changes happening on the high-tax and low-tax side of regional borders. In each panel, the blue line indicates own-region diesel taxes, and the red line indicates the diesel tax level in the region of the nearest competitor.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

province is located on the high-tax or low-tax side of the regional border.

Table 4 provides three main results. First, we estimate substantial responses in diesel purchases near regional borders, with the magnitude of the effects declining as the distance from the border increases. Although the estimates for areas immediately adjacent to the border are relatively imprecise, those for broader distance bands are estimated more precisely. Second, cross-regional tax changes have statistically significant effects on both the high-tax and low-tax sides of regional borders. Among the estimates that are sufficiently precise, the responses are broadly symmetric across both sides of the border. This finding directly relates to our price effects, as it suggests that

Table 4: Effects of diesel excise taxes on province diesel purchases

	All observations		High-tax side ($\tau_{it} \geq \overline{\tau^c}_{it}$)		Low-tax side ($\tau_{it} \leq \overline{\tau^c}_{it}$)	
	Own tax (τ_{it}) (1)	Comp. tax ($\overline{\tau^c}_{it}$) (2)	Own tax (τ_{it}) (3)	Comp. tax ($\overline{\tau^c}_{it}$) (4)	Own tax (τ_{it}) (5)	Comp. tax ($\overline{\tau^c}_{it}$) (6)
0-10km	−19.06**	12.66	−27.37*	20.37	−18.28*	11.44
	(6.95)	(7.23)	(11.61)	(11.03)	(8.75)	(9.35)
0-20km	−6.66***	5.02**	−7.33***	6.58*	−7.17**	5.40*
	(1.98)	(1.83)	(2.05)	(2.65)	(2.60)	(2.64)
0-30km	−3.98**	2.97***	−5.59***	4.91**	−3.96**	3.16**
	(1.23)	(0.80)	(1.37)	(1.64)	(1.44)	(1.00)
0-40km	−2.94***	1.97***	−4.53***	3.64***	−2.69**	1.98**
	(0.83)	(0.53)	(1.06)	(1.06)	(0.85)	(0.62)
0-50km	−2.60***	1.65***	−3.69***	2.79***	−2.33***	1.59**
	(0.62)	(0.42)	(0.79)	(0.74)	(0.63)	(0.50)
0-60km	−2.63***	1.54***	−3.47***	2.34***	−2.10***	1.26**
	(0.49)	(0.35)	(0.69)	(0.62)	(0.55)	(0.46)
0-70km	−2.58***	1.43***	−3.25***	1.93***	−2.05***	1.11*
	(0.43)	(0.30)	(0.69)	(0.53)	(0.48)	(0.43)
70+km	−1.95***	−0.39	−1.83**	−0.50	−1.19*	−1.28
	(0.33)	(0.28)	(0.57)	(0.31)	(0.56)	(0.75)
N(obs)	1,723,184		1,255,424		1,046,145	

Notes: This table presents the baseline estimates of the effects of diesel taxes on fuel purchases. Column (1) reports the overall effect of changes in own-region diesel taxes on diesel purchases, while column (2) shows the response to changes in diesel taxes in the closest neighboring region. Columns (3) and (4) restrict the analysis to cases where the petrol station faces a tax disadvantage, reporting the effects of own and neighboring-region taxes, respectively. Columns (5) and (6) repeat the analysis for cases of tax advantage. Standard errors, clustered at the province level, are reported in parentheses. * p<0.05, ** p<0.01, *** p<0.001.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

the observed price asymmetries are unlikely to be driven by market-wide quantity adjustments. Third, the estimated effects of neighboring regions' diesel taxes are quantitatively similar to those of own-region taxes. This finding suggests that the observed responses primarily reflect fuel purchases being relocated across regional borders rather than reductions in overall diesel demand (Iraizoz & Labeaga, 2026).

This evidence suggests that cross-regional purchases may not explain the observed asymmetry in price responses. To be explained by cross-regional purchases, we would require that purchases on the low-tax side of borders should not have increased in response to cross-regional tax gaps. However, we find a substantial and statistically significant increase in fuel purchases to a tax advantage on the low-tax side. This apparent disconnect suggests that pass-through dynamics may be shaped by factors beyond the predictions of tax incidence models with linear demand curves, which would predict similar price responses to similar quantity effects.

6.4 Effects in gasoline markets

We compare our main results with the corresponding estimates in gasoline markets. In Spain, diesel powers most professional and long-distance transport, whereas gasoline is more prevalent in high-performance and recreational vehicles. Consequently, the propensity for spatial relocation is expected to be less pronounced in gasoline markets.

Gasoline prices. Figure F.2 present estimates of gasoline tax pass-through on retail prices near regional borders. The patterns broadly resemble those observed for diesel, though the magnitudes are smaller. We estimate that gasoline taxes are passed through at a rate of 89.1% to own prices and 18.2% to competitors' prices—compared to 81.7% and 22.7%, respectively for diesel within 10 km of regional borders. When tax changes are disaggregated on either side of borders, the asymmetry in pass-through remains. When taxes change on the high-tax side, affected stations within 10 km shift only 62.9% of their own gasoline taxes, with no significant effects for low-taxed competitors. However, tax changes on the low-tax side lead the high-taxed side to shift 39.7% of their competitors' taxes. These results are consistent with the notion that spatial tax differentials are less salient to gasoline consumers, who typically travel shorter distances.

Gasoline purchases. Table F.2 shows that gasoline purchases near regional borders are highly sensitive to tax differences. This response is similar on the high-tax side (14.2%) as on the low-tax side (12.5%). Both estimates are substantially smaller than those for diesel, consistent with the more muted consumer substitution behavior in the gasoline market. They also do not explain the asymmetry in pass-through on the high- and low-tax side of regional borders.

6.5 Robustness checks

We perform several robustness checks to assess the credibility and stability of our baseline pass-through estimates and purchases responses to tax changes.

TWFE methods (Table E.1). We apply the TWFE estimator proposed by De Chaisemartin and d'Haultfoeuille (2026), which addresses potential bias stemming from treatment effect heterogeneity across units and over time. Our baseline TWFE results remain virtually unchanged when using this alternative estimator.

Travel time (Table E.2). The cost of spatial substitution in diesel purchases can be expressed either in terms of physical distance, capturing monetary travel costs, or in terms of travel time, which incorporates time-use costs (Perdiguero & Borrell, 2019). Spatial pass-through patterns remain consistent when we use bins of travel time to the nearest cross-border competitor instead of distance. This robustness to alternative measures of spatial substitution costs strengthens the credibility of our empirical strategy and main findings.

No control for second station (Table E.3). Our baseline spatial pass-through estimates controls for the taxes in the second nearest cross-regional stations in different regions. To evaluate whether the estimates are sensitive to these controls, we re-estimate the pass-through across regional borders without such controls. We show that results stay broadly consistent, reinforcing the robustness of our main pass-through estimates.

No control for international borders (Table E.4). Our baseline results control for proximity to international borders with France and Portugal. To investigate the sensitivity, we re-estimate our results without dropping the observations within 50km near borders. We show that results are similar and consistent under the inclusion of these stations.

Observation weighting (Table E.5). We assess the sensitivity of effects on diesel purchases when province-level observations are not weighted using station numbers. We show that the estimated effects are very similar, and the overall interpretation of responses is robust to not using province-level weights.

Anticipation effects (Table E.6). In our analysis on fuel purchases, our baseline analysis excludes months immediately before and after excise tax changes to minimize contamination from anticipatory behavior to tax changes (Coglianese et al., 2017). We show that including these observations does not materially affect the estimates, suggesting that anticipatory purchasing plays a limited role in shaping fuel demand responses in this setting[18].

7 Discussion

We discuss the implications of our estimation results with regard to models of tax incidence and its broader policy implications. First, we illustrate how competitive dynamics can explain the observed price responses. Then, we discuss the broader implications of our results for understanding the pass-through of differential taxes among competitors.

7.1 Demand curvature and pass-through

We consider how demand curvature can explain our main findings. As discussed above, the canonical incidence model with linear demand cannot account for our central empirical finding: demand increases induced by a tax advantage generate no price response, whereas comparable demand reductions on the high-tax side lead to substantial price adjustments.

We show how the pass-through asymmetry of differential taxes can be rationalized by competitive dynamics in oligopolistic markets (Bulow & Pfleiderer, 1983; Weyl & Fabinger, 2013). Specifically, we illustrate that these patters can be explained by a kink-shaped demand (Hall & Hitch, 1939; Sweezy, 1939). Maskin and Tirole (1988) show that, in oligopoly, competitors may be more likely to match price reductions than price increases. As a result, firm-level demand becomes more elastic for raising prices above those of competitors than for prices below them, generating a kinked demand curve. In retail fuel markets, asymmetric competitive responses of this form have been widely documented, even in the absence of asymmetric cost shocks (Noel, 2007a, 2007b; Wang, 2009).

Under this standard kinked-demand framework, the associated marginal revenue curve contains a vertical segment. Whenever marginal cost intersects this vertical segment, the profit-maximizing price remains fixed at the kink price[19]. Above this price, competitive pressure makes demand highly

[18] Our estimates refer to a static TWFE model, while anticipation is only relevant when the effects are estimated using a first-differenced model.

[19] We remain agnostic about the exact kink price for any given retailer. However, it is reasonable that these prices are the equilibrium prices in the absence of cross-regional tax differences.

elastic because consumers can readily substitute toward nearby competitors[20]. Below it, demand is less elastic because rivals are expected to match price reductions. This mechanism is commonly invoked to explain price rigidity in response to changes in marginal cost.

Figure 10 illustrates how positive and negative demand shifts affect prices under a kinked demand curve. We focus on the asymmetric pricing responses to demand shifts arising from tax-induced cost differences between competing firms to isolate this key mechanism. Figure 10a considers a positive demand shift. When marginal cost intersects the vertical segment of the marginal revenue curve, the equilibrium price remains pinned at the kink price. Following a positive demand shift from D to D', the corresponding marginal revenue curve MR' continues to intersect marginal cost within the vertical segment. As a result, equilibrium prices remain unchanged while quantities increase. This outcome is particularly likely when supply is relatively elastic, as is often the case in retail gasoline markets.

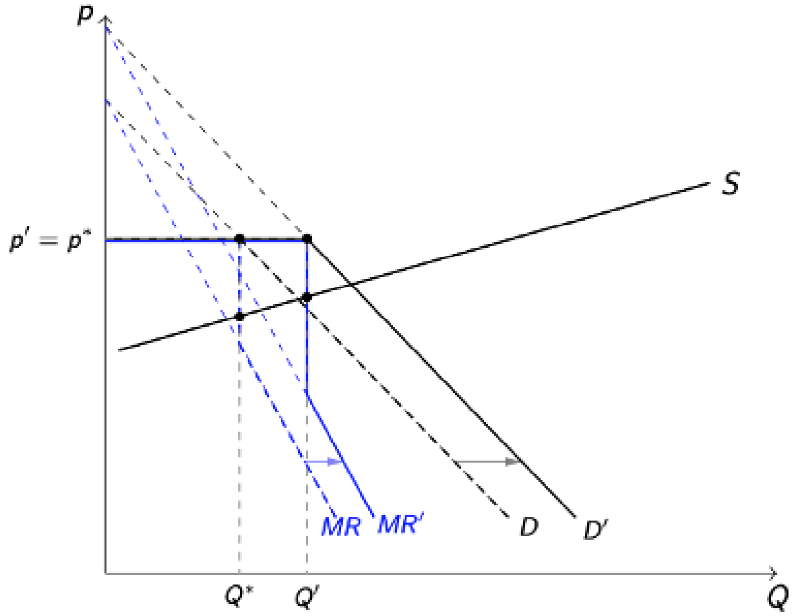
Figure 10b considers an equivalent negative demand shift. In this case, the decline in demand may move the optimal pricing point outside the vertical segment of the marginal revenue curve, resulting in a lower equilibrium price. For sufficiently large demand contractions, the kink may disappear altogether. The framework also predicts substantial ranges of negative demand shocks that generate little or no price adjustment, consistent with our empirical finding that price effects are concentrated within a narrow distance of regional borders. Even with relatively elastic supply, sufficiently large negative demand shocks can induce meaningful price reductions.

Overall, the kinked-demand framework captures the three main features of our empirical results. First, it rationalizes the asymmetric pass-through observed on either side of regional borders. Positive demand shifts generated by tax advantages do not necessarily translate into higher prices because competitive pressure constrains firms from pricing above nearby rivals. By contrast, equivalent negative demand shifts induced by tax disadvantages can make price reductions optimal. Second, in the absence of various nearby symmetric competitors, the asymmetry of differential tax pass-through is substantially smaller, finding positive price effects in response to tax advantages.

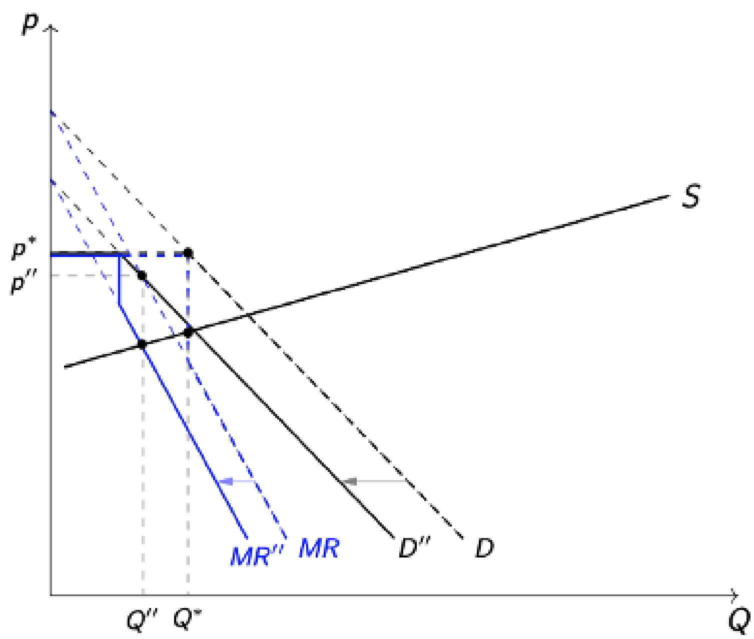
[20] For expositional simplicity, we consider demand to be perfectly elastic above the kink price.

Figure 10: Price effect of demand shifts under a kinked demand curve

(a) Positive demand shift



(b) Negative demand shift



Notes: The figure illustrates the effect of a tax change applied to market A on market A and B. The red arrow represents the movements along the demand curve following a tax change. The blue arrows represent the substitution effect, capturing the demand shifts because of changes relative prices. The y-axis plots the price under $p_A = p_B$, reflecting the demand curve when prices in all substitutable markets adjust simultaneously.
Source: Own calculations.

Third, the model helps explain why price effects are highly localized, despite sizeable quantity responses extending well beyond border areas. Under a kinked demand curve, substantial demand shocks may be absorbed through quantity adjustments rather than price changes, implying that only large competitive disturbances generate observable price responses.

7.2 Implications of results

Our findings have broader implications for understanding the pass-through of taxes and other cost shocks that apply differentially across competing firms. In many policy settings, taxes, regulations and firm innovations create cost asymmetries between firms that compete for the same consumers. Examples include import tariffs, cost shocks, sector-specific environmental regulations, and place-based taxes.

Our results show that pass-through in such environments depends on the competitive position of the affected firm relative to its asymmetric rivals, as well as competition with symmetric rivals. Firms that acquire a cost advantage over nearby competitors may be unable to raise prices despite experiencing an outward shift in demand, if their symmetric competitors exhert sufficient competitive pressure. Conversely, firms that face a tax-induced cost disadvantage may respond by reducing prices in order to remain competitive. As a result, the pass-through of differential taxes can deviate substantially from the predictions of standard models that abstract from these competitive interactions.

More broadly, our findings suggest that the burden of differential taxation may be distributed asymmetrically across firms facing otherwise similar tax changes. Competitive pressure can limit the ability of advantaged firms to exploit favorable tax treatment while simultaneously forcing disadvantaged firms to absorb part of the tax burden. Consequently, assessments of tax incidence based solely on average pass-through may obscure important heterogeneity arising from firms' relative competitive positions.

We discuss our results in public, international, environmental and industrial economics.

Public economics. Our findings contribute to the literature on tax incidence (Fullerton & Metcalf, 2002). They suggest that the incidence of differential taxes depends not only on the magnitude of tax differentials but also on their direction and on firms' competitive environments, particularly the presence of close symmetric competitors. Our results thus relate to prior studies on cross-border differences in taxes (Asplund et al., 2007; Bajo-Buenestado & Borrella-Mas, 2019; DeCicca et al., 2013; Harding et al., 2012; Hurtado, 2023; Stolper, 2016). As differential taxation becomes increasingly common, these mechanisms may help improve predictions of tax incidence. They may also help explain empirical anomalies documented when tax changes affect only a subset of firms or consumers rather than an entire market (Benzarti, 2024). More generally, our results highlight that firms' competitive positions are central to understanding the pass-through of differential taxes.

International economics. The mechanism documented in this paper is relevant for understanding the pass-through of import tariffs and exchange rates. Our results indicate that tariffs imposed on products with a cost disadvantage will be partially shifted, while those on those with a tax advantage will be fully shifted. This prediction aligns with recent evidence from the US-China trade war. US tariffs on Chinese imports were largely passed through to US consumer prices. In contrast, China's retaliatory tariffs on undifferentiated US exports were only partially shifted (Cavallo et al., 2021; Fajgelbaum et al., 2020). This explanation could also have contributed to the incomplete pass-through of exchange rate shocks faced by relatively undifferentiated products such as beer (Goldberg & Hellerstein, 2013) and coffee (Nakamura & Zerom, 2010).

Environmental economics. Similar considerations apply to taxes applying depending on the carbon-intensity of products. In particular, our results indicate that the pass-through of environmental taxes will depend on whether they apply differential burdens, and whether they apply mainly to cost advantaged or disadvantaged firms. For market-wide taxes, we expect a high degree of pass-through, as observed for emissions costs into electricity prices (Fabra & Reguant, 2014; Miller et al., 2017). In the presence of substitution opportunities, the pass-through is reduced (Ganapati et al., 2020). Relatedly, carbon border adjustment mechanisms (CBAMs) impose charges on imports based on their embodied carbon emissions in order to reduce carbon leakage and level the playing field between domestic and foreign producers (Keen et al., 2022; Fontagné and Schubert, 2023). To the extent that foreign products enjoy an underlying cost advantage when escaping carbon-taxes, our framework predicts relatively high pass-through of these charges into consumer prices.

Industrial organization. Our findings also contribute to the literature on cost pass-through and market structure (Borenstein et al., 1997; Fabra & Reguant, 2014; Goldberg & Hellerstein, 2008; Muehlegger & Sweeney, 2022). Existing work relating pass-through to the curvature of demand largely considers symmetric cost shocks (Weyl & Fabinger, 2013), including the conditions under which pass-through exceeds one (Pless & van Benthem, 2019). Empirically, however, identifying demand curvature is challenging, and direct evidence remains limited. Our setting provides a complementary approach. By exploiting differential tax changes that generate asymmetric cost shocks within oligopolistic markets, we identify conditions under which firms' perceived demand may exhibit kink-like features, thereby offering a new perspective on the relationship between competition and pass-through.

8 Conclusion

This paper provides novel empirical evidence on the spatial pass-through of fuel taxes. Leveraging Spain's decentralized tax framework from 2002 to 2019, during which regional governments had the authority to set diesel excise taxes up to 5.8 cents per liter, we analyze how these taxes are passed through to retail prices and how their effects vary by the direction of tax differences and the presence of symmetric competitors.

Using a TWFE strategy and high-frequency administrative data, we document substantial asymmetry in tax pass-through of cross-regional tax changes near regional borders. The pass-through critically depends on whether tax changes place affected firms at a competitive advantage or disadvantage relative to cross-regional rivals. High-tax stations near borders only partially shift their taxes, while their neighboring low-tax competitors do not respond to rivals' tax changes. In contrast, low-tax stations fully shift their taxes, and adjacent high-tax competitors also respond by raising their prices.

We show that these asymmetric responses are particularly large in the presence of nearby regional competitors. The results are consistent with a kinked demand curve. Taken together, our findings contribute to the literature on pass-through by showing that under commodity taxation, the combination of spatial differentiation, and relative cost structures critically shapes both the magnitude and asymmetry of tax pass-through. While standard models of tax incidence emphasize demand and supply elasticities, our results suggest that demand curvature plays a central role in shaping tax pass-through, offering evidence in line with deviations from traditional pass-through predictions.

Several important questions remain for future research. In particular, understanding how persistent cross-border tax differentials influence the long-run dynamics of market structure, including entry, exit, and investment decisions, would offer deeper insight into the full pass-through of decentralized taxation. Additionally, our results offer relevant insights for the design of differential tax instruments such as carbon border adjustment mechanisms or destination-based profit taxes, where relative cost positions and market competition are similarly central in determining pass-through.

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Appendix to

The Pass-Through of Differential Commodity Taxes: Do Relative Taxes among Competitors Matter?

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The appendix provides additional institutional details (Appendix A), additional details on the data (Appendix B), additional details on the empirical strategy (Appendix C), additional results on the spatial incidence of fuel taxes (Appendix D), additional results on sales responses (Appendix E), and additional results on gasoline tax incidence and sales responses (Appendix F).

A Institutional design

This appendix provides additional details on the fuel markets and fuel taxation system in Spain.

A.1 Health cent: Regional fuel excise taxes

In 2002, the Spanish Government introduced the Tax on Retail Sales of Certain Mineral Oils[21] (*Impuesto sobre las Ventas Minoristas de determinados Hidrocarburos*, IVMDH). This regional excise tax band allowed Spanish Autonomous Communities to set a fuel excise tax of in excess of the central government's fuel excise tax. From 2002 to 2003, the ceiling for the regional excise fuel tax was 1.7 cents/liter, from 2004 to 2007 the ceiling was 2.4 cents/liter and since 2008 this is set at 4.8 cents/liter. Sixteen Autonomous Communities had competence to modify this tax, while the Canary Islands, Ceuta and Melilla did not since they have a separate indirect tax regime.

In 2013, the IVMDH was integrated into the general Excise Duty on Mineral Oils (*Impuesto Especial sobre Hidrocarburos*, IEH) to comply with European Union Law. The IVMDH was ruled unconstitutional as it was justified based on budgetary purposes, while EU Law dictates that fuel excise taxes should aim to influence fuel consumption based, for instance, on environmental objectives. In 2014, the European Court of Justice ruled that the IVMDH was unconstitutional and requested the return of its revenues between 2002 and 2013.

Regional excise tax changes Table A.1 reports the characteristics of the tax changes applied in the period of study between 2007 and 2019.

[21] Ley 24/2001, de 27 de diciembre, de Medidas Fiscales, Administrativas y del Orden Social.

Table A.1: Characteristics of regional diesel excise tax changes

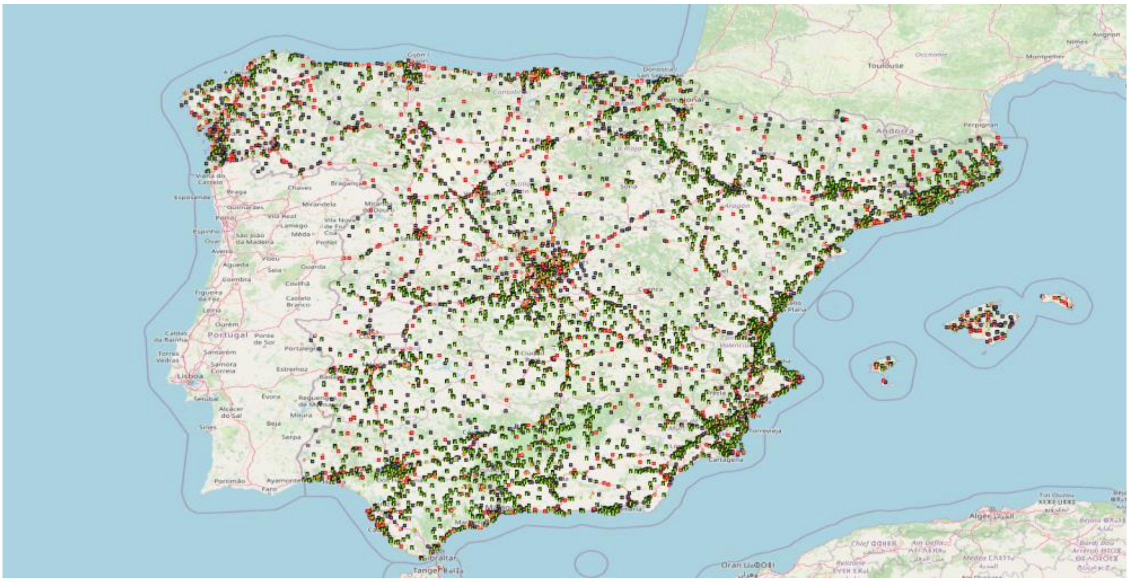
	Monthly data: 2002-2019	Geoportal data: 2014-2019
	(1)	(2)
N. of changes	40	16
Increases	33	11
Decreases	7	5
Average dimension (cent/l)	2.69	2.9
$\lvert\Delta t\rvert \leq 2$	12	4
$2 < \lvert\Delta t\rvert \leq 3$	15	5
$\lvert\Delta t\rvert > 3$	13	7

Notes: The table describes the characteristics of regional excise tax changes in Spain. This describes all changes in the period for which monthly data is available between 2002 and 2019 (column 1) and the period for which we have petrol station level data (column 2).

Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

B Geoportal data

Figure B.1: Map of real-time petrol station data under the Geoportal data



Notes: The figure shows the interactive map of petrol stations showing real-time prices of petrol stations, along with their location and petrol station brand, as shown in the Geoportal website on 10/03/2023.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

C Empirical strategy

This appendix provides additional details on the empirical strategy for estimating sales responses to cross-border differences in fuel prices.

C.1 Competitor prices and taxes at the province level

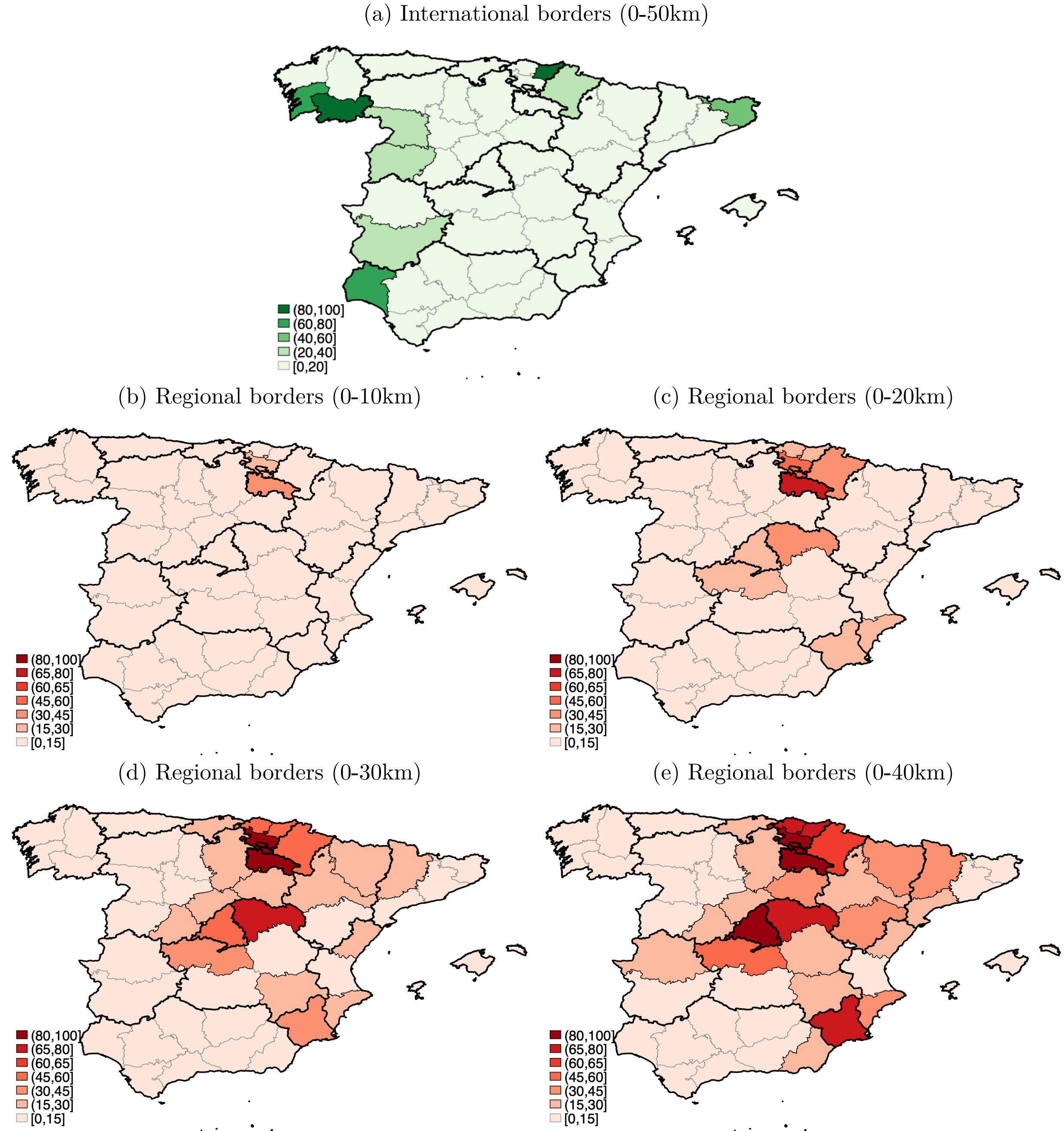
Our analysis on fuel sales is at the province level, requiring us to calculate the taxes and prices for each province's cross-border competitors in different Autonomous Communities. Given that some provinces border with various Autonomous Communities, we use a combination of the fuel prices and taxes of adjacent provinces in different Autonomous Communities. For this, we first identify the closest cross-border competitor for each individual station using the location of all petrol stations in Spain using Geoportal data. We then estimate a weighted average of province-level taxes and prices of individual cross-border competitors.

$$P_{jt} = \sum_{k \neq i} w_{i_p k} P_{kt}$$

$$\overline{\tau^c}_{pt} = \sum_{k \neq i} w_{i_p k} \tau_{kt}$$

where P_{jt} and $\overline{\tau^c}_{pt}$ are respectively the diesel prices and taxes for the combination of closest cross-border competitor provinces k of province p, and $w_{i_p k}$ is the share of petrol station i in province p whose closest cross-border competitor is in province k.

Figure C.1: Location of petrol stations by distance to regional and international borders



Notes: The figure shows the map of all petrol stations in Spain in January 2015, highlighting stations in driving distance to regional (panel a) and geometric distance to international borders (panel b). The bright red dots refer to petrol stations within driving distance of 25 km-s to regional borders, the dark red dots between 25 and 75 km-s. In both figures, gray dots refer to petrol stations whose driving distance is higher than 75 km-s.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

D Additional results: Spatial pass-through

This appendix presents additional results on the heterogeneity of the pass-through of differential taxes across regional borders. First, we present the heterogeneity of spatial pass-through for top station brands and the rest of station brands. Second, we present the heterogeneity of spatial pass-through for stations with at most one symmetric competitor station and those with more than one symmetric competitor station.

D.1 Full baseline results

Table D.1 reports the full results including the pass-through of second-closest petrol stations. The table shows that the effect of the second nearest petrol station is also significant near borders. Indeed, 18.2% of second-nearest stations' taxes are shifted on to own fuel prices. The effect of these taxes are similar on the high- and the low-tax side for the nearest station, ranging between 17.3% and 21.7%.

Table D.1: Full results on the pass-through of diesel excise taxes

	All observations			Tax disadvantage ($\tau_{it} \geq \tau_{it}^c$)			Tax advantage ($\tau_{it} \leq \tau_{it}^c$)		
	Own (τ_{it}) (1)	Comp. 1 (τ_{it}^c) (2)	Comp. 2 (τ_{kt}) (3)	Own (τ_{it}) (4)	Comp. 1 (τ_{it}^c) (5)	Comp. 2 (τ_{kt}) (6)	Own (τ_{it}) (7)	Comp. 1 (τ_{it}^c) (8)	Comp. 2 (τ_{kt}) (9)
0-10km	81.68***	22.65***	18.17**	56.80***	43.34***	17.35**	99.43	1.94	21.68**
	(5.38)	(4.90)	(6.94)	(7.15)	(6.47)	(6.58)	(6.46)	(6.39)	(7.25)
10-20km	97.06	5.27*	-7.41	87.80**	10.19*	-3.00	99.65	0.98	-4.55
	(2.36)	(2.53)	(7.08)	(4.49)	(3.99)	(6.95)	(2.93)	(3.45)	(7.34)
20-30km	103.52	4.64*	2.59	89.92*	13.35***	8.14**	108.10**	-3.56	6.99*
	(2.31)	(2.12)	(2.66)	(4.37)	(3.52)	(2.91)	(2.82)	(3.07)	(2.75)
30-40km	104.92*	4.50*	-3.67	95.58	9.15**	1.92	108.03**	-2.52	1.82
	(2.24)	(1.99)	(2.03)	(4.34)	(2.88)	(2.63)	(2.61)	(3.38)	(2.29)
40-50km	101.47	6.57**	3.91	96.23	9.87**	6.68*	104.36	0.50	8.76***
	(2.28)	(2.34)	(2.01)	(5.80)	(3.63)	(2.84)	(2.36)	(3.82)	(2.33)
50-60km	99.13	7.84**	4.66**	100.78	6.19	6.42*	95.43	13.23***	8.14***
	(2.19)	(2.47)	(1.79)	(4.08)	(3.21)	(2.70)	(2.81)	(3.84)	(2.08)
60-70km	103.51	-0.28	5.49***	108.17	-2.99	3.21	99.80	6.13	8.32***
	(2.80)	(2.60)	(1.23)	(4.77)	(3.20)	(2.37)	(4.30)	(5.64)	(1.37)
70+km	98.15*	6.49***	4.80***	97.28	6.17***	3.77***	98.29	5.44*	9.11***
	(0.89)	(0.96)	(0.61)	(1.73)	(1.07)	(0.77)	(1.51)	(2.53)	(0.86)
N(obs)		2,428,915			2,046,801			1,704,495	

Notes: This table provides spatial incidence using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

D.2 Heterogeneity: Petrol station type

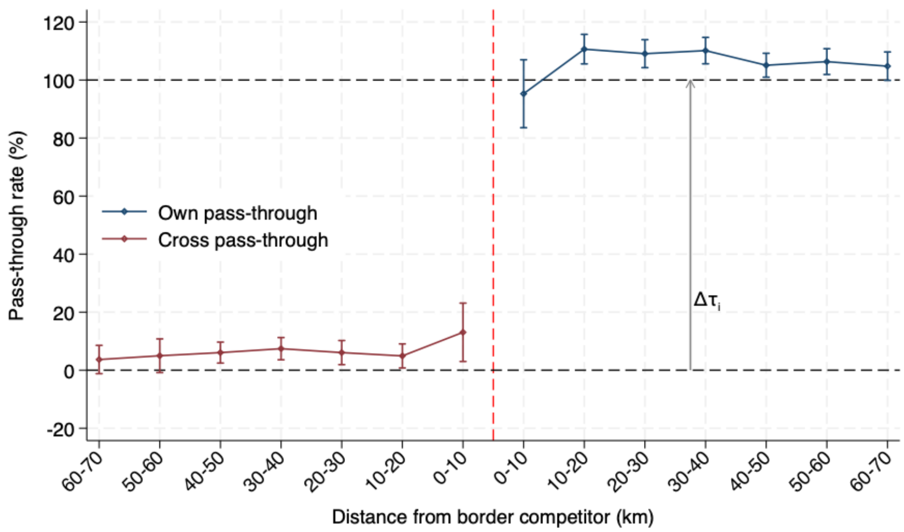
Table D.2: Effects of diesel excise taxes on fuel prices depending on station brands

	All observations		High-tax side ($\tau_{it} \geq \tau_{it}^c$)		Low-tax side ($\tau_{it} \leq \tau_{it}^c$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ_{it}^c) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ_{it}^c) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ_{it}^c) (6)
Panel A: Top station brands						
0-10km	95.28	13.06*	75.55**	25.70***	108.43	-1.31
	(5.98)	(5.13)	(7.67)	(6.97)	(6.82)	(6.79)
10-20km	110.64***	4.93*	97.40	11.03***	115.69***	-4.57
	(2.59)	(2.11)	(3.97)	(2.96)	(3.39)	(3.59)
20-30km	109.08***	6.08**	91.24*	15.68***	115.36***	-7.27*
	(2.46)	(2.12)	(4.25)	(3.49)	(2.95)	(3.20)
30-40km	110.14***	7.43***	100.64	11.33***	112.43***	0.86
	(2.32)	(1.95)	(4.11)	(2.81)	(2.86)	(3.78)
40-50km	105.10*	6.08***	100.71	7.14**	105.47*	3.63
	(2.10)	(1.84)	(4.24)	(2.59)	(2.53)	(3.45)
50-60km	106.35**	4.99	109.45*	1.27	99.90	14.72***
	(2.27)	(2.96)	(4.19)	(4.07)	(2.71)	(3.62)
60-70km	104.78	3.69	106.12	2.29	100.72	8.25
	(2.50)	(2.49)	(4.06)	(3.00)	(3.62)	(4.39)
70+km	101.15	9.09***	101.24	8.07***	100.30	6.40*
	(0.87)	(1.09)	(2.03)	(1.19)	(1.51)	(2.79)
	1,197,856		983,093		843,951	
Panel B: Smaller station brands						
0-10km	74.67**	26.32**	45.88***	55.43***	94.22	2.90
	(8.62)	(8.25)	(11.98)	(10.82)	(10.17)	(10.37)
10-20km	86.11***	7.18	84.68*	8.34	84.12***	7.50
	(3.60)	(4.05)	(6.80)	(6.68)	(4.50)	(4.89)
20-30km	97.55	4.73	91.89	10.53	97.92	1.45
	(3.84)	(3.75)	(7.10)	(6.16)	(4.63)	(4.78)
30-40km	99.29	1.86	95.94	5.35	99.65	-2.46
	(3.67)	(3.28)	(6.30)	(4.61)	(4.31)	(4.93)
40-50km	98.37	8.53*	93.46	13.23*	102.88	-2.28
	(4.11)	(4.25)	(8.30)	(5.91)	(4.43)	(6.12)
50-60km	94.74	7.82*	97.38	6.75	91.91	10.24
	(3.83)	(3.92)	(6.59)	(4.99)	(5.24)	(6.45)
60-70km	101.73	-2.23	107.48	-6.04	98.45	4.01
	(4.94)	(4.52)	(8.47)	(5.68)	(7.64)	(9.99)
70+km	94.96**	6.44***	92.37**	6.68***	96.79	3.68
	(1.54)	(1.44)	(2.81)	(1.59)	(2.64)	(4.28)
	1,231,054		1,063,701		860,540	

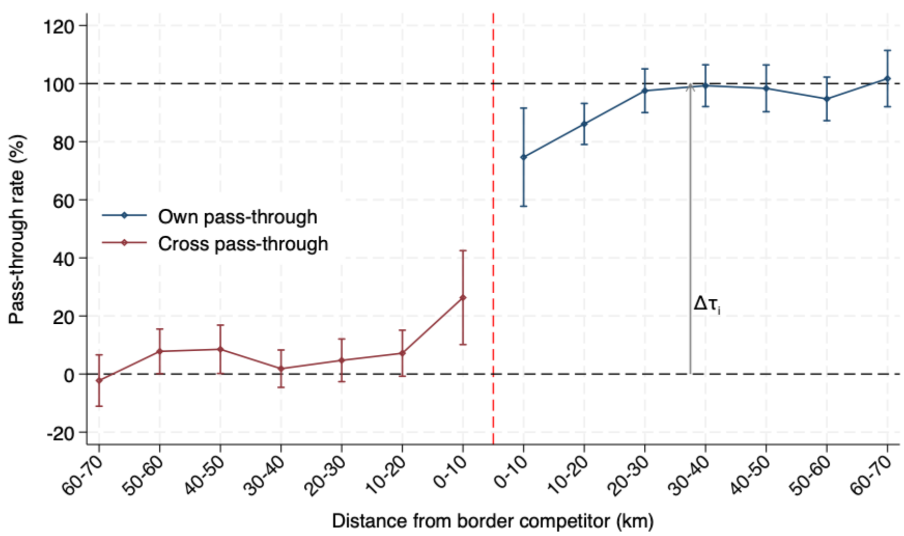
Notes: This table provides spatial incidence using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

Figure D.1: Spatial incidence by type of petrol station

(a) Top brands



(b) Smaller brands



Notes: : The figure illustrates the spatial incidence of diesel taxes as a function of the distance to the nearest cross-border competitor, separately by petrol station brand group. Panel (a) shows results for the top petrol station brands (Cepsa, Repsol, and BP), while Panel (b) displays the results for all other smaller brands. In each panel, the blue line indicates own-region diesel taxes, and the red line indicates the diesel tax level in the region of the nearest competitor.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

D.3 Heterogeneity: Symmetric competitors

Table D.3: Effects of diesel excise taxes on fuel prices depending on symmetric competitors

	All observations		High-tax side ($\tau_{it} \geq \tau^c_{it}$)		Low-tax side ($\tau_{it} \leq \tau^c_{it}$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ^c_{it}) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ^c_{it}) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ^c_{it}) (6)
Panel A: Few competitors (0-1)						
0-10km	64.01***	37.80***	45.16***	50.79***	78.23	22.90*
	(10.16)	(9.36)	(15.68)	(13.95)	(11.38)	(10.44)
10-20km	91.90*	8.87*	76.54**	16.32**	98.65	-2.51
	(4.08)	(3.99)	(7.56)	(5.96)	(4.81)	(6.96)
20-30km	95.13	7.83*	94.02	7.59	96.41	3.74
	(4.94)	(3.96)	(8.62)	(5.00)	(6.22)	(7.83)
30-40km	100.35	4.59	101.24	1.71	102.07	1.23
	(5.06)	(3.94)	(9.06)	(5.86)	(6.15)	(6.62)
40-50km	97.76	2.71	102.36	0.05	94.23	8.09
	(4.09)	(3.80)	(5.62)	(4.69)	(6.17)	(6.56)
50-60km	101.55	11.61*	105.87	9.71	97.96	13.40*
	(3.18)	(4.66)	(6.29)	(6.10)	(4.29)	(6.32)
60-70km	100.04	3.91	99.47	2.88	103.98	1.60
	(4.12)	(4.57)	(8.49)	(5.63)	(5.29)	(9.73)
70+km	98.30	7.00***	101.26	5.04*	95.85	7.65*
	(1.64)	(1.88)	(2.93)	(2.31)	(2.77)	(3.83)
	367,482		289,988		255,654	
Panel B: Many competitors (2+)						
0-10km	86.12*	18.54**	58.52***	41.27***	105.11	-3.87
	(6.15)	(5.65)	(8.09)	(7.47)	(7.21)	(7.08)
10-20km	99.91	2.71	93.93	4.90	99.90	1.35
	(2.82)	(3.02)	(5.40)	(4.90)	(3.53)	(3.97)
20-30km	106.41*	3.07	88.48*	14.82**	109.51**	-4.13
	(2.66)	(2.52)	(5.61)	(4.75)	(3.16)	(3.34)
30-40km	106.82**	4.32	94.06	10.30**	108.64**	-2.60
	(2.49)	(2.27)	(5.02)	(3.24)	(2.86)	(3.96)
40-50km	103.08	8.67**	94.35	13.13**	105.58*	0.94
	(2.63)	(2.75)	(7.67)	(4.50)	(2.51)	(4.67)
50-60km	98.11	7.38*	99.55	4.89	92.78*	14.43**
	(2.80)	(2.96)	(5.07)	(3.82)	(3.60)	(4.74)
60-70km	104.84	-1.36	108.96	-4.33	97.16	8.28
	(3.46)	(3.16)	(5.41)	(3.82)	(6.13)	(7.35)
70+km	98.47	6.49***	96.06	6.47***	100.27	1.85
	(1.05)	(1.06)	(2.15)	(1.15)	(1.80)	(3.34)
	2,061,374		1,756,757		860,540	

Notes: This table provides spatial incidence using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

E Additional results: Robustness checks

This appendix provides robustness checks using alternative specifications.

E.1 TWFE estimator

We compare our baseline two-way fixed effects (TWFE) estimator to the estimators developed by the emerging TWFE literature. Recent studies have shown that heterogeneity in treatment effects over time and across units could bias ordinary TWFE estimators. In particular, the literature is concerned about cases when already treated units enter the control group, as increasing dynamic effects would contaminate the control group. In our setting, this is likely to play a very limited role, since we observe in Figure 4 that the effects are immediate and stable over time. Therefore, standard TWFE estimation would appropriately estimate the effects of fuel taxes on prices and fuel sales. We verify this in the most simple case available. Despite important developments in the literature, most studies are only applicable to binary treatments and staggered adoption (Sun and Abraham, 2021; Borusyak et al., 2024; Callaway and Sant'Anna, 2021). However, our fuel tax treatments can be multiple per treatment unit and treatment is continuous. Therefore, we check our estimations with the estimator developed by De Chaisemartin and d'Haultfoeuille (2020), which is compatible with multiple and continuous treatments. As far as we are aware, the De Chaisemartin and d'Haultfoeuille (2020) estimator cannot be generally used with multiple treatment variables and in the 2SLS setting[22]. We estimate the following regression simple TWFE regression to check the robustness of our estimation:

$$y_{pt} = \alpha_p + \gamma_t + \beta\tau_{pt} + \mathbf{x_{pt}}\theta + \varepsilon_{pt}$$

y_{pt} represents the outcomes of interest, which are diesel prices, $y_{pt} = P_{pt}$, and the log of diesel sales, $y_{pt} = \ln S_{pt}$, in province p and month t. α_p refers to province fixed effects and γ_t refer to monthly fixed effects. τ_{pt} refer to regional diesel taxes in province p and month t. $\mathbf{x_{it}}$ includes province level employment rate, the logarithm of population and the logarithm of real

[22] Multiple treatments can only be used under staggered adoption, which is not our case.

GDP per capita. We use clustered standard errors at the province level, and we weight province level observations using the number of petrol stations since this is the sampling unit for the CNMC fuel price and sales data.

Table E.1 shows that our simple TWFE estimator provides almost identical point estimates as the estimator developed by De Chaisemartin and d'Haultfoeuille (2020), while estimation is more precise in our simple TWFE estimator. This gives confidence on the validity of our baseline TWFE estimator for the rest of our analysis.

Table E.1: Comparison of the TWFE estimators

	Baseline TWFE method (1)	De Chaisemartin & D'Hautefeuille (2020) (2)
P_{pt}	0.853***	0.829***
	(0.038)	(0.162)
$\ln S_{pt}$	−0.018***	-0.018***
	(0.003)	(0.005)

Notes: The table provides the TWFE estimation of effect of diesel taxes on diesel prices and on the logarithm of diesel sales by province for our baseline TWFE estimator (column 1) and for the TWFE estimator developed by De Chaisemartin and d'Haultfoeuille (2020) (column 2). Standard errors clustered at the province level in parenthesis. * p<0.05, ** p<0.01, *** p<0.001.
Source: Spanish National Markets and Competition Commission (CNMC).

E.2 Travel duration

The cost of spatial substitution of diesel can be measured in terms of distance, representing the monetary cost, or travel time, reflecting the time use cost (Perdiguero and Borrell, 2019). For approximate equivalence of the number of observations in distance or duration ranges, we define the duration ranges in 8-minutes ranges. Figure E.1 and E.2 illustrate that estimating spatial incidence at various bins of travel times from the closest cross-border competitor yields a similar interpretation as when using distances.

Table E.2: Effects of diesel excise taxes on fuel prices: Depending on duration

	All observations		Tax disadvantage ($\tau_{it} \geq \tau^c_{it}$)		Tax advantage ($\tau_{it} \leq \tau^c_{it}$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ^c_{it}) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ^c_{it}) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ^c_{it}) (6)
0-8min	83.67**	17.25***	60.32***	34.93***	99.82	-2.82
	(5.00)	(5.06)	(7.34)	(6.97)	(5.85)	(6.12)
8-16min	99.04	6.25*	88.20**	13.12***	103.46	-0.69
	(2.29)	(2.44)	(4.34)	(3.86)	(2.83)	(3.31)
16-24min	100.07	7.40***	83.79***	17.63***	105.52*	-1.86
	(2.08)	(1.77)	(3.62)	(2.68)	(2.65)	(2.96)
24-32min	103.04	8.65***	93.52	14.81***	107.71***	-1.11
	(1.94)	(1.90)	(4.17)	(3.02)	(2.23)	(2.81)
32-40min	96.93	4.81*	108.16	-0.78	91.32***	15.08***
	(2.16)	(2.39)	(4.43)	(3.20)	(2.48)	(3.60)
40-48min	102.59	4.72*	99.57	5.58*	102.18	5.84
	(2.35)	(2.06)	(3.76)	(2.40)	(3.41)	(4.53)
48-56min	97.47	18.08***	85.95***	21.41***	107.12	-2.39
	(2.34)	(2.41)	(3.99)	(2.93)	(3.75)	(5.62)
56+min	98.61	3.54***	97.64	3.47**	97.98	3.28
	(0.96)	(1.02)	(1.93)	(1.12)	(1.59)	(2.67)
N(obs)	2,428,915		2,046,801		1,704,495	

Notes: This table provides spatial incidence using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

E.3 No controls for second-closest region

Spatial pass-through estimates depending on the closest cross-border competitor could be affected by tax differentials relative to the second closest Autonomous Community. We check the robustness of our results to not including controls for diesel taxes in the closest cross-border competitor from the second-closest Autonomous Community. We describe our regression specification and the estimation results when including controls for second-closest petrol stations.

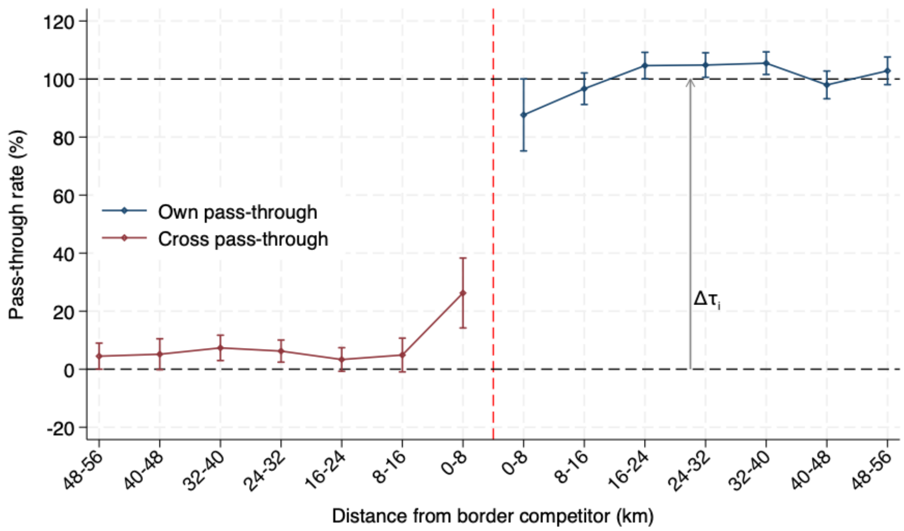
Regression specification. We undertake the following regression specification:

$$P_{it} = \alpha_i + \gamma_t + \sum_{d=1}^{8} \beta_d (d_{ij} \times \tau_{it}) + \sum_{d=1}^{8} \lambda_d (d_{ij} \times \tau^c_{it}) + \mathbf{x_{it}}\theta + \varepsilon_{it} \tag{E.1}$$

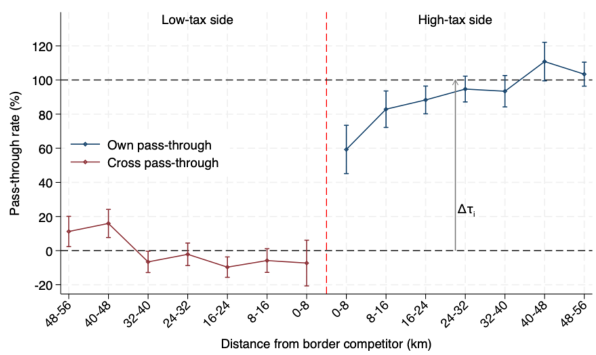
where P_{it} denotes diesel prices for petrol station i at week t, α_i denotes petrol station fixed effects and γ_t stands for weekly time effects, d_{ij} denotes the indicator variable taking value 1 if

Figure E.1: Spatial incidence of change in τ_{it} on either side of borders: Duration

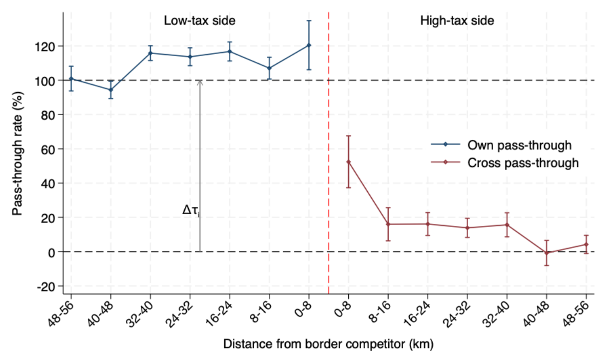
(a) All observations



(b) Tax disadvantage ($\tau_i \geq \tau_j$)



(c) Tax advantage ($\tau_i \leq \tau_j$)



Notes: The figure shows the spatial incidence of gasoline taxes by the travel time to the nearest cross-border competitor, provided in 8 min bins. Panel (b) displays the results across all tax changes, reporting the results in columns (1) and (2) in Table E.2, respectively for blue and red lines. Panel (b) displays the results when tax changes happen in the disadvantaged side, reporting the results in columns (3) and (6) in Table E.2, respectively for blue and red lines. Panel (c) displays the results when tax changes happen in the advantaged side, reporting the results in columns (4) and (5) in Table E.2, respectively for red and blue lines. The blue line represents the incidence of own taxes and the red line represents the effect on competitor prices.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

distance between petrol station i and its closest cross-border competitor j is in 10km bin d, where $d = 8$ captures all distances above 70km. τ_{it} represents the diesel tax applying to petrol station i, τ_{it}^c stands for the diesel tax applying to the closest cross-regional competitor petrol station j. $\mathbf{x_{it}}$ includes differential time trends in each autonomous community. Standard errors are clustered at the petrol station level.

Results. Table E.3 shows that our main results on τ_{it} and τ^c_{it} are broadly unaffected by the inclusion of this control.

Table E.3: Effects of diesel excise taxes on fuel prices: No second-station

	All observations		Tax disadvantage ($\tau_{it} \geq \tau^c_{it}$)		Tax advantage ($\tau_{it} \leq \tau^c_{it}$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ^c_{it}) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ^c_{it}) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ^c_{it}) (6)
0-10km	83.98**	23.90***	59.07***	46.57***	107.33	0.26
	(5.44)	(4.81)	(7.00)	(6.51)	(6.51)	(6.00)
10-20km	98.01	3.90	87.93**	12.01**	106.78*	-4.41
	(2.30)	(2.42)	(4.30)	(3.93)	(2.84)	(3.16)
20-30km	105.94**	2.82	91.73*	14.12***	116.98***	-9.07**
	(2.27)	(2.11)	(4.17)	(3.55)	(2.77)	(3.00)
30-40km	108.24***	3.62	98.41	9.79***	117.02***	-5.78
	(2.09)	(1.95)	(3.99)	(2.90)	(2.46)	(3.13)
40-50km	103.96	6.28**	98.82	10.38**	111.31***	-2.12
	(2.23)	(2.35)	(5.77)	(3.62)	(2.35)	(3.91)
50-60km	100.21	8.46***	102.16	6.83*	98.32	14.48***
	(2.15)	(2.45)	(4.06)	(3.18)	(2.75)	(3.86)
60-70km	104.39	-0.24	109.13	-2.65	103.37	4.87
	(2.80)	(2.58)	(4.75)	(3.18)	(4.35)	(5.66)
70+km	99.57	4.53***	99.56	4.57***	100.52	5.92*
	(0.89)	(0.95)	(1.70)	(1.04)	(1.51)	(2.53)
N(obs)	2,428,915		2,046,801		1,704,495	

Notes: This table provides spatial incidence using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

E.4 Including stations near international stations

Our baseline analysis excludes the petrol stations within 50km from international borders, so that our cross-regional analysis is not contaminated with international differences in fuel taxes. We assess the sensitivity of our results to including these stations. Table E.4 shows that the results are very similar whether the observations within 50km from international borders are included or excluded from our main sample.

E.5 Petrol station weights

We also assess the sensitivity of our results to weighting observations by the number of petrol stations in each province, reflecting the level at which data are collected. This approach shifts

Table E.4: Effects of diesel excise taxes on fuel prices: Including international stations

	All observations		Tax disadvantage ($\tau_{it} \geq \tau_{it}^c$)		Tax advantage ($\tau_{it} \leq \tau_{it}^c$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ_{it}^c) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ_{it}^c) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ_{it}^c) (6)
0-10km	79.78***	22.52***	53.75***	44.57***	99.30	-0.17
	(5.34)	(4.85)	(6.69)	(6.24)	(6.53)	(6.39)
10-20km	95.17*	4.04	82.78***	11.90**	99.66	-3.14
	(2.32)	(2.47)	(4.19)	(3.87)	(2.86)	(3.28)
20-30km	102.93	2.98	87.92**	14.17***	109.03***	-7.45**
	(2.22)	(2.00)	(3.97)	(3.34)	(2.71)	(2.75)
30-40km	103.42	4.78*	94.14	10.62***	107.75**	-3.40
	(2.11)	(1.87)	(3.91)	(2.77)	(2.46)	(2.98)
40-50km	100.10	6.72**	92.71	11.39***	104.30	-2.26
	(2.21)	(2.24)	(5.22)	(3.42)	(2.33)	(3.55)
50-60km	97.35	7.74***	97.05	7.54*	94.84	11.21**
	(2.11)	(2.32)	(3.76)	(3.02)	(2.70)	(3.59)
60-70km	99.41	1.02	103.39	-1.04	96.14	6.90
	(2.53)	(2.48)	(4.32)	(3.00)	(4.20)	(5.61)
70+km	96.68***	7.27***	97.09	7.12***	96.32**	6.81**
	(0.84)	(0.80)	(1.63)	(0.87)	(1.43)	(2.46)
N(obs)	2,652,797		2,232,059		1,848,844	

Notes: This table provides spatial incidence using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

the interpretation of the estimates toward the station level. Tables **??** shows that the estimated effects are slightly smaller in magnitude, but the overall results and their interpretation remain very similar to our baseline province-level estimates.

E.6 Anticipation

We assess the sensitivity of our results to anticipation effects surrounding tax reforms. Our baseline specification addresses this issue by excluding observations immediately before and after tax changes. We re-estimate the results including these observations. Table **??** shows that anticipation has a negligible effect on our static elasticity estimates.

Table E.5: Effects of diesel excise taxes on province diesel sales: No station weights

	All observations		Tax disadvantage ($\tau_{it} \geq \tau_{it}^c$)		Tax advantage ($\tau_{it} \leq \tau_{it}^c$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ_{it}^c) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ_{it}^c) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ_{it}^c) (6)
0-10km	-22.95**	13.96	-27.18*	16.85	-22.64*	13.02
	(8.55)	(8.14)	(13.22)	(13.41)	(10.25)	(9.46)
0-20km	-9.60***	5.97**	-7.06**	4.61	-10.30***	6.27*
	(2.48)	(2.25)	(2.39)	(3.23)	(2.98)	(2.75)
0-30km	-6.09***	3.75***	-5.65***	3.97	-5.95**	3.72**
	(1.54)	(1.00)	(1.51)	(2.11)	(1.89)	(1.14)
0-40km	-4.60***	2.70***	-4.71***	3.16*	-4.08*	2.54**
	(1.30)	(0.81)	(1.20)	(1.47)	(1.60)	(0.95)
0-50km	-3.80***	2.24**	-3.80***	2.45*	-3.34*	2.09*
	(1.06)	(0.70)	(0.90)	(1.08)	(1.39)	(0.88)
0-60km	-3.32***	1.90***	-3.59***	2.28*	-2.40*	1.44
	(0.70)	(0.57)	(0.77)	(0.90)	(1.17)	(0.83)
0-70km	-3.07***	1.73***	-3.35***	1.95**	-2.08*	1.17
	(0.59)	(0.51)	(0.76)	(0.72)	(0.95)	(0.77)
70+km	-2.02***	-0.32	-1.73*	-0.54	-0.77	-1.71
	(0.42)	(0.40)	(0.70)	(0.42)	(0.92)	(1.12)
N(obs)	9,448		6,842		6,037	

Notes: This table presents the baseline estimates of the effects of diesel taxes on fuel sales. Column (1) reports the overall sales response to changes in own-region diesel taxes, while column (2) shows the response to changes in diesel taxes in the closest neighboring region. Columns (3) and (4) restrict the analysis to cases where the petrol station faces a tax disadvantage, reporting the effects of own and neighboring-region taxes, respectively. Columns (5) and (6) repeat the analysis for cases of tax advantage. Standard errors, clustered at the province level, are reported in parentheses. Province level observations are weighted by the number of petrol stations. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

Table E.6: Effects of diesel excise taxes on province diesel sales

	All observations		Tax disadvantage ($\tau_{it} \geq \tau_{it}^c$)		Tax advantage ($\tau_{it} \leq \tau_{it}^c$)	
	Own tax (τ_{it})	Comp. tax (τ_{it}^c)	Own tax (τ_{it})	Comp. tax (τ_{it}^c)	Own tax (τ_{it})	Comp. tax (τ_{it}^c)
	(1)	(2)	(3)	(4)	(5)	(6)
0-10km	-18.67**	12.34	-26.69*	19.56	-17.71*	10.96
	(6.94)	(7.18)	(11.71)	(11.08)	(8.68)	(9.24)
0-20km	-6.56***	4.88**	-7.13***	6.28*	-6.91**	5.09
	(1.95)	(1.82)	(2.02)	(2.57)	(2.62)	(2.65)
0-30km	-3.95**	2.92***	-5.44***	4.72**	-3.84**	3.00**
	(1.20)	(0.80)	(1.36)	(1.61)	(1.42)	(1.01)
0-40km	-2.92***	1.94***	-4.41***	3.51***	-2.62**	1.87**
	(0.81)	(0.52)	(1.06)	(1.06)	(0.83)	(0.62)
0-50km	-2.59***	1.63***	-3.60***	2.71***	-2.28***	1.51**
	(0.61)	(0.41)	(0.79)	(0.75)	(0.61)	(0.50)
0-60km	-2.63***	1.53***	-3.40***	2.28***	-2.05***	1.18*
	(0.48)	(0.35)	(0.69)	(0.63)	(0.53)	(0.46)
0-70km	-2.58***	1.42***	-3.19***	1.88***	-2.01***	1.03*
	(0.42)	(0.30)	(0.68)	(0.53)	(0.47)	(0.44)
70+km	-1.93***	-0.35	-1.78***	-0.45	-1.27*	-1.13
	(0.32)	(0.28)	(0.53)	(0.30)	(0.54)	(0.74)
N(obs)	1,762,124		1,282,418		1,068,047	

Notes: This table presents the baseline estimates of the effects of diesel taxes on fuel sales. Column (1) reports the overall sales response to changes in own-region diesel taxes, while column (2) shows the response to changes in diesel taxes in the closest neighboring region. Columns (3) and (4) restrict the analysis to cases where the petrol station faces a tax disadvantage, reporting the effects of own and neighboring-region taxes, respectively. Columns (5) and (6) repeat the analysis for cases of tax advantage. Standard errors, clustered at the province level, are reported in parentheses. This specification does not drop the observations before and after tax changes. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

F Additional results: Gasoline

This appendix describes the results on gasoline tax pass-through and sales responses. It should be noted that gasoline taxes have historically been larger in Spain, which has prompted most cars to be powered by diesel. Given its lower fuel consumption figures, diesel is more often used for longer travel, including professional transportation, and gasoline is more often used than diesel in powerful cars. Therefore, we expect that cross-border fuel tax differences are more relevant for diesel than for gasoline. First, we present the event study evidence on the dynamic effects of gasoline taxes on gasoline prices and gasoline sales. Second, we describe our results on gasoline tax incidence across regional borders.

F.1 Event study evidence

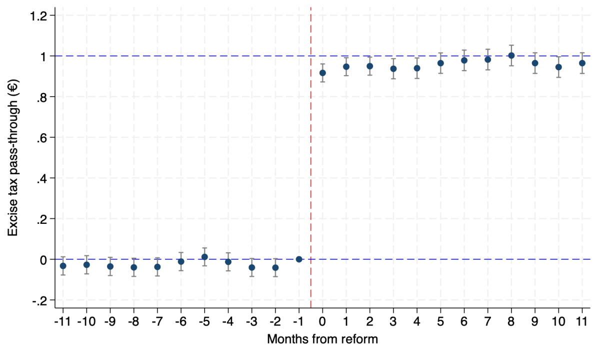
Figure F.1 displays the event study results on the dynamic effect of regional gasoline taxes on gasoline prices and sales. In the same way as for diesel, we can observe that no differential regional trend is apparent before gasoline tax reforms, both on gasoline prices and sales. After the reform, we estimate a highly instantaneous shifting of fuel taxes on to prices, which ranges between 90% and 95% of diesel excise taxes translate into diesel prices after an excise tax change. These pass-through results are very similar to diesel tax pass-through. In addition, we observe an instantaneous and stable gasoline sales response in treated regions relative to untreated regions. We also observe a significant anticipation to the reform the month prior tax changes happen. The pattern of responses is therefore similar to diesel, but responses are stronger for diesel than gasoline, which could indicate the smaller responses to cross-border tax differentials for gasoline relative to diesel.

F.2 Gasoline tax incidence across regional borders

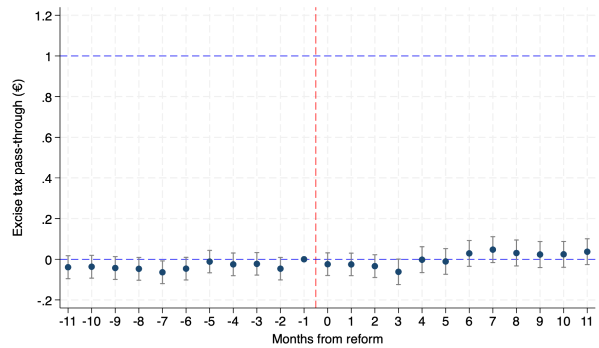
We further estimate the effects of cross-border gasoline tax differentials on prices on both sides of borders. Figure F.2 shows that gasoline taxes close to borders are shifted by 88.4%, while competitor's taxes are shifted by 17.4%. The effects of tax differentials on prices are similar, but slightly smaller for gasoline and diesel. This may be because gasoline is less often used for long-

Figure F.1: Event study evidence on price and sales responses to regional gasoline excise taxes

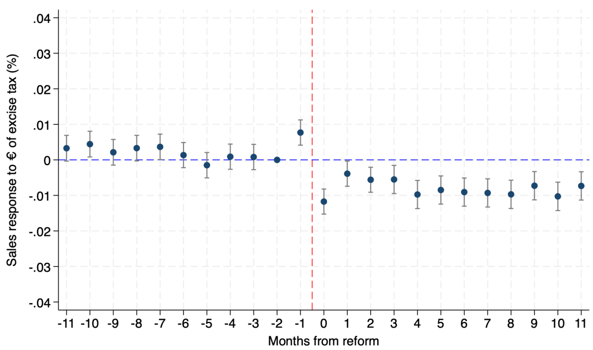
(a) Pass-through: Own province tax



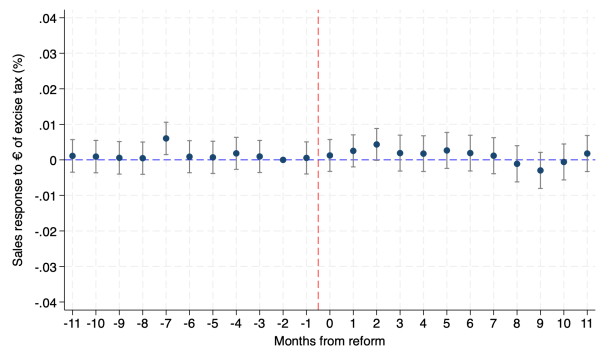
(b) Pass-through: Cross-province tax



(c) Sales: Own province tax



(d) Sales: Cross-province tax



Notes: The figure shows the event study graph on the dynamic effect of the diesel excise taxes on diesel prices using *Geoportal* daily data (panel a) and CNMC monthly data (panel b), as well as the dynamic effects of fuel taxes on sales responses (panel c). The vertical dashed red line refers to the period prior to the reform.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge and Spanish National Markets and Competition Commission (CNMC).

distance travel in Spain, which may mitigate demand responses to spatial differences. However, gasoline is expected to evolve closely with diesel, as gasoline and diesel prices are set simultaneously by petrol stations.

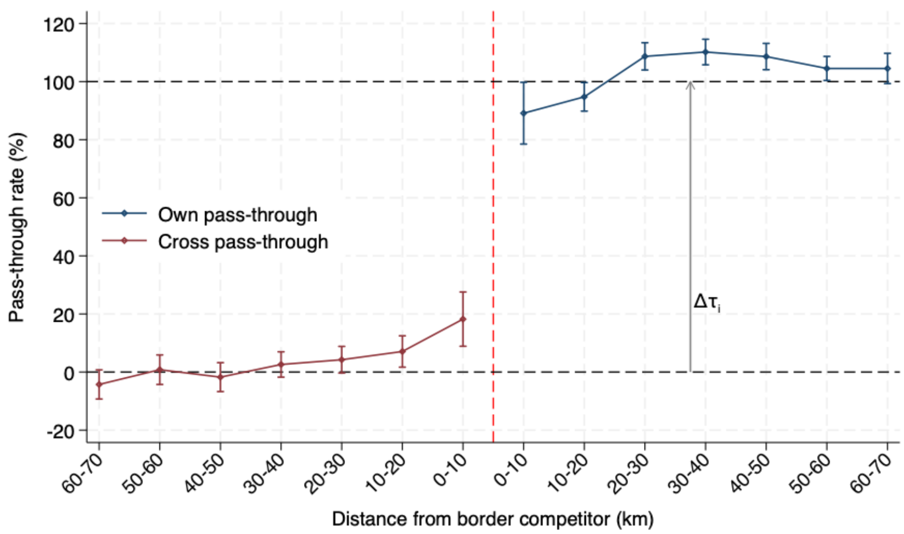
Table F.1: Effects of diesel excise taxes on fuel prices

	All observations		Tax disadvantage ($\tau_{it} \geq \tau_{it}^c$)		Tax advantage ($\tau_{it} \leq \tau_{it}^c$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ_{it}^c) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ_{it}^c) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ_{it}^c) (6)
0-10km	89.13*	18.23***	62.93***	39.68***	110.43	-6.23
	(5.42)	(4.77)	(6.95)	(6.27)	(6.57)	(6.26)
10-20km	94.76*	7.08*	82.83***	13.01**	101.97	-2.09
	(2.51)	(2.75)	(4.62)	(4.21)	(3.07)	(3.69)
20-30km	108.69***	4.26	88.44**	15.77***	120.03***	-13.58***
	(2.40)	(2.33)	(4.41)	(3.70)	(2.98)	(3.30)
30-40km	110.19***	2.62	92.25	11.29***	121.29***	-15.96***
	(2.25)	(2.23)	(4.00)	(3.05)	(2.72)	(3.47)
40-50km	108.63***	-1.74	104.08	1.79	114.84***	-9.23*
	(2.31)	(2.54)	(5.15)	(3.51)	(2.63)	(4.01)
50-60km	104.54*	0.82	106.39	0.34	101.44	8.54
	(2.11)	(2.59)	(4.39)	(3.33)	(3.01)	(4.64)
60-70km	104.52	-4.26	109.96*	-6.50*	100.03	6.67
	(2.66)	(2.56)	(4.15)	(2.94)	(4.13)	(5.41)
70+km	103.57***	-1.69	103.93*	-2.25*	103.46**	2.62
	(0.82)	(0.99)	(1.66)	(1.07)	(1.08)	(2.18)
N(obs)	2334110		1985457		1709891	

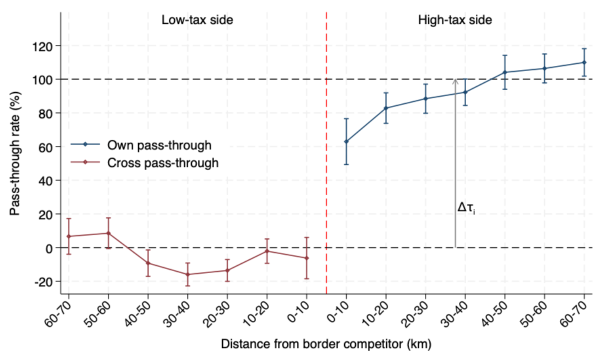
Notes: This table provides spatial incidence using alternative specifications, including baseline results for a tax disadvantage (column 1) and a tax advantage (column 2) relative to the closest competitor; controlling for the second closest competitor from a different Autonomous Community for a tax disadvantage (column 3) and a tax advantage (column 4); controlling for quintiles of the level of competition on the effect of pass-through for a tax disadvantage (column 5) and a tax advantage (column 6). Standard errors clustered at the province level in parenthesis.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

Figure F.2: Gasoline spatial incidence depending on distance to cross-border competitors

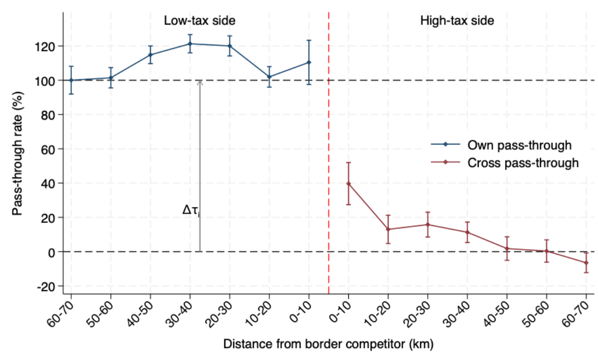
(a) All tax changes



(b) Change in high-tax side



(c) Change in low-tax side



Notes: The figure shows the spatial incidence of gasoline taxes by the distance to the nearest cross-border competitor, provided in 10 km bins. Panel (b) displays the results across all tax changes, reporting the results in columns (1) and (2) in Table F.1, respectively for blue and red lines. Panel (b) displays the results when tax changes happen in the disadvantaged side, reporting the results in columns (3) and (6) in Table F.1, respectively for blue and red lines. Panel (c) displays the results when tax changes happen in the advantaged side, reporting the results in columns (4) and (5) in Table F.1, respectively for red and blue lines. The blue line represents the incidence of own taxes and the red line represents the effect on competitor prices.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

F.3 Gasoline sales response across regional borders

Table F.2 describes the result on the effect of gasoline taxes on gasoline sales depending on the distance range considered. First, we can observe large sales responses to gasoline taxes, especially close to regional borders. When considering all observations, gasoline sales in petrol stations located within 10km from closest-cross regional borders decrease by 12.4% for each pp in excise taxes. These responses are smaller than the responses for diesel taxes. This helps explain the more modest tax incidence found for gasoline compared to diesel taxes. In addition, unlike for diesel, we find substantially smaller responses for competitor's taxes compared to own taxes. This may reflect the lower responsiveness of gasoline sales to tax differentials, since gasoline-fueled vehicles are less often used for long travel.

Table F.2: Effects of gasoline excise taxes on province gasoline sales

	All observations		Tax disadvantage ($\tau_{it} \geq \tau_{it}^c$)		Tax advantage ($\tau_{it} \leq \tau_{it}^c$)	
	Own tax (τ_{it}) (1)	Comp. tax (τ_{it}^c) (2)	Own tax (τ_{it}) (3)	Comp. tax (τ_{it}^c) (4)	Own tax (τ_{it}) (5)	Comp. tax (τ_{it}^c) (6)
0-10km	-12.59***	2.34	-14.17**	12.01*	-12.47***	0.46
	(2.91)	(4.82)	(5.02)	(5.43)	(2.40)	(4.96)
0-20km	-4.44**	1.83	-4.63***	4.91**	-4.47**	1.40
	(1.66)	(1.57)	(1.34)	(1.64)	(1.69)	(1.78)
0-30km	-2.61**	1.29	-3.17***	3.30***	-2.62*	1.41
	(0.92)	(0.71)	(0.73)	(1.00)	(1.06)	(0.75)
0-40km	-1.87**	0.97*	-2.46***	2.50***	-1.84**	1.21**
	(0.59)	(0.44)	(0.46)	(0.70)	(0.66)	(0.47)
0-50km	-1.60***	0.83*	-1.99***	1.97***	-1.57**	1.11**
	(0.45)	(0.36)	(0.36)	(0.57)	(0.51)	(0.39)
0-60km	-1.43***	0.79**	-1.66***	1.58***	-1.30**	1.02**
	(0.34)	(0.30)	(0.28)	(0.45)	(0.43)	(0.33)
0-70km	-1.30***	0.73**	-1.45***	1.30***	-1.21***	0.99**
	(0.28)	(0.27)	(0.24)	(0.36)	(0.34)	(0.31)
70+km	-0.56*	-0.39	-0.33	-0.56*	-0.23	-0.40
	(0.25)	(0.22)	(0.37)	(0.27)	(0.45)	(0.55)
N(obs)	1,723,184		1,252,852		1,032,188	

Notes: This table presents the baseline estimates of the effects of gasoline taxes on gasoline sales. Column (1) reports the overall sales response to changes in own-region gasoline taxes, while column (2) shows the response to changes in gasoline taxes in the closest neighboring region. Columns (3) and (4) restrict the analysis to cases where the petrol station faces a tax disadvantage, reporting the effects of own and neighboring-region taxes, respectively. Columns (5) and (6) repeat the analysis for cases of tax advantage. Standard errors, clustered at the province level, are reported in parentheses. * p<0.05, ** p<0.01, *** p<0.001.
Source: Spanish Ministry of Ecological Transition and Demographic Challenge.

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