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Do Cooperatives Exercise Market Power? Evidence from Pass-Through to Retail Prices

Abstract

Cooperatives, formally established to enhance social welfare and local economic development, often face pressures that divert them from these foundational goals and lead to their transformation into profit-driven entities that exploit market power. Leveraging an unexpected tax change following a vote of no confidence, we examine the pass-through to retail prices as a test for market power, using data from over 250 cooperatives operating in the Spanish fuel market. Our findings reveal a complete pass-through of the tax increase to retail prices. Additionally, descriptive evidence suggests that cooperatives consistently offer lower prices than their for-profit counterparts. These results are indicative of the absence of markup adjustments and market power exertion among cooperatives and are consistent with their prioritization of consumer welfare over profit maximization, thereby justifying the regulatory advantages they enjoy.

JEL-Codes: D220, H220, H320, L210, L290, P130.

Keywords: cooperatives, pass-through to prices, market power, firm conduct, retail fuel market.

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1 Introduction

Cooperatives, which are firms owned by individuals with shared interests (e.g., workers, consumers, or farmers), have long played a crucial role in various sectors, including agriculture, food, and construction. Currently, they employ 10% of the global labor force and generate a turnover exceeding \$2.17 trillion (ICA, 2023). By bringing together like-minded individuals who aim to achieve a common goal, cooperatives have the potential to enhance market outcomes and promote local communities' socio-economic development, as often formally stated in their constitutions and by-laws (Novkovic, 2008; Bouchard et al., 2020; Hunter et al., 2022). However, Birchall (2014) highlights cooperatives' potential risk of being captured by interest groups. Ambitious managers, in particular, may steer these entities away from their original objectives, transforming them into profit-driven enterprises and potentially compromising social welfare. If this were to occur, as Duarte et al. (*forthcoming*) notes, cooperatives would become what early leaders of the cooperative movement feared: "degenerates" that strayed from their genuine purpose.

In light of these concerns, this paper aims to address a straightforward empirical question: do cooperatives exercise market power? This question becomes particularly intriguing when examining cooperatives that were primarily (though not exclusively) formed to sell their products to their memberowners, with the explicit aim of maximizing their *collective interests*. These cooperatives should exhibit behavior that aligns with efficient pricing as a way to internalize the consumer surplus they generate (Mikami, 2003; Dewatripont and Tirole, 2024). Conversely, the exercise of market power—which would result in a markup in their prices—may appear inconsistent with their underlying principles and nature. Furthermore, if their behavior does not significantly diverge from that of their profit-maximizing counterparts, it raises pertinent questions regarding the justification for tax exemptions (Burdin and Dean, 2009; Pencavel, 2013; Tortia et al., 2013) and other regulatory advantages—for example, antitrust (Crespi and MacDonald, 2022)—often granted to cooperatives in many jurisdictions.

To explore this question, we rely on daily price data from the universe of cooperatives operating in the retail transportation fuel market in Spain between January 2018 and June 2019 to uncover whether their pricing behavior aligns with the presence of a markup, a result that is consistent with the exercise of market power. Our analysis not only provides descriptive data that merely outlines the "raw" price differences between cooperatives and for-profit gas stations. More significantly, we exploit an exogenous and unexpected change in fuel duties following a *vote of no confidence*—resulting in an approximate 5-6% rise in the price of fuel for gas stations in specific regions of Spain—to examine to what extent this tax change was passed on to cooperatives' final retail fuel prices. Given the direct connection between pass-through behavior and market power—see, for example, Weyl and Fabinger (2013), Pless and van Benthem (2019), and Genakos and Pagliero (2022)—this analysis allows us to test whether the observed price differences before and after the tax shock among cooperative-owned gas stations are consistent with a markup adjustment (which would be expected in a for-profit business), or if the pass-through rate rather reflects efficient pricing, preserving consumer (and overall) welfare.

The pass-through test is not only a parsimonious tool extensively employed to identify the presence of market power (Hong and Li, 2017; Miller et al., 2017; Muehlegger and Sweeney, 2022); its implementation in our specific empirical setting also presents some key attributes that make it particularly well suited to address the question at hand. To begin with, we focus on an industry (the retail fuel market) where exercising market power is frequently considered the norm (Deltas, 2008; Byrne and De Roos, 2019). The potential for market power is particularly apparent in the case of cooperative gas stations in our sample, as many of them are located in isolated areas, catering to small towns with very limited or no competition. This unique positioning enables us to investigate the extent to which they exploit their status as the sole supplier, effectively exercising market power. Additionally, our sample comprises information from over 250 cooperatives—in stark contrast to previous analyses that often use data from a single cooperative or a few—thus enhancing the robustness of our findings. Furthermore, it includes diverse types of cooperatives, encompassing both agricultural cooperatives and a consumer-workers cooperative that owns multiple outlets. These cooperative forms are characterized by their mission to prioritize the well-being of their members (consumers) rather than pursuing profit maximization.¹

Using a difference-in-differences approach, our estimates reveal an average fuel price increase of 0.056-0.059€ per liter among gas stations owned by cooperatives in the five states of Spain affected by the tax change, indicating a pass-through rate of about 100%. This finding remains consistent across different model specifications, sample selections, and other robustness checks for both unleaded gasoline

¹In Spain, a formal association of all agricultural cooperatives engaged in fuel sales (called *Cooperativas Agro-alimentarias*) explicitly declares its commitment to providing an essential service in the areas where the cooperatives operate and maintaining competitive prices to benefit all the residents in the areas served (see Section 2.2 for further details).

and diesel fuels, providing compelling evidence of the absence of a markup adjustment. Even when considering only the subsample of cooperative-owned gas stations in areas with very limited competition, these gas stations still consistently display a 100% pass-through rate. Additionally, descriptive data reveals that cooperatives consistently offer prices roughly 6 cents per liter lower than non-cooperatives throughout the entire sample period, further reinforcing the "absence-of-markup" result—this price difference coincides with the markups among for-profit gas stations estimated by the Spanish competition authority.

Our paper contributes to the literature that empirically investigates cooperatives' market behavior. This body of research is rooted in theoretical foundations summarized by Bonin et al. (1993) and Soboh et al. (2009). Building on this theoretical work, prior scholars tested whether cooperatives' organizational conduct aligns with the diverse objectives outlined in their constitutions and by-laws. Notable examples include studies on dividend and employment maximization within worker cooperatives (Craig and Pencavel, 1993; Pencavel and Craig, 1994) and cost minimization (Clymer et al., 2021). While these studies predominantly focus on internal organizational dynamics, a gap persists in understanding cooperatives' "external" (i.e., market) behavior—a dimension that underpins the policy benefits they receive. Addressing this gap is the main objective of our study.

In this strand, a related study by Duarte et al. *(forthcoming)* examines the market behavior of Coop Italia—the largest Italian cooperative in the grocery sector. Their empirical analysis, based on granular data from this cooperative, reveals no evidence of its behavior deviating from profit-maximizing objectives.² By contrast, using the pass-through test—a widely applied tool in the literature (Loy et al., 2016; Duso and Szücs, 2017; Pless and van Benthem, 2019)—we document a behaviour not consistent with market power exertion among cooperatives. Our context, however, differs in several ways from that of Duarte et al. *(forthcoming)*. They study stores under the common brand and strategic direction of one of the largest players in the grocery sector, where internal agency conflicts are likely to occur, leading to deviations from pro-social behavior. We focus instead primarily on small cooperatives that own one or two gas stations, often operated as a "side business" (not major players in the retail fuel sector), and with clear pro social objectives. In this context, such agency conflicts are potentially less likely to occur.³

²In the same vein, employing aggregated market data from the US dairy market, Cakir and Balagtas (2012) reveals compelling evidence of market power exertion wielded by cooperatives.

³In addition, the grocery sector and the retail fuel sector present notable differences. One significant distinction is that the latter involves homogeneous commodities, namely transportation fuels (diesel and gasoline). This setup allows us to abstract

These differences suggest that, when regulating cooperatives, policymakers should shift from one-sizefits-all approaches and consider tailored policies, evaluating groups of cooperatives in different sectors individually.

Our study also contributes to a broader literature that examines the behavior of not-for-profit and prosocial firms (Philipson and Posner, 2009; Fioretti, 2022; Eggleston, 2024; Ericson, 2024). Within this literature, a significant focus has been put on the healthcare industry. Previous works in this domain, such as Duggan (2002), Silverman and Skinner (2004), Dormont and Milcent (2005), and Capps et al. (2020), have often found minimal disparities in the conduct of not-for-profit hospitals compared to their for-profit counterparts. By contrast, our findings align with the observations of Lynk (1995), highlighting that not-for-profit hospitals frequently offer lower prices than their for-profit counterparts (particularly in highly concentrated market environments), and the results of Dafny (2019), who noted a significant increase in premiums when a not-for-profit health insurer transitioned to for-profit status.

Finally, a related and well-established body of literature has extensively explored the factors that constrain the formation of cooperatives, including issues related to corporate governance, difficulties in securing financing, misaligned incentives among members with diverse skills, and other internal conflicts; see, for example, Hart and Moore (1996), Kremer (1997), Banerjee et al. (2001), and Rey and Tirole (2007). While this literature focuses on the *ex-ante* challenges of cooperative formation, our contribution lies in addressing the *ex-post* question. That is, once a cooperative is established, we aim to provide empirical evidence on whether it actually functions in accordance with its foundational socially driven mission.

The rest of the paper proceeds as follows. Section 2 provides background information on the fuel market in Spain, the role of cooperatives, and the fuel tax reform under consideration. Section 3 briefly discusses theoretical predictions on pass-through under different firm objectives (conduct). In Section 4, we present the data and empirical strategy to identify the causal impact of the tax on cooperative prices. Section 5 presents empirical results and robustness checks. Finally, Section 6 concludes and provides some policy recommendations.

from discrepancies in the quality of goods and services between cooperatives and other business models (Boylan, 2016).

2 Institutional background

2.1 The Spanish transportation fuel market

In Spain, the transportation fuel market presents some characteristics commonly observed in many other countries. To begin with, it features diverse vertical relationships between refiners and gas stations (Hastings, 2004; Houde, 2012; Faber and Janssen, 2019). These relationships can be broadly classified into two categories that give rise to two main types of gas stations: vertically integrated gas stations, which are owned and managed by refiners, and independent ones, owned and operated by retailers (i.e., entrepreneurs). We specifically focus on the latter category because cooperative gas stations in Spain exclusively fall within this group (no cooperative gas stations are vertically integrated with refiners).

Vertically independent gas stations enter into fuel supply contracts with wholesalers (refiners), which are established on a price-per-liter basis using a benchmark wholesale price index (Balaguer and Ripollés, 2012; Cuadrado et al., 2018; CNMC, 2021; Arocena et al., 2023).⁴ Specifically, the relevant benchmark indices for Spain are the Genoa market price index (Mediterranean or MED price) and the Rotterdam price index (North–Western Europe or NWE price), both published by Platt's (a leading provider of energy information).⁵ In addition, gas stations are subject to excise taxes, including both state and national levies, which impose a constant marginal tax rate per liter sold. Together, the cost of fuel supply and excise taxes—both determined on a per-liter basis—constitute the two primary cost components of retail fuel prices. According to estimates by the Spanish competition authority, these components account for approximately 90% of the final price of diesel and gasoline (CNMC, 2021).

The Spanish transportation fuel market exhibits a high level of imperfect competition. Market concentration is particularly pronounced in the wholesale segment, with three companies (Repsol, Cepsa, and BP) owning all nine oil refineries in Spain and holding majority stakes in the national pipeline distribution network (Stolper, 2018). In 1998, the aforementioned three major oil firms controlled approximately 82% of gas stations through vertical restraints. However, the implementation of liberalization policies in the late 1990s opened the retail segment, enabling new independent firms to enter the mar-

⁴Linear wholesale pricing is also used in other countries (Wilson, 2012; Genakos and Pagliero, 2022). As Manuszak (2010) explains, this practice is a key mechanism for wholesalers when dealing with independent gas stations: wholesale prices constitute the main form of payment from retailers to suppliers.

⁵The choice between the MED and NWE price indices depends on a gas station's location. For example, gas stations in central and southeastern Spain typically use MED prices, while those in northwestern Spain generally use NWE prices.

ket. By 2009, the percentage of gas stations they controlled decreased to 70% and further declined to 61% by 2018 (Contín-Pilart et al., 2009; Stolper, 2018). Currently, a significant number of independent gas stations cater to consumers along with these three major oil companies in the retail segment.

2.2 Cooperatives in the Spanish retail fuel market

Among the vertically independent gas stations operating in Spain, a subset are owned by cooperatives.⁶ According to the Spanish law, cooperatives are entities with three singular characteristics. First, ownership is vested in the members, and decision-making follows the "one person, one vote" principle. Second, any profits generated must either be distributed collectively among the members or reinvested in the cooperative. Third, they are required to fulfill a social purpose within a defined geographical area (e.g., providing an essential good or service). Cooperatives are legally categorized into different types, with the majority of the gas stations we consider in our analysis owned by agricultural ones. The fact that *agricultural cooperatives* (as opposed to other types, such as healthcare or educational ones) predominantly own gas stations is due to their members' regular use of refined oil products and is also consistent with the prominent role cooperatives play in Spain's primary sector (CEPES, 2021, 2020).

The presence of gas stations owned by agricultural cooperatives dates back to the 1980s, with the initial aim of providing their members access to petroleum products for agricultural machinery, particularly diesel—which is also the most popular fuel for passenger vehicles in Spain. Following the liberalization of the fuel sector, these cooperatives were allowed to extend their supply to the general public. As of 2020, over 250 gas stations were owned by a diverse range of agricultural cooperatives in Spain, spanning from large entities with billions in revenue and thousands of members (e.g., Grupo AN) to small cooperatives with just a few members and annual revenues under one million euros (e.g., Olivarera de Socuellamos).⁷ According to the Spanish Organization of Agricultural Cooperatives (*Cooperativas Agro-alimentarias*), these gas stations play a crucial role in providing an *essential service* to the communities where they operate, ensuring the availability of fuel for all local residents. Furthermore, this organization emphasizes that cooperatives are committed to maintaining "competitive prices", benefiting not only their cooperative members but also the broader population in these areas.

⁶Gas stations owned and operated by cooperatives are present in many other countries, such as in the UK (Birchall, 2014), the US (Wilson et al., 2011), Brazil (Martins and Lucato, 2018), and South Korea (Ahlin et al., 2021).

⁷Over 62% of these cooperatives are primarily engaged in wholesaling grain, fruit, olive oil, and wine—products that are central to Spain's agricultural sector.

These gas stations owned by agricultural cooperatives display considerable heterogeneity (some feature convenience stores, some offer non-fuel products, some operate 24/7, etc.). However, overall, they do not differ significantly from their for-profit counterparts. In fact, they resemble typical for-profit gas stations, as illustrated in Figure A.1 (Appendix A), which includes snapshots of six agricultural cooperative gas stations.⁸ Additionally, these gas stations are geographically dispersed across Spain (see map below), and their locations show no systematic differences from those of for-profit gas stations, with two exceptions. First, they are absent from toll highways, which are exclusively served by vertically integrated gas stations due to regulatory restrictions (Bajo-Buenestado, 2021). Second, they are not present in Spain's two largest metropolitan areas (Madrid and Barcelona), though they are located near other major urban centers (e.g., Valencia and Zaragoza). Agricultural cooperative gas stations are often found in smaller towns and rural areas, where the prevalence of for-profit stations is proportionally similar.

In addition to the gas stations owned by agricultural cooperatives (which make up the majority of our sample), we also consider those owned by Eroski, a prominent *worker-consumer hybrid cooperative*, whose governance is shared between these two groups (Birchall, 2014; Roche et al., 2023). Eroski is part of the renowned Mondragon Group (Bonin et al., 1993), known for its strong emphasis on *social impact* (particularly on its worker- and consumer-owners) as a primary goal (Morlà-Folch et al., 2021). By leveraging its extensive presence across the country—it owns a widespread retail network, including numerous supermarkets and other businesses (e.g., travel agencies, insurance, etc.)—Eroski has successfully expanded into the transportation fuel market. As a result, it has established its own brand of gas stations, managing over 50 outlets across the country.

In line with the objective of focusing on social impact and a commitment to maintaining competitive prices, Figure 1 illustrates the difference in the evolution of diesel prices (the predominant transportation fuel in Spain) at cooperatives and for-profit gas stations from January 2018 to June 2019. Panel A shows that, on average, diesel prices at cooperative gas stations are consistently 6 euro cents lower than at for-profit ones, based on data from the universe of gas stations. We then restrict the analysis to gas stations with similar demand conditions, operating hours, and personnel, inventory, and storage costs. Specifically, for each cooperative gas station in our sample, we identify a for-profit one *(i)* located in the

⁸In some instances, it is indicated on-site that a gas station is operated by a cooperative. This distinction, however, does not have any particular implications for consumers beyond the fact that the gas station is owned by cooperative members.





(A) Full sample of gas stations

(B) Gas stations with similar demand and costs

Note: The figure displays the average weekly price (in euros per liter) of diesel from the first week of 2018 to the first week of June 2019. The solid dark gray line represents the average price for for-profit gas stations, while the solid light gray line represents the average price for cooperative gas stations. Panel A presents data from the universe of gas stations in Spain. Panel B focuses on a subsample of 328 gas stations—164 cooperative-owned and 164 for-profit—that are located within the same zip code, have comparable personnel costs, maintain similar operating hours, and sell a similar range of fuels. The dataset was obtained from *Geoportal* (Spanish Ministry for the Ecological Transition); see Section 4.1 for further details.

same zip code, (*ii*) with comparable personnel costs,⁹ (*iii*) with the same opening hours (24/7 or otherwise), and (*iv*) selling a similar range of fuels (diesel, nonroad diesel, gasoline, etc.). This process yields a subsample of 328 gas stations (164 cooperative-owned and 164 for-profit), for which the evolution of diesel prices is plotted in Panel B. Once again, we find that cooperative gas stations consistently offer diesel at prices 6 euro cents lower than their for-profit counterparts. A similar difference is observed for gasoline prices (see Figure A.2, Appendix A). This difference observed in the raw data coincides with the estimated gas station markup suggested by the Spanish competition authority (CNMC, 2021) and provides descriptive evidence supporting the absence of any pricing markup among cooperatives.

2.3 The 2019 gas tax reform

Petroleum-derived transportation fuels are heavily taxed in Spain, as is the case in many other countries in the European Union (EU). According to the Gasoline Bulletin EU, about half of the retail price of unleaded gasoline and diesel (the most commonly used fuels) consists of taxes. These taxes are imposed at two different administrative levels. First, the Spanish central government collects the national excise fuel tax, which is currently 0.4246€ per liter for unleaded gasoline and 0.331€ per liter for diesel.

⁹All cooperative gas stations are classified as "self-service, with staff present". Accordingly, we restrict our subsample to for-profit ones within the same category. Note, however, that this information has been available from *Geoportal* since July 2020, while our data extends until June 2019. Thus, we assume that gas stations did not change their type during this period.

The central government also imposes a value-added tax (VAT) of 21%, which is applied to both the excise duties and the retail price of fuels. Second, each of the 17 regional states (in Spanish, *Comunidades Autónomas*) is allowed to implement an excise fuel tax. Until 2018, states could choose a rate anywhere between 0 and 4.8 cents per liter. However, these state tax rates were also subject to the VAT, resulting in a maximum tax-inclusive rate of 5.808 cents per liter. States typically imposed either no tax or the full rate permitted,¹⁰ which resulted in significant heterogeneity in the (tax-inclusive) fuel prices across Spain.

This heterogeneity in fuel taxes was unexpectedly brought to an end due to a fiscal reform implemented by the newly formed national government in January 2019. Prior to this reform, the central government had been controlled by the right-wing party, led by then-prime minister Mr. Rajoy. However, in June 2018, Mr. Rajoy's government was removed as a result of a successful *vote of no confidence* against him, which was filed by the leader of the left-wing party, Mr. Sanchez. This vote of no confidence was based on the court ruling that Mr. Rajoy's party was allegedly involved in a system of institutional corruption that manipulated public tenders. Despite lacking a majority in the congress, Mr. Sanchez negotiated and obtained the support of 180 deputies from a wide spectrum of parties—a national far-left party, two right-conservative pro-independence parties, two far-left pro-independence parties, and two center-left regionalist parties. By contrast, only 169 deputies voted for the incumbent candidate. As per the Spanish Constitution, Mr. Rajoy resigned and Mr. Sanchez was appointed prime minister.

In July 2018, the newly formed left-wing government approved the Spanish national budget, which included a reform of fuel duties with the aim of harmonizing the state rate.¹¹ In particular, this reform mandated the implementation of a unified excise duty rate for regular diesel and unleaded gasoline across all states, set at the maximum permissible level of 5.808 cents per liter, effective from January 1, 2019. As a result, all states that previously had a 0 rate experienced an abrupt increase of 5-6% in the prices of these fuels. Specifically, this was the case in the five states labeled as "treated" and shown in darker orange on the map in Figure 2. By contrast, the tax rate remained unchanged in the other six

¹⁰There are four exceptions to this general pattern, namely, the states of Aragón, Asturias, Extremadura, and Madrid, which applied either an intermediate tax rate or different rates for different fuels. Additional details are provided below.

¹¹Although the reform was passed by the unexpectedly newly formed left-wing government, the previous government had already contemplated a similar reform in its preliminary bill of the Spanish national budget released in April 2018. Despite receiving relatively little attention (this possibility was mentioned only in the preamble of the bill), we include in Appendix B.1 our main set of results, controlling also for a potential anticipation effect from the last week of April until June 2018, as a robustness check.

Figure 2. Cooperative gas stations (and states) used in the empirical analysis



Note: The figure displays a map of mainland Spanish states. The darker orange shading indicates the states where the fuel tax increased by 5.808 cents per liter in January 2019 (treated group). The lighter orange shading represents the states where the fuel tax remained unchanged (control group). In the state of Asturias (marked by grid lines), the fuel tax remained unchanged only for unleaded gasoline and is thus included in the control group solely for the analysis of the prices of this fuel. Each white dot represents a cooperative-owned gas station located in both subsets of states. The states not included in our empirical analysis, which experienced only a partial change in the fuel tax, are represented in white. The analysis also excludes the overseas states (not shown in the map), which have distinct tax regimes.

states, referred to as the "control" states, which are shaded in lighter orange on the same map. In the state of Asturias (indicated by grid lines), the tax rate remained steady exclusively for unleaded gasoline, with a minor uptick in diesel duties. Consequently, we employ this state as a control exclusively for analyzing gasoline prices. All cooperative-owned gas stations in our sample across these states are marked by white dots. Finally, three other states—indicated in white on the map—experienced only marginal tax rate changes and, thus, are not included in the baseline empirical analysis, with a similar exclusion applied to Asturias in the context of diesel prices.¹² We also exclude the overseas states, which have distinct tax regimes.

3 Theoretical framework

Firm pricing behavior and the extent to which various shocks (such as an abrupt change in a tax) are transmitted into final prices in the presence of market power have been extensively studied and are well understood (Bulow and Pfleiderer, 1983; Seade, 1985; Weyl and Fabinger, 2013). In this section, we

¹²The analysis of the impact on fuel prices for these states is relegated to Appendix B.4.

provide a concise overview of these findings, with particular emphasis on how the outcomes vary under different assumptions of firm conduct—reflecting different firm objectives (Agbo et al., 2015).

3.1 Monopoly tax pass-through pass under different objectives

First, we present a simple monopoly model that lays the groundwork for the oligopoly analysis that follows. Consistent with our empirical setting, we assume the monopolist faces a constant marginal cost, and is levied a tax per unit sold. In the classic scenario where the monopolist exercises market power, the optimal price is determined by the intersection of the firm's marginal revenue (MR) and marginal cost (MC), resulting in a positive markup.¹³ Hence, an increase in the per-unit tax levied on the firm (denoted by τ) raises its costs and, in turn, its price. However, due to the presence of the markup, the tax is not fully passed on to the final consumers. Instead, the firm absorbs a portion of the tax through its markup, resulting in a pass-through rate of less than 100%. This prediction is illustrated in Figure 3, Panel A, which shows that the increase in the price (ΔP) is lower than the tax increase (τ). This theoretical insight has been tested in various sectors among for-profit firms with market power; see, for example, Duso and Szücs (2017); Miravete et al. (2018); Ganapati et al. (2020); Wang et al. (2022).

Next, we consider the scenario where the firm aims to maximize the combined benefits for consumers and the producer. This objective arises, for example, if the firm frequently supplies to its members (e.g., agricultural cooperatives) and also when it seeks to maximize consumer welfare (e.g., consumer cooperatives)—see Bonin et al. (1993) and Royer (2014). Under this objective, the firm optimally sets prices at marginal cost, eliminating the price markup and resulting in a lower final price relative to its profit-maximizing counterpart. Moreover, since an increase in the per-unit tax directly raises the firm's marginal costs, the tax increase is fully passed on to the consumers. This outcome is depicted in Figure 3, Panel B, which illustrates that the price increase (ΔP) is proportional to the tax increase.

An alternative scenario also frequently considered in the cooperatives literature is that where the firm's objective is to maximize total output (Coelli and Rao, 2005; Martínez-Victoria et al., 2017; Royer, 2014). Under this objective, the optimal solution occurs when the price is set equal to the average total cost. Given the constant nature of the marginal cost, this alternative case yields the same solution as the one included in Figure 3, Panel B. As a consequence, an increase in the per-unit tax uniformly raises the

¹³This applies similarly to the upstream supplier, which also sets the price above marginal cost, leading to an additional markup and giving rise to the *double marginalization* problem (Spengler, 1950; Williamson, 1971).

Figure 3. Monopolist pricing behaviour and tax pass-through under different objectives



Note: The figure illustrates the optimal solution achieved by a monopolist under different objectives and the effect of a tax increase (τ) on the price for each of the objectives considered, given the demand (D), the corresponding marginal revenue (MR), and the marginal cost (MC). Panel A depicts the price and quantity pair chosen by a profit-maximizing firm (given by the intersection of MR-MC) and demonstrates that the tax is not fully passed through to the price due to the existence of a markup. Panel B shows the price and quantity pair chosen by a surplus- or output-maximizing firm (given by the intersection of D-MC). In this case, the absence of a markup results in the full pass-through of the tax increase to the price.

firm's cost, leading once again to a full pass-through of the tax increase into the final price.

3.2 Tax pass-through in a differentiated products oligopoly

The previous section provides a simplified yet illustrative analysis of how a tax increase affects a monopolist's pricing behavior under different objectives. However, retail fuel markets are frequently characterized as markets for spatially differentiated products (Houde, 2012). Therefore, we now present an overview of classic theoretical results within this alternative market structure, which we use to offer insights into the relationship between different firm conduct assumptions (reflecting different firms' objectives) and tax pass-through.

We consider a model with *n* firms, indexed by $i \in \{1, ..., n\}$, each selling a quantity q_i that is negatively related to its own price (p_i) and positively related to the prices of other firms. As before, we assume that firms face a (positive) constant marginal cost c_i and are subject to a per-unit tax τ . For simplicity, and consistent with previous literature (Miller et al., 2017), we focus on the symmetric case, where the subscript *i* is dropped from the parameters. As shown by Weyl and Fabinger (2013), at equi-

librium, firms' prices are given by the following expression:

$$\frac{p-c-\tau}{p}\varepsilon_D = \theta, \tag{3.1}$$

where $\varepsilon_D = -\frac{p}{p'q}$ is the price elasticity of demand, and θ is the *conduct parameter*, which captures the degree of market power exerted by firms. Thus, at equilibrium, this parameter equals the elasticity-adjusted Lerner index. If $\theta = 0$, firms price at marginal cost, indicating no exertion of market power. Conversely, when $\theta = 1$, the outcome aligns with that of a profit-maximizing monopolist. In this framework, *ceteris paribus*, a firm that does not exercise market power ($\theta = 0$) sets a price strictly lower than a firm that exerts some degree of market power ($\theta > 0$), provided that ε_D is finite.

Weyl and Fabinger (2013) show that in this model, the pass-through of the tax to the equilibrium price (denoted by ρ) is given by the following expression:

$$\rho = \frac{1}{1 + \theta \varepsilon_{\theta} + \frac{\theta}{\varepsilon_{ms}}},\tag{3.2}$$

where ε_{θ} measures how the conduct parameter changes with the quantity served, defined as $\varepsilon_{\theta} = \frac{d\theta}{dq} \frac{q}{\theta}$, while $\varepsilon_{ms} = \frac{ms}{ms'q}$ is the elasticity of the inverse marginal surplus (ms = -p'q), which measures the curvature of demand. Specifically, when demand is logarithmically concave (log-concave), $\frac{1}{\varepsilon_{ms}} > 0$, and when demand is log-convex, $\frac{1}{\varepsilon_{ms}} < 0$. Consequently, the curvature of demand plays a crucial role in deriving implications about firm conduct based on the tax pass-through (Miravete et al., 2023a,b).

In line with previous literature, we consider the case where θ is invariant to changes in q, implying that $\varepsilon_{\theta} = 0$. Under this assumption, the tax pass-through depends solely on the ratio $\frac{\theta}{\varepsilon_{ms}}$. Full tax pass-through of a tax change ($\rho = 1$) can occur either when $\theta = 0$ (indicating no exertion of market power) or when $\frac{1}{\varepsilon_{ms}} \rightarrow 0$, a condition satisfied by exponential demand functions (Bulow and Pfleiderer, 1983)—a functional form unlikely to hold over the price range relevant to our empirical context. Therefore, for a wide range of demand functions commonly used in the literature (including linear and constant-elasticity demand), full pass-through is achievable only in the absence of market power exertion, where firms set prices equal to marginal cost.¹⁴ Conversely, any pass-through parameter that deviates from

¹⁴Pless and van Benthem (2019) argue that the second-order and stability conditions for a firm's profit maximization problem also require ε_{ms} to be bounded. These conditions further rule out the possibility of $\frac{1}{\varepsilon_{ms}} \rightarrow 0$, thereby reinforcing the conclusion that $\theta = 0$ is the only scenario under which $\rho = 1$ can occur, given the above assumptions.

unity is indicative of market power exertion ($\theta > 0$).

4 Data and empirical strategy

This section presents the data first and then the empirical strategy that we use to identify the causal impact of the 2019 fiscal reform on cooperative gas station pricing conduct.

4.1 Data

To examine the impact of the gas tax change on fuel prices at cooperative gas stations in the states affected by the fiscal reform, we rely on data from *Geoportal*, a website managed by the Spanish Ministry for the Ecological Transition. This website provides daily spreadsheets containing retail prices of diesel, unleaded gasoline, and other fuels, as well as related information (such as the geo-localization, zip code, town, brand, and opening hours) for all gas stations in Spain. Our dataset has approximately 10,300 gas stations, with around 3% being cooperatives. To identify them, we employ two criteria. Namely, we search for keywords such as "coop" (and its variations) in their names or brands, and we also look for recognizable cooperative brands (e.g., Eroski and Grupo AN). Gas stations in states that experienced a tax change in January 2019 are classified as "treated", while the "control" ones are those in states where the fuel tax remained unchanged. Our dataset covers daily data for all these gas stations from January 2018 to June 2019 (i.e., six months before the tax announcement and six months after the tax change), which we aggregate at the weekly level.

We complement the gas station-level data with additional information on the retailers' wholesale cost of fuel. Specifically, we use daily data on the Europe Brent Spot Price (FOB), which serves as a reference price for petroleum products in Spain. This information, obtained from the US Energy Information Administration (EIA), is given in dollars per barrel and converted to euros per barrel using the euro/dollar exchange rate provided by the Federal Reserve Bank of St. Louis.¹⁵

Table 1 (Panel A) provides summary statistics for the retail prices of diesel and unleaded gasoline, which are used in our main empirical analysis. We provide the mean of the prices for both treated and control gas stations before and after the tax reform. Column (7) displays the price differences between

¹⁵The Brent crude oil prices closely track the behavior of MED and NWE prices, which, as mentioned earlier, serve as the benchmark wholesale price indices in Spain (Balaguer and Ripollés, 2016; Bajo-Buenestado, 2021). As such, the Brent crude oil prices effectively capture fluctuations in refinery input costs (Deltas and Polemis, 2020).

Table 1. Summary statistics for different fuel prices, gas stations, and brands

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Before	e (Jan ´18-E	9ic´18)	After (Jan ´19-Jun ´19)				
	Control	Treated	Obs.	Control	Treated	Obs.	Diff	p-v
Panel A. Prices								
Diesel (€/l)	1.16	1.13	12,897	1.16	1.18	5,328	0.0595	0.000
Gasoline (unleaded) (€/l)	1.26	1.21	9,533	1.22	1.24	4,011	0.0647	0.000
Diesel (nonroad) (€/l)	0.798	0.788	9,393	0.801	0.796	3,877	0.0047	0.037
	Before (Jan ´18-Dic ´18)			After (Jan´19-Jun´19)				
	Control	Treated	Obs.	Control	Treated	Obs.	Diff	p-v
Panel B. Gas Stations								
Open 24/7 (%)	54.20	77.60	276	55.00	78.30	270	-0.100	0.908
Types of fuels sold (#)	2.63	2.21	276	2.65	2.22	270	-0.006	0.867
Competitors in 2 km radius (#)	2.58	1.82	276	2.60	1.79	270	-0.044	0.926
Number of gas stations (#)	174	102		168	102			
	(Gas statior	<u>ו</u>	Diesel Ga			oline	
Panel C. Brands	All	Control	Treated	Mean	Obs.	Mean	Obs.	
Eroski	50	24	26	1.15	3,282	1.23	3,430	
Grupo AN	39	0	39	1.15	2,836	1.22	2,132	
Coops with ≥ 2 gas stations	34	26	8	1.16	2,133	1.25	1,515	
Coops with 1 gas station	157	126	31	1.16	9,974	1.25	6,470	
All	280	176	104	1.16	18,225	1.24	13,544	

Note: Panel A presents summary statistics of the average weekly retail fuel prices during both the pre-reform period (January-December 2018) and the postreform period (January-June 2019). In Column (7), we present a "raw" difference-in-differences of means, calculated as [(After - Before) - (Treated - Control)] based on Columns (5), (4), (2), and (1), respectively. Additionally, Column (8) reports the *p*-value derived from a two-sided test under the null hypothesis of no difference in means. Panel B displays summary statistics of some key characteristics of the gas stations included in our sample. Panel C shows the average weekly retail diesel and gasoline prices spanning the entire duration covered by our sample, but grouped by brand/size. In the post-period, ten gas stations shut down (they no longer report prices), and four gas stations opened and started to report prices.

the two subsets of gas stations after the tax reform, with column (8) reporting the *p*-value for testing the null hypothesis of zero difference, which we reject for both fuels. We also include summary statistics for nonroad diesel—a fuel that contains additives that are specific to use in tractors and agricultural engines—which was unaffected by the tax reform and which, hence, we use for a placebo-based falsification test. In this case, we fail to reject the null hypothesis at the 1% confidence level. Then, Panel B of the same table presents summary statistics for key characteristics of the gas stations, such as opening hours, number of fuels sold, and number of competitors within a 2-kilometer radius. Finally, Panel C provides information on the distribution of gas stations across brands, where Eroski and Grupo AN account for approximately one-third of the ownership, while the remaining brands represent relatively small cooperatives.

4.2 **Regression model**

The ideal setting to estimate the causal effect of a tax increase on the pricing of cooperatives would involve a randomized change of the tax for a group of them (the "treatment" group) while keeping it constant for another group (the "control" group). In this ideal setting, spillovers should not affect cooperatives across these two groups. While our study does not rely on a randomized experiment, we exploit instead the exogenous variation in fuel taxes across states resulting from the fiscal harmonization implemented in January 2019. Since none of the cooperative gas stations in our sample affected by the tax reform are located near an unaffected state, and vice versa (see Figure 2), the possibility of spillover effects is minimal.¹⁶ Thus, we use this setup to estimate the causal impact by comparing the fuel prices of cooperative gas stations in treated and control states.

More precisely, our main regression model to estimate the pass-through of the tax change into retail prices is as follows:

$$Price_{ist}^{J} = \alpha_{0} + \alpha_{1} Tax_{s} + \alpha_{2} Post_{t} + \alpha_{3} Tax_{s} \times Post_{t} + X_{is}' + \mu_{s} \times Brent_{t} + \delta_{t} + \lambda_{i} + \varepsilon_{ist}$$
(4.1)

where the price of fuel f, such that $f \in \{\text{diesel}, \text{gasoline}\},^{17}$ at gas station i, in state s, in week t, is regressed on the following variables. First, we include the dummy variable Tax_s , which takes the value of 1 for states where the tax increased by 5.808 cents per liter (treated states) and 0 otherwise (control states). Next, we include the dummy variable $Post_t$, which is equal to 1 for all weeks from January 2019 onward (and 0 otherwise). Additionally, we include the interaction term between Tax_s and $Post_t$. This model specification allows us to estimate the basic difference-in-differences (DiD) estimator. We then successively modify and augment this standard specification as follows. First, we replace $Post_t$ with week-year fixed effects (δ_t), which account for time-varying factors that commonly affect all gas stations (e.g., fluctuations in wholesale fuel prices). Second, we introduce a vector of time-invariant variables (\mathbf{X}'_{is}) to control for certain gas station characteristics that may influence their retail prices. This vector includes a binary variable indicating whether the gas station is open 24/7, the number of different

¹⁶Note, though, that some gas stations in the state of Navarra (treated) border the state of Aragón (dropped). However, as explained above, Aragón underwent only a minor fuel tax increase, reducing the likelihood of substantial spillover effects. Our results stand even when excluding these gas stations (results are available upon request).

¹⁷The inability of diesel drivers to purchase gasoline, and vice versa, for their vehicles, eliminates any potential short-term substitution effect between the two fuels. Thus, the unrelated nature of the demand for diesel and gasoline fuels prevents the potential occurrence of cross-tax pass-through between these products (Besanko et al., 2005; Armstrong and Vickers, 2018).

fuels it sells, the number of competing gas stations within a 2-kilometer radius, and dummy variables representing the brand of the gas station.

Next, we estimate equation (4.1) by including gas station fixed effects (λ_i), which capture any timeinvariant gas station characteristics that may affect prices. For this specification, which allows us to estimate the two-way fixed effects (*TWFE*) estimator, both *Taxs* and *X'*_{is} are omitted. Finally, we further augment this specification by incorporating the interaction between the Brent crude oil price and state dummies, which controls for the potential asymmetric impact of changes in wholesale prices on gas station prices in different states (due to, for example, proximity to refineries). It is important to remark that we include in all specifications of equation (4.1) that do not include week fixed effects a dummy representing the period after the announcement but before the tax change (July-December 2019), and we also include in all specifications the interaction term between this "announcement-period" dummy and *Taxs* to account for the potential anticipation effect that the fiscal reform announcement had on cooperatives' fuel prices (Coglianese et al., 2017). Moreover, in all model specifications, we cluster ε_{ist} at the zip code level.¹⁸

In equation (4.1), the parameter of interest is α_3 , which captures the causal effect of the fuel tax increase on the prices of cooperative gas stations located in treated states. This parameter represents the pass-through of the tax into retail fuel prices. The key identifying assumption is that, in the absence of the policy reform, cooperative gas stations in both subsets of states would have exhibited similar price trends over time, which ensures that the estimated price change captured by α_3 can be attributed solely to the policy reform. To provide support for this assumption, below we conduct a standard pre-treatment parallel trend test, which rules out potential concerns that the estimated price changes may be attributed to factors other than the reform. Moreover, the identification of the causal impact hinges on the nonexistence of spillover effects between gas stations in treated and control states (as previously discussed, this is improbable) and the absence of correlation between the characteristics of treated states and the characteristics of the gas stations located there. The latter assumption is also reasonable, considering the balance in key characteristics observed across gas stations in both treated and control states, as detailed in Table 1 (Panel B). In the subsequent section, we present and discuss specific robustness checks that lend further support to the plausibility of these assumptions.

¹⁸Clustering the standard errors at the zip code level yields similar results to clustering at the gas station level, as the majority of gas stations in our sample are located in different zip code areas. Our results prove robust to alternative clustering strategies.

5 Empirical results

5.1 Main results

We start by presenting the estimation results from equation (4.1) in Table 2 to analyze the causal effect of the 2019 tax increase on fuel prices at cooperative gas stations. Panel A shows the coefficients obtained from the analysis of diesel prices, while Panel B displays the estimates for unleaded gasoline prices. In both panels, we report the *p*-value of a test that examines the complete pass-through of the tax increase under the null hypothesis (H₀) that the estimated coefficient α_3 equals 0.058.

First, column (1) displays the point estimates obtained using the simple DiD specification, which does not incorporate any additional controls other than the announcement period dummy and its interaction with Tax_s . Panel A reveals that the coefficient of interest is equal to 0.057, indicating a near-complete pass-through of the tax increase. In column (2), we extend the model specification by introducing additional controls at the gas station level, namely, a binary variable indicating whether it operates 24/7, the number of fuels sold, the number of competitors within a 2-kilometer radius, and week-year dummies. Moreover, to account for a potential bias stemming from unobservable heterogeneity across brands, we further introduce brand dummies in column (3). In both columns (2) and (3), the coefficient of interest remains largely unchanged. Finally, in column (4), we report the results obtained from the *TWFE*, which include both week and gas station fixed effects, while column (5) additionally introduces the interaction between Brent crude oil prices and state dummies to capture potential heterogeneous effects. Again, the coefficients in these columns (0.056-0.057) closely mirror those in the preceding ones, further supporting the conclusion that cooperatives fully passed through the tax increase.

The same model specifications discussed above are also included in Panel B, which displays the estimated coefficient of interest using data on gasoline prices. The coefficients obtained across all the columns in this panel closely resemble those reported in Panel A—ranging between 0.059 and 0.061. In fact, in both panels and across all model specifications, the test under the null hypothesis of complete pass-through fails to be rejected at a 10% significance level. In other words, our analysis does not provide evidence to reject the hypothesis that the tax increase was fully passed on to retail fuel prices among cooperative gas stations, irrespective of the model specification employed. These results, which align with the preliminary evidence presented in columns (7) and (8) of Table 1 (Panel A), further confirm the

Table 2. The effect of tax reform on diesel and gasoline prices among cooperatives

	(1)	(2)	(3)	(4)	(5)
Panel A Outcome pariable D	iosol prico (C /	() ()			
Funei A. Outcome ourmole. D	lesei price (E/i	-			
Tax imes Post	0.0565***	0.0559***	0.0560***	0.0571***	0.0564***
	(0.00207)	(0.00210)	(0.00179)	(0.00177)	(0.00176)
	· · · ·	· · · ·	· /	· · ·	· · · ·
Treated	-0.0280***	-0.0240***	-0.0245***		
	(0.00407)	(0.00417)	(0.00578)		
Deel	0.0250***				
Post	(0.0350^{****})				
?	(0.00133)	0.650	0.010	0.001	0.004
	0.322	0.653	0.910	0.901	0.904
P-Value $H_0=0.058$	0.471	0.315	0.264	0.609	0.377
N. Observations	18,225	18,225	18,225	18,225	18,225
N. Gas Stations	259	259	259	259	259
Panel B. Outcome variable: Ga	isoline price (€	₹/l)			
Tar imes Post	0.0611***	0.0603***	0 0598***	0.0603***	0 0590***
$10x \times 105t$	(0.0011)	(0.0003)	(0.00245)	(0.0005)	(0.0000)
	(0.00270)	(0.00201)	(0.00243)	(0.00200)	(0.00230)
Treated	-0.0424***	-0.0382***	-0.0300***		
	(0.00429)	(0.00483)	(0.00532)		
	(0100)	(01001000)	(0100000)		
Post	-0.00486***				
	(0.00177)				
Week FE		\checkmark	\checkmark	\checkmark	\checkmark
Gas Station Characteristics		\checkmark	\checkmark		
Brand Dummias			/		
Brand Dunnines			v		
Gas Station FE				\checkmark	\checkmark
State×Brent					✓
R ²	0.199	0.693	0.900	0.884	0.890
P-Value $H_0=0.058$	0.270	0.378	0.462	0.349	0.695
N. Observations	13,544	13,544	13,544	13,544	13,544

Note: The outcomes are diesel prices (Panel A) and unleaded gasoline prices (Panel B), in euro per liter. Column (1): simple *DiD* estimator, controlling for the announcement period (June-December 2018) and its interaction with *Treated*. Column (2): same as the previous column but with *Post* replaced by week-month fixed effects and the addition of control variables at the gas station level—a dummy variable indicating whether the station is open 24/7, the number of fuels sold, and the number of gas stations within a 2-kilometer radius. Column (3): same as the previous column but also including brand dummies. Column (4): *TWFE* estimator, including gas station and week-month fixed effects, with no other controls. Column (5): same as the previous column but also including State dummies interacted with the Brent crude oil price. All the point estimates are obtained through OLS, and standard errors clustered at the zip code level (in parentheses). The significance levels are indicated as follows: * p < 0.01, ** p < 0.05, *** p < 0.01.

N. Gas Stations

absence of a markup adjustment in these firms' pricing behavior.

These empirical findings highlight the existence of heterogeneity in pricing and markup adjustment behavior among different types of firms, specifically between cooperatives (whose behavior in our context is consistent with the absence of market power exertion) and for-profit firms. In fact, in the same context as our study, Bajo-Buenestado and Borrella-Mas (2022) document a pass-through rate of only 72% among (non-vertically integrated) for-profit gas stations, indicating a partial transmission of the tax increase to fuel prices. This result is rather consistent with the exploitation of market power.

5.2 Validity

The findings presented in the previous section provide compelling evidence that the fiscal harmonization policy resulted in a complete pass-through of the tax increase into retail fuel prices at the affected cooperative gas stations, implying the absence of markup adjustment. The unexpected passage of this reform in June 2018, in the aftermath of a successful vote of no confidence, provides a clear and compelling setting for identifying its causal impact. However, to further strengthen these results' validity, this section presents alternative tests that provide additional confidence in the causal relationship between the tax change and the observed pricing behavior at cooperative gas stations.

To begin with, a critical assumption for identifying the coefficient of interest (α_3) in equation (4.1) is that the pricing behavior of cooperative gas stations in both treated and control states would exhibit a similar time trend in the absence of the fiscal reform—i.e., the tax change should be orthogonal to ε_{ist} —thus ensuring that the observed changes in prices can be attributed solely to the policy reform. A visual inspection of the temporal evolution of the average price of diesel and unleaded gasoline at both subgroups of cooperative gas stations (see Figure A.3 in Appendix A) provides initial evidence supporting the plausibility of this parallel trend assumption. However, we go beyond a visual inspection and perform additional empirical tests to robustly confirm this assumption.

First, we formally examine the presence of differential trends in the pricing behavior of both treated and control cooperative gas stations prior to the tax reform's implementation. To do so, we extend our main regression model, given by equation (4.1), by introducing the interaction between the treatment dummy (i.e., Tax_s) and several dummies that take the value of 1 for the different weeks before and after the implementation of the tax change. In particular, we estimate the following regression model:

$$Price_{ist}^{f} = \beta_{0} + \sum_{j=-r}^{r} \beta_{1,j} Tax_{s} \times Week_{t+j} + \mu_{s} \times Brent_{t} + \delta_{t} + \lambda_{i} + \varepsilon_{ist}$$
(5.1)

where $Week_t$ is a dummy equal to 1 for the first week after the implementation of the tax reform—while $Week_{t+j}$ is the j-th week before or after that one—and the rest of the variables are as defined above. This equation, which is an augmented version of the most complete specification of the model presented in equation (4.1), allows us to assess whether there are differential trends in pricing between the two groups. If the fuel price trends in the treatment and control cooperative gas stations are the same prior to the reform, then $\beta_{1,j}$ should be close to zero for all $j \in [-r, 0)$. This would provide evidence against the estimated effect stemming from a previously existing trend, instead of the 2019 tax harmonization. On the contrary, $\beta_{1,j}$ should be positive and significant for all $j \in [0, r]$, that is, right after the tax reform. Figure 4. Impact on cooperative diesel and gasoline prices before the announcement and after the implementation of the tax

reform



Note: The figure shows the estimated impact of the January 2019 tax harmonization reform on the prices of diesel (Panel A) and unleaded gasoline (Panel B) for cooperative gas stations before its announcement and after its implementation. The estimates are obtained using the most complete specification of equation (5.1)—used in column (5) in Table 2—, augmented with week-by-week leads and lags dummy variables interacted with *Tax_s*. Vertical bands represent a 90% confidence interval. Point estimates are displayed for up to 8 weeks before the announcement of the tax reform, for the week of its announcement (indicated with A), and for up to 8 weeks after its implementation.

Figure 4 shows the estimated impact on diesel prices (Panel A) and unleaded gasoline prices (Panel B) on a week-by-week basis. The analysis covers up to eight weeks prior to the announcement of the tax reform in June 2018, the week of its announcement (indicated as A on the horizontal axis), and the

eight subsequent weeks following its implementation in January 2019.¹⁹ The coefficients for the lead weeks are close to zero, and most of them are statistically insignificant for both fuels, indicating that the price changes were not attributable to preexisting trends among the treated cooperative gas stations. By contrast, all coefficients after the implementation of the tax change are statistically significant, which are, on average, at around 0.05-0.06.²⁰ These findings provide further evidence that the tax increase had a positive impact on retail fuel prices only after January 2019.

Second, to further strengthen the validity of the empirical results discussed above, we present additional evidence that the price increase observed among cooperatives after the fiscal reform is specific to the fuels affected by the tax change, namely, unleaded gasoline and diesel. To do so, we examine whether there is a corresponding price increase in other energy products sold by the same cooperatives in our sample that were not impacted by the tax reform in January 2019. Specifically, we estimate equation (4.1) using the prices of non-road diesel (referred to as "Diesel B" in Spain), which is exclusively used in machinery, tractors, and similar agricultural devices. The rationale behind this analysis is that there should be no significant differences in non-road diesel prices among cooperative gas stations, as this fuel was not subject to the 2019 tax reform. Consequently, if the estimated coefficient α_3 is close to zero and statistically insignificant, it would alleviate concerns about potential time-varying unobservable factors influencing fuel prices across gas stations in the states affected by the fiscal harmonization.

The results of this additional empirical exercise are presented in Table 3. Across all model specifications, the estimated coefficient of interest is consistently close to zero and not statistically significant. These findings provide additional support for our main empirical results, indicating that the observed price increases among cooperatives can be solely attributed to the fiscal harmonization reform rather than being influenced by other time-varying unobserved factors.

5.3 Robustness checks

In this section, we conduct a battery of robustness checks using alternative specifications and sample restrictions to reinforce the main findings presented in Table 2.

¹⁹In Appendix A, we provide figures that display the complete set of point estimates, encompassing also each week from the announcement of the reform to its actual implementation (see Figure A.4).

²⁰Note that in the initial weeks following the implementation of the fiscal reform, the coefficients are below 0.05, indicating an under-shift of the tax. This phenomenon can be attributed to a lagged price adjustment caused by inventory holding by refiners and/or gas stations (Borenstein and Shepard, 2002; Levin et al., 2017). However, it is noteworthy that after the fifth week (Panel A) or sixth week (Panel B), a complete pass-through of the tax increase is observed.

	(1)	(2)	(2)	(4)	(5)
	(1)	(2)	(3)	(4)	(5)
Tax imes Post	0.00291	0.00276	0.00122	0.00175	0.000619
	(0.00331)	(0.00342)	(0.00301)	(0.00297)	(0.00309)
Treated	-0.00820	0.00303	0 0286***		
1101101	0.00020	0.00505	0.0200		
	(0.00607)	(0.00617)	(0.00612)		
Post	0.0487***				
	(0.00232)				
Week FF	· /	(((
WeekTE		v	v	v	v
Gas Station Characteristics		.(.(
Gas Station Characteristics		v	v		
Brand Dummies			\checkmark		
Gas Station FE				\checkmark	\checkmark
State×Brent					✓
R ²	0.258	0.466	0.891	0.827	0.835
N. Observations	13,270	13,270	13,270	13,270	13,270
N. Gas Stations	189	189	189	189	189

Table 3. The effect of tax reform on nonroad diesel prices among cooperatives

Note: The outcome is nonroad diesel price in euros per liter. Column (1): simple *DiD* estimator, controlling for the announcement period (June-December 2018) and its interaction with *Treated*. Column (2): same as the previous column but with *Post* replaced by week-month fixed effects and the addition of control variables at the gas station level—a dummy variable indicating whether the station is open 24/7, the number of fuels sold, and the number of gas stations within a 2-kilometer radius. Column (3): same as the previous column but also including brand dummies. Column (4): *TWFE* estimator, including gas station and week-month fixed effects, with no other controls. Column (5): same as the previous column but also including State dummies interacted with the Brent crude oil price. All the point estimates are obtained through OLS, and standard errors clustered at the zip code level (in parentheses). The significance levels are as follows: * p < 0.10, ** p < 0.05, *** p < 0.01.

5.3.1 Market competition

One potential concern is that the observed results may not solely be attributed to the absence of profit-seeking behavior but rather to intense market competition. In a highly (perfectly) competitive market, firms act as price takers, setting prices equal to marginal costs, which leads to a complete pass-through of the tax to consumers. Consequently, full tax pass-through can be expected not only from firms seeking to maximize total surplus but also from for-profit firms operating in a perfectly competitive environment (Alm et al., 2009; Ganapati et al., 2020). While transportation retail fuel markets are generally acknowledged as imperfectly competitive (Havranek et al., 2012; Houde, 2012), and despite the widespread recognition that fuel retailers often exercise market power and deviate from efficient pricing (Deltas, 2008), it remains plausible that market competition plays a role in our findings: the presence of rival gas stations may influence cooperatives to set their prices closer to their marginal costs.

We address this concern by re-estimating equation (4.1) using a subset of cooperative gas stations located in areas where there is no nearby competition in their local markets. Specifically, we focus our analysis on gas stations that have no rivals within a 2-kilometer radius. Since assuming that these "isolated" gas stations operate in a perfectly competitive environment may seem even more implausible, this test allows us to assess the extent to which our results are driven by the absence of for-profit behavior rather than competitive market conditions. We present the estimates of this robustness check using diesel prices (Panel A) and unleaded gasoline prices (Panel B) in Table 4, following the same structure as in Table 2. Across all the model specifications and for both fuels, the coefficient of interest consistently remains positive and equal to 0.054-0.055. Moreover, in all the cases considered, the estimates are not statistically indistinguishable from full pass-through—in fact, we fail to reject the null hypothesis of full pass-through of the tax increase at the less stringent (10%) level of significance. These findings suggest once again that even cooperative gas stations that face no nearby competition exhibit a similar pattern of pass-through, providing further support for the absence of markup adjustment in their pricing behavior.

Still, one might raise concerns about the arbitrariness of the 2-kilometer threshold used in the analysis above. In fact, previous studies employ alternative thresholds to define local markets in the context of transportation fuel retailers, as exemplified by Carranza et al. (2015) and Luco (2019). To address this potential concern, we extend the analysis by estimating our most complete model specification including gas station fixed effects, week fixed effects, and interactions between state-specific dummies and the Brent crude oil price—using cooperative gas stations that face no competition within increasing thresholds. Specifically, we consider gas stations with no competitors in concentric circles with a radius increment of 1 kilometer around each gas station, ranging up to 6 kilometers. The results of this additional empirical exercise are presented in Figure 5, with Panel A focusing on diesel prices and Panel B on unleaded gasoline prices. In both cases, our results consistently fail to reject the null hypothesis of full pass-through (indicated by the horizontal dotted line in both panels) at the 5% significance level across the different considered thresholds.²¹ Thus, our main result that cooperative gas stations do not engage in markup adjustments remains robust to alternative definitions of isolated firms.

These findings further reinforce the contrasting markup adjustment behavior between cooperatives and for-profit firms. In fact, Genakos and Pagliero (2022) and Dimitrakopoulou et al. (2024) examine the

²¹Note that as we consider increasingly isolated firms, the number of observations decreases, leading to wider confidence intervals.

Table 4. The effect of tax reform on diesel and gasoline prices among cooperatives without nearby competitors

	(1)	(2)	(3)	(4)	(5)			
Panel A. Outcome variable: Da	iesel price (€	/1)						
Tar imes Post	0.0545***	0 0538***	0.0547***	0.0546***	0.0534***			
$Tux \wedge TOSt$	(0.0343)	(0.000396)	(0.0347)	(0.0340)	(0.00338)			
	(0.00100)	(0.000)0)	(0.00002)	(0.00002)	(0.00000)			
Treated	-0.0384***	-0.0327***	-0.0399***					
	(0.00875)	(0.00767)	(0.0105)					
Pact	0 0360***							
1 051	(0.0300)							
\mathbb{R}^2	0.318	0.620	0.925	0.886	0.893			
P-Value $H_0 = 0.058$	0.389	0.297	0.318	0.316	0.177			
N. Observations	4,925	4,925	4,925	4,925	4,925			
N. Gas Stations	71	71	71	71	71			
Panel B. Outcome variable: Ga	soline price ($\in /l)$						
$Tar \times Post$	0.0537***	0.0542***	0 0520***	0.0527***	0 0510***			
$1ux \times 105i$	(0.0000)	(0.0042)	(0.0000)	(0.0000)	(0.0019)			
	(0.00000)	(0.00070)	(0.00000)	(0.001)0)	(0.00002)			
Treated	-0.0568***	-0.0512***	-0.0439***					
	(0.0109)	(0.00987)	(0.00464)					
Deet	0.00446							
FOST	-0.00440							
Week FE	(0.00040)	<u> </u>	<u> </u>	<u> </u>	1			
		·	•	•	·			
Brand FE			\checkmark					
Cas Station Changestanistics		/	/					
Gas Station Characteristics		v	v					
Gas Station FE				\checkmark	\checkmark			
State×Brent					<u>√</u>			
K ⁴	0.234	0.636	0.910	0.855	0.871			
P -value $H_0=0.058$	0.429	0.513 3 106	0.420	0.391	0.229			
N Gas Stations	46	46	46	46	3,190 46			

Note: The outcomes are diesel prices (Panel A) and unleaded gasoline prices (Panel B), in euros per liter. We restrict the sample to those gas stations that have no other competitor in a radius of 2 km. Column (1): simple *DiD* estimator, controlling for the announcement period (June-December 2018) and its interaction with *Treated*. Column (2): same as the previous column but with *Post* replaced by week-month fixed effects and the addition of control variables at the gas station level—a dummy variable indicating whether the station is open 24/7, the number of fuels sold, and the number of gas stations within a 2-kilometer radius. Column (3): same as the previous column but also including brand dummies. Column (4): *TWFE* estimator, including gas station and week-month fixed effects, with no other controls. Column (5): same as the previous column but also including State dummies interacted with the Brent crude oil price. All the point estimates are obtained through OLS, and standard errors are clustered at the zip code level (in parentheses). The significance levels are as follows: * p < 0.01, ** p < 0.05, *** p < 0.01.

Figure 5. The effect of tax reform on diesel and gasoline prices for increasingly isolated cooperative gas stations



Note: The figure displays the estimated impact of the June 2019 tax harmonization reform on the prices of diesel (Panel A) and unleaded gasoline prices (Panel B) for cooperative gas stations. The estimates are obtained for different samples of gas stations, categorized by their lack of competition within a radius ranging from 1 to 6 kilometers (in 1-kilometer increments), as denoted on the horizontal axis. Point estimates (indicated by dots) are obtained using the most complete specification of equation (4.1)—used in column (5) in Table 2. Vertical bands represent 95% confidence intervals. The dashed horizontal line captures the threshold for full tax pass-through.

pass-through of tax changes among for-profit gas stations operating in isolated markets in Greece and document that these gas stations passed through only approximately 40-50% of the tax change indicating that a significant portion of the tax is absorbed through their markups—which arise from the exercise of market power. This disparity highlights the distinct behavior observed between (isolated) for-profit gas stations and cooperative gas stations, as the latter demonstrate a near-complete pass-through of the tax increase, further supporting the absence of markup adjustment in their pricing policy.

5.3.2 Additional robustness checks

Our results remain robust across various alternative sample selection criteria and estimation strategies, which can be found in Appendix B. In this section, we summarize the extensive analysis presented in that appendix. In all these alternative scenarios, we consistently observe a complete pass-through of the tax into retail prices among cooperative gas stations.

First, in Section 2.3, we elaborate on the unexpected nature of the tax harmonization reform that we exploit in our empirical analysis. This reform was unpredictably passed by a newly established left-wing government resulting from a vote of no confidence. Nevertheless, it is noteworthy that the preceding (right-wing) government had already contemplated a similar reform in the preliminary draft of the Spanish national budget, made public in April 2018. Even though it received limited media coverage,

there remains the possibility that this preliminary bill could have triggered a preemptive reaction among the affected cooperatives. Therefore, to address this potential concern, we again estimate equation (4.1) controlling for the period spanning from the last week of April 2018 to the week right before the actual announcement in June 2018. More precisely, we introduce an additional dummy variable that equals 1 for the weeks within this time frame interacted with Tax_s . The results of this second robustness check, included in Appendix B.1 (Table B.1), exhibit remarkable consistency with those displayed in Table 2.

Second, another concern arises from the unbalanced structure of our panel dataset—which is a common issue when examining markets with firm entry and exit. To address this problem, we replicate the results from Table 2 using a balanced panel of cooperatives. Specifically, we use the subsample of gas stations that continued to sell fuel in the market from January 2018 to mid-2019.²² Table B.2 displays the estimates for both fuels under this approach; once again, the empirical results remain virtually unchanged compared to those of the full sample in Table 2.

Third, we further ensure that our main findings are not driven by specific groups of cooperatives or by those located in a particular state. To this end, we re-estimate our main regression model using certain subsets of cooperatives from our sample. These additional robustness checks, carried out using the most complete specification of equation (4.1) for both diesel and unleaded gasoline, are included in Table B.3 (Appendix B.3). Panel A displays the estimates of the coefficient of interest using data from the following subgroups of cooperatives: *(i)* gas stations owned by Eroski and AN (large cooperatives),²³ *(ii)* all cooperatives with more than two gas stations, excluding Eroski and AN (medium-sized cooperatives), and *(iii)* all cooperatives with only one gas station (small cooperatives). Additionally, Panel B presents the same set of results after excluding one treated state (i.e., those affected by the tax reform). The results included in this table confirm that our findings remain robust, as they show consistency both quantitatively and qualitatively with those presented in column (5) in Table 2, re-ensuring that they are not driven by any specific cooperative brand (or group of cooperatives) or particular subsets of gas stations within a single state.

Finally, as an additional empirical analysis, we estimate the tax reform's impact on the prices of

²²For diesel fuel, 79% of the cooperative gas stations in our sample satisfy this criterion, while for unleaded gasoline, the number is 80%. A brief reporting lapse of 4 weeks, possibly due to holidays, was observed.

²³Eroski operates grocery stores, which raises the concern that it may sell fuel at cost as a strategy to attract shoppers. While most Eroski gas stations are located near its grocery outlets, not all are. Thus, Table B.3 presents additional estimates for large cooperatives (AN and Eroski), both excluding and exclusively including Eroski gas stations situated near a grocery store.

cooperatives in states where fuel duties experienced only minor increases, namely, Aragón (with a tax increase of 2.9 cents per liter) and Extremadura (with an increase of 1.2 cents per liter)—see Figure 2.²⁴ To this end, we augment our regression model by introducing additional dummy variables, each representing one of the mentioned states. Then, we estimate the coefficients of the interaction between these dummies and *Post*_t. The results of this empirical analysis are presented in Table B.4 (see Appendix B.4). Once again, all the point estimates associated with gas stations in these states align with a full pass-through of the respective tax changes, except for diesel in Aragón, where the null hypothesis of full pass-through is rejected in three columns at the 5% level (although it is not rejected at the 1% level). However, readers should interpret these findings with caution for two main reasons. First, concerns about the validity of the *TWFE* and *DiD* estimators arise in settings with multiple treatments (Fricke, 2017; De Chaisemartin and d'Haultfoeuille, 2020, 2023). As explained by De Chaisemartin and d'Haultfoeuille (2023), such contexts may yield incorrectly estimated coefficients, as they capture not only the effect of a particular treatment but also the effects of other treatments. Secondly, the limited sample size in certain regions warrants careful consideration.

6 Conclusion and policy implications

In this paper, we empirically study the competitive behavior of cooperatives. Specifically, we examine whether cooperatives exercise market power when setting prices or, conversely, if their behavior is rather aligned with efficiency pricing. Although the cooperatives within our study ostensibly share a common goal, often formalized in their by-laws and charters, of maintaining competitive prices to benefit their customers and promote societal impact, previous literature has raised questions regarding the extent to which these objectives are genuinely pursued. This skepticism finds roots, for example, in the potential dissonance between managerial incentives and the cooperatives' socially oriented goals, and the intricate influence of particular economic groups (Birchall, 2014).

Our empirical analysis takes root in a well-established theoretical framework that formalizes the conditions under which the pass-through of an exogenous tax shock serves as a straightforward test for market power. Guided by this premise, we leverage a dataset on daily pricing data (aggregated on a

²⁴In this analysis, we exclude the state of Asturias (which experienced a modest 1 cent increase solely for diesel), as it has only three gas stations owned by cooperatives. Additionally, there are no cooperative gas stations in the state of Madrid, which also experienced a partial increase in fuel duties.

weekly basis) and other characteristics from over 250 cooperatives engaged in the transportation retail fuel sector across Spain. We use it to exploit the enactment of regional fuel tax harmonization in January 2019 within Spain—an outcome that unexpectedly emerged after a successful vote of no confidence which precipitated an unforeseen spike in fuel price of approximately 6% for gas stations in some states. This regulatory change allows us to examine the tax pass-through exhibited by the affected cooperatives using a standard difference-in-differences approach.

We find that the tax shock experienced by cooperatives operating in states affected by fiscal harmonization was entirely transmitted to their retail diesel and gasoline prices: for both fuel types, we fail to reject the null hypothesis of full pass-through. This result, consistent across a battery of robustness checks, reveals the absence of any markup adjustment among these cooperatives and cohesively aligns with efficient (welfare-maximizing) pricing. It also diverges from the tax adjustment patterns observed among for-profit gas stations in closely related studies. For example, Genakos and Pagliero (2022) report a pass-through rate as low as 40% for gas stations in competition-deprived settings. In our case, the full pass-through rate is observed even for the subset of cooperatives without nearby competitors.

Our examination of cooperative behavior introduces a nuanced departure from existing literature. While prior researchers, such as Duggan (2002), Philipson and Posner (2009), and Duarte et al. (forthcoming), suggest that cooperatives and not-for-profit firms deviate from their stated objectives by exploiting market power, our findings unveil a trajectory aligned with the "pro social" principles enshrined in their charters. Unlike these previous studies, which frequently focus on one or a few large entities (or multiple ones operating under the same renowned brand), our results are based on data from over 175 cooperatives managing approximately 250 gas stations. None of these cooperatives, though, are major players in the retail fuel sector; in fact, they operate the gas stations as a "side business". Given the distinct contexts explored in these different studies, a potential avenue for further research is to develop a theory explaining why and under which circumstances both sets of results—cooperatives not maximizing profits in certain markets but doing so in others—may simultaneously coexist.

Our empirical findings, suggesting that the bulk of cooperatives studied here adhere to their consumeroriented objectives, highlight the need for policymakers to abandon a one-size-fits-all approach when regulating cooperatives. Instead of assuming that cooperatives universally exert market power, a nuanced evaluation of subgroups of cooperatives' behavior and governance structure would provide a

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better understanding of the gains of granting exemptions for not-for-profit firms. It is crucial to consider the diverse outcomes observed across industries and organizational forms, emphasizing the necessity of tailored policy frameworks that account for the specificities of each cooperative. Blindly extending such exemptions may not be warranted, and subsidies must be rigorously evaluated against the actual benefits they provide to consumers. In summary, policymakers play a pivotal role in fostering environments where not-for-profit firms genuinely serve the interests of their members and consumers.

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Appendix A: Additional background figures

First, to provide a clearer understanding of cooperative gas stations, we include Figure A.1 in this appendix, displaying pictures of six selected cooperatives gas stations. As seen across Panels A through F, cooperative gas stations share many visual similarities with typical for-profit gas stations, though they exhibit some diversity in size and features. Some stations are small, while others are larger; some offer convenience stores, while others are more basic, providing only fuel nozzles. Additionally, some of them prominently display their cooperative status, while others do not. However, the fact that a gas station is cooperatively-owned hold no practical implications for consumers beyond the fact that the it is owned by their members. For further details, please refer to Section 2.2.

Next, Figure 1 in Section 1 illustrates the difference in the evolution of retail diesel prices—the predominant transportation fuel in Spain—between cooperatives and for-profit gas stations throughout our sample period. For the sake of completeness, we present a similar figure (Figure A.2) for retail gasoline prices (another fuel considered in our empirical analysis) in this appendix. Following the format of Figure 1, we present in Panel A of Figure A.2 the evolution of gasoline prices using data from the universe of gas stations in Spain, while in Panel B we refine this analysis by focusing on a matched subsample of cooperative and for-profit gas stations that share similar demand conditions and operational costs. Specifically, for each cooperative gas station in our sample, we identify a for-profit one (*i*) located in the same zip code, (*ii*) with comparable personnel costs, (*iii*) with the same opening hours, and (*iv*) selling a similar range of fuels. This process yields a subsample of 304 gas stations (152 cooperative-owned and 152 for-profit). As observed in Figure 1, Figure A.2 similarly demonstrates that gasoline prices at cooperative gas stations are consistently about 6 euro cents lower than at for-profit counterparts. As discussed in Section 1, this observed difference aligns with the estimated gas station markup suggested by the CNMC (2021), providing compelling preliminary evidence supporting the absence of any markup among cooperative gas stations.

Third, in Section 5.2, we state that a key assumption for identifying the causal impact of the tax increase on the prices of cooperative gas stations in treated states is that the pricing behavior of gas stations in both treated and control states would follow a similar time trend in the absence of the fiscal harmonization implemented. This appendix provides additional visual evidence in Figure A.3 supporting the

Figure A.1. Pictures of selected cooperative gas stations



(A) Cocope S. Coop. (Cogeces del Monte, Valladolid)



(B) San Antonio Abad Coop. (Fuentealbilla, Albacete)



(C) Grupo AN (Arizcun, Navarra)



(D) Campo Roquetas (La Gangosa, Almeria)



(E) AlziCoop Carburants (Alzira, Valencia)



(F) Cooperativa Albalat (Albalat dels Sorells, Valencia)

Note: The figure shows pictures of selected cooperative-owned gas stations. In Panels A through F, the following cooperative gas stations are included, respectively (with the town and province indicated in parentheses): Cocope S. Coop., in Cogeces del Monte (Valladolid), San Antonio Abad Coop., Fuentealbilla (Albacete), Grupo AN, Arizcun (Navarra), Campo Roquetas, La Gangosa (Almeria), AlziCoop Carburants, Alzira (Valencia), Cooperativa Albalat, Albalat dels Sorells (Valencia). All the pictures were obtained from Google Maps.





Note: The figure displays the average weekly price (in euros per liter) of gasoline from the first week of 2018 to the first week of June 2019. The solid dark gray line represents the average price for for-profit gas stations, while the solid light gray line represents the average price for cooperative gas stations. Panel A presents data from the universe of gas stations in Spain. Panel B focuses on a subsample of 304 gas stations—152 cooperative-owned and 152 for-profit—that are located within the same zip code, have comparable personnel costs, maintain similar operating hours, and sell a similar range of fuels. The dataset was obtained from *Geoportal* (Spanish Ministry for the Ecological Transition); see Section 4.1 for further details.

plausibility of such an assumption. First, Panels A and B show the temporal evolution of the average prices of diesel and unleaded gasoline, respectively, in both treated and control cooperative gas stations from our sample. These figures indicate a fairly similar price evolution at both subsets of gas stations, with alterations only surfacing after the implementation of the tax reform (January 2019). This provides descriptive evidence in favor of the parallel trend assumption. The same trend is corroborated by Panel C, which depicts the price difference between gas stations in treated and control states for both fuels. Before January 2019, the price difference in both subsets of gas stations was negligible. However, after the tax reform, we observe a substantial increase in the price difference between gas stations in treated and control states, approximately 5.5-6 cents. This observed jump in the raw data aligns in magnitude with the increase in the fuel duty experienced by gas stations in treated states, further suggesting that these gas stations fully passed through the tax change.

Finally, in Section 5.2, we illustrate in Figure 4 the estimated impact on diesel prices (Panel A) and unleaded gasoline prices (Panel B) on a week-by-week basis. This figure covers the eight weeks before the announcement of the tax reform in June 2018, the announcement week, and the subsequent eight weeks following its implementation in January 2019. However, for the sake of clarity, we excluded estimates of all other leads prior to the reform and for each week from its announcement to implementation. Thus, for completeness, in this final appendix, we provide Figure A.4, presenting the complete



Figure A.3. Average diesel and gasoline retail prices in all cooperative gas stations in control and treated states

(C) Price gap (both fuels)

Note: This figure illustrates the difference in average retail fuel prices across all cooperative gas stations in control and treated states throughout our sample period. Panel A captures this difference for retail diesel prices, while Panel B does the same for retail gasoline prices. In both figures, the dark line represents the average price in cooperatives located in the treated area, while the gray line represents the average price for those in the control area. The vertical dashed line indicates the week when tax harmonization was implemented (January 2019). Panel C shows the price gap between both areas for both fuels, with the dark line representing the difference in diesel prices and the gray line representing the difference in gasoline prices. For ease of visual comparison, the gap for both fuels is normalized to zero in the first week of 2018.

set of point estimates, including all leads since January 2018 (excluding just the first week) and for each week from the announcement to implementation.



Figure A.4. Impact on cooperative diesel and gasoline prices before and after the announcement and after the implementation of the tax reform



The results of this final empirical exercise, using both diesel and gasoline prices, are included in Panels A and B of Figure A.4 respectively. Once again, we observe no evidence of pre-trends in these lead coefficients: all are close to zero. However, some exhibit slight statistical significance (either positive or negative) for both fuels. These minor deviations from zero may be attributed to seasonal patterns and inventory holdings, resulting in slight price fluctuations and adjustments throughout the year (Borenstein and Shepard, 2002; Levin et al., 2017; González and Moral, 2023). Importantly, in both panels, all coefficients post-implementation of the tax change are statistically significant, averaging around 0.055-0.06. These findings not only confirm the absence of differential pricing trends between treated and control groups but also provide further evidence of the tax increase's positive impact on retail fuel prices after January 2019.

Appendix B: Robustness checks and additional empirical results

While we believe that our empirical strategy robustly supports the causal interpretation of the estimates in Section 5, we acknowledge that alternative sample selections and definitions of treatment and control groups could have been considered. In this appendix, we present several checks to ensure that our results remain robust and are not sensitive to the choices made throughout the paper.

B.1 Controlling for previous weeks to the announcement

In Section 2.3, we explained that the previous national government, prior to the vote of no confidence, had already considered a tax harmonization reform in the preliminary draft for the Spanish national budget in April 2018, which closely resembled the one announced in June 2018. Despite receiving limited media coverage, there remains the possibility that this preliminary bill could have triggered a preemptive reaction among cooperatives located in treated states. Therefore, an additional concern arises regarding a potential anticipation effect triggered by this preliminary draft, not accounted for in our main regression model. To address this concern, we re-estimated equation (4.1), this time also controlling for this pre-announcement period. Specifically, we included in all specifications of equation (4.1), excluding those with week-fixed effects, a dummy variable that equals one from the last week of April until the week before the announcement of the actual tax reform in June 2018. Additionally, we included in all specifications the interaction term between this "pre-announcement period" dummy and *Tax_s*. The results of this second robustness check are presented in Table B.1.

Once again, the coefficients in Table B.1 closely resemble those in Table 2. For diesel (Panel A), the coefficient of interest ranges between 0.057 and 0.059 across all model specifications in columns (1) to (5). In each case, we fail to reject the null hypothesis that this coefficient equals 0.058, consistently demonstrating a full pass-through of the tax change among cooperative gas stations in treated states. A fairly similar pattern is observed in Panel B for gasoline prices. However, columns (1) and (4) display coefficients slightly higher in magnitude than those in the corresponding columns in Table 2. Nevertheless, when we include the full set of controls and the most granular set of fixed effects, namely, in the most robust specification of our regression model—see column (5)—, the coefficient of interest equals 0.058, precisely matching the tax change; once again, this result demonstrates consistency with a complete

	(1)	(2)	(3)	(4)	(5)					
Panel A. Outcome variable: Diesel price (\in /l)										
Tax imes Post	0.0575***	0.0571***	0.0573***	0.0584***	0.0565***					
	(0.00221)	(0.00224)	(0.00196)	(0.00194)	(0.00194)					
R ²	0.385	0.653	0.910	0.901	0.904					
P-Value $H_0 = 0.058$	0.836	0.702	0.724	0.837	0.429					
N. Observations	18,225	18,225	18,225	18,225	18,225					
N. Gas Stations	259	259	259	259	259					
Tax imes Post	0.0632*** (0.00291)	0.0625*** (0.00279)	0.0621*** (0.00267)	0.0626*** (0.00271)	0.0584*** (0.00271)					
Week FE	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark					
Gas Station Characteristics		\checkmark	\checkmark							
Brand Dummies			\checkmark							
Gas Station FE				\checkmark	\checkmark					
State×Brent					\checkmark					
\mathbb{R}^2	0.247	0.693	0.900	0.885	0.890					
P-Value $H_0 = 0.058$	0.0765	0.107	0.128	0.0914	0.895					
N. Observations	13,544	13,544	13,544	13,544	13,544					
N. Gas Stations	195	195	195	195	195					

Table B.1. The effect of tax reform on diesel and gasoline prices among cooperatives (expanding the announcement period)

Note: The outcomes are diesel prices (Panel A) and unleaded gasoline prices (Panel B), in euros per liter. We add a dummy variable indicating the period that goes from the last week of April until the announcement in June 2018, and its interaction with the treatment (tax) dummy. Column (1): simple DiD estimator, controlling for the announcement period (June-December 2018) and its interaction with *Treated*. Column (2): same as the previous column but with *Post* replaced by week-month fixed effects and the addition of control variables at the gas station level. Column (3): same as the previous column but also including brand dummies. Column (4): *TWFE* estimator, including gas station and week-month fixed effects, with no other controls. Column (5): same as the previous column but also including State dummies interacted with the Brent crude oil price. All the point estimates are obtained through OLS, and standard errors are clustered at the zip code level (in parentheses). The significance levels are as follows: * p < 0.10, ** p < 0.05, *** p < 0.01.

pass-through of the tax into retail fuel prices.

B.2 Balanced panel (dropping gas stations that enter/exit)

Table 1 in Section 4.1 reveals a discrepancy in the number of gas stations between the "before" (January-December 2018) and "after" (January-June 2019) periods. This disparity may stem from some cooperative gas stations entering or exiting the market during the period covered by our sample. Consequently, there is a potential concern regarding attrition bias; e.g., one could argue that gas stations with lower prices may have been disproportionately affected by the tax implementation in the treated states, leading them to exit the market due to increased costs. This could introduce bias into the estimated coefficients. To address this concern, we conduct an additional robustness check using a perfectly balanced panel of cooperative gas stations. Specifically, we include only those gas stations that were actively operating in the market throughout the entire period covered by our sample.

The results of this additional empirical analysis are presented in Table B.2, where we include the same model specifications as in Table 2. The estimated coefficients in Table B.2 closely resemble those included in Table 2: across Columns (1) to (4), the estimates show minimal variation compared to those in Table 2, ranging from 0.0579 to 0.0583 for diesel and from 0.0596 to 0.0599 for gasoline. Furthermore, our primary specification in Column (5) indicates a complete pass-through of the tax change, with estimated coefficients of 0.057 for diesel (Panel A) and 0.058 for gasoline (Panel B), reaffirming once more the absence of markup adjustment among cooperative gas stations for both fuels.

B.3 Alternative samples by cooperative size/brand and states

In this appendix, we further ensure that our main findings are not driven by specific subsets of cooperative gas stations or by those located in certain treated states. To this end, we re-estimate our main regression model using various subsets of cooperatives from our sample. These additional robustness checks, obtained using the most complete specification of equation (4.1) for both diesel and unleaded gasoline, are presented in Table B.3.²⁵

In Panel A, we present estimates of the coefficient of interest using data from three distinct sub-

²⁵To mitigate potential attrition bias concerns, as explained in Appendix B.2, the estimates for these subsamples of cooperative gas stations presented in this table are obtained by including only those that were actively operating throughout the entire period covered by our sample.

	(1)	(2)	(3)	(4)	(5)				
Panel A. Outcome variable: Diesel price (\in /l)									
Tax imes Post	0.0580***	0.0583***	0.0579***	0.0580***	0.0572***				
	(0.00191)	(0.00191)	(0.00190)	(0.00191)	(0.00192)				
R ²	0.332	0.663	0.912	0.904	0.907				
P-Value $H_0 = 0.058$	0.987	0.868	0.974	0.987	0.679				
N. Observations	15,170	15,170	15,170	15,170	15,170				
N. Gas Stations	205	205	205	205	205				
Panel B. Outcome variable: Gasoline price (€/l)									
Tax imes Post	0.0596***	0.0599***	0.0597***	0.0596***	0.0580***				
	(0.00261)	(0.00260)	(0.00262)	(0.00262)	(0.00262)				
Week FE		\checkmark	\checkmark	\checkmark	\checkmark				
		,	,						

Table B.2. The effect of tax reform on diesel and gasoline prices among cooperatives (balanced panel)

Tax imes Post	0.0596***	0.0599***	0.0597***	0.0596***	0.0580***
	(0.00261)	(0.00260)	(0.00262)	(0.00262)	(0.00262)
Week FE		\checkmark	\checkmark	\checkmark	\checkmark
Gas Station Characteristics		\checkmark	\checkmark		
Brand Dummies			\checkmark		
Gas Station FE				\checkmark	\checkmark
State×Brent					\checkmark
R ²	0.203	0.704	0.902	0.887	0.893
P-Value $H_0 = 0.058$	0.534	0.463	0.519	0.535	0.987
N. Observations	11,544	11,544	11,544	11,544	11,544
N. Gas Stations	156	156	156	156	156

Note: The outcomes are diesel prices (Panel A) and unleaded gasoline prices (Panel B), in euros per liter. We keep gas stations that have fully reported prices in the time interval to have a perfectly balanced panel. Column (1): simple DiD estimator, controlling for the announcement period (June-December 2018) and its interaction with *Treated*. Column (2): same as the previous column but with *Post* replaced by week-month fixed effects and the addition of control variables at the gas station level. Column (3): same as the previous column but also including brand dummies. Column (4): *TWFE* estimator, including gas station and week-month fixed effects, with no other controls. Column (5): same as the previous column but also including State dummies interacted with the Brent crude oil price. All the point estimates are obtained through OLS, and standard errors are clustered at the zip code level (in parentheses). The significance levels are as follows: * p < 0.01, ** p < 0.05, *** p < 0.01.

groups of cooperatives. First, we consider gas stations owned by Eroski and Grupo AN, two relatively large cooperatives that own gas stations along with other businesses in our sample. Given the potential concern that Eroski gas stations might sell fuel at cost as a strategy to attract shoppers (rather than as a reflection of non-exertion of market power), we further refine this subsample by alternatively excluding and exclusively including Eroski gas stations located near a grocery store. Second, we analyze mid-size cooperatives that own multiple gas stations, excluding Eroski and Grupo AN. Finally, in the third row, we narrow the sample to the smallest cooperatives that own and manage just one gas station. Then, Panel B displays the same set of results after excluding one treated state (Cantabria, País Vasco, La Rioja, Navarra, and Castilla y León).

In both panels, the coefficients closely align with those in Table 2, ranging from 0.055 to 0.060 for both diesel and gasoline, with slight downward deviations observed only for the coefficients of the smallest cooperatives. Overall, the null hypothesis of full pass-through cannot be rejected at the 5% significance level in all cases. In fact, across all 20 cases considered, covering various subsamples and fuel types, we fail to reject the null hypothesis of full pass-through at the 10% significance level in all but two cases. Overall, these results confirm that our findings are unlikely driven by any specific cooperative brand or group of cooperatives, nor by particular subsets of gas stations within a single state.

		Diesel				Gasoline			
		p-value		N. Gas		p-value		N. Gas	
Time	Beta	$\hat{H_0} = 0.058$	Obs	Stations	Beta	$\hat{H_0} = 0.058$	Obs	Stations	
Panel A. Estimates by brand/siz	ze								
Eroski and AN	0.0571	0.836	5,402	73	0.0587	0.885	4,884	66	
Eroski with groceries and AN	0.0567	0.779	5,328	72	0.0585	0.922	4,810	65	
Eroski w/o groceries and AN	0.0551	0.498	3,774	51	0.0570	0.838	3,256	44	
Coops with ≥ 2 gas stations	0.0579	0.980	1,628	22	0.0521	0.057	1,332	18	
Coops with 1 gas station	0.0527	0.094	8,140	110	0.0479	0.215	5,328	72	
Panel B. Dropping one state									
Cantabria	0.0574	0.773	15,022	203	0.0579	0.958	11,470	155	
País Vasco	0.0557	0.160	13,912	188	0.0545	0.161	10,286	139	
La Rioja	0.0577	0.871	14,800	200	0.0588	0.740	11,470	155	
Navarra	0.0571	0.755	12,580	170	0.0577	0.949	9,620	130	
Castilla y León	0.0580	0.982	13,690	185	0.0608	0.311	10,508	142	

Table B.3. Robustness check by cooperative size/brand and geographic region

Note: All estimations are obtained using the most robust specification of our regression model, outlined in Table 2, column (5). Panel A employs subsamples of cooperatives categorized according to their size. Panel B we narrowed the sample by excluding one state. In both panels, we keep gas stations that have fully

reported prices in the time interval to have a perfectly balanced panel. Standard errors are clustered at the zipcode level.

B.4 Tax pass-though in partially treated states

In this appendix, we estimate the impact of the tax reform on the prices of cooperatives in states where fuel duties saw only minor increases. Specifically, we consider Aragón (with a tax increase of 2.9 cents per liter) and Extremadura (with an increase of 1.2 cents per liter), which were dropped from the sample used in our empirical analysis in the main text.²⁶ To do so, we estimate our main regression model by introducing additional dummy variables, each denoting one of these two states, and also the interaction between these two additional dummies and $Post_t$. The results of this empirical analysis are included in Table B.4.

Once again, the point estimates associated with gas stations in these states generally align with a full pass-through of the respective tax changes. Across both panels (using both diesel and unleaded gasoline prices) and all five model specifications included in columns (1) to (5) in Table B.4, we cannot reject the null hypothesis of full pass-through of the tax change into retail prices at the 5% significance level. Only in Aragón, for diesel (Panel A), do some columns show a slight deviation from full pass-through; specifically, columns (3) to (5). In this case, although there is statistical evidence to reject the null hypothesis of full pass-through at the 5% significance level (but not at the 1% significance level), the deviation of full pass-through is relatively small (86% pass-through), with a difference of less than half a cent. Nevertheless, these findings should be interpreted with caution for two main reasons. First, due to concerns about the validity of the *TWFE* and *DiD* estimators in settings with multiple treatments: as explained by De Chaisemartin and d'Haultfoeuille (2023), in such contexts, the estimated coefficients may be incorrect as they capture not only the effect of a particular treatment but also the effects of other treatments. Second, due to the limited sample size in certain states (e.g., in Extremadura there are only 27 cooperative gas stations). Despite this exception and considering these potential caveats, our results are overall consistent once again with the absence of markup adjustment among cooperative gas stations.

²⁶There are no cooperative gas stations in the state of Madrid. Additionally, we exclude the state of Asturias from this analysis as it has only three gas stations owned by cooperatives. Furthermore, Asturias experienced a minor increase, of just one cent per liter, which only affected diesel prices but not unleaded gasoline.

Table B.4. The effect of tax reform on diesel and gasoline prices among cooperatives (considering partially treated states)

	(1)	(2)	(3)	(4)	(5)				
Panel A. Outcome variable: D	iesel price (€	e /l)							
Tax imes Post	0.0565***	0.0557***	0.0559***	0.0571***	0.0564***				
	(0.00207)	(0.00209)	(0.00180)	(0.00177)	(0.00176)				
Tan V Daat	0.02(0***	0.0350***	0.0246***	0.0740***	0.0246***				
$Iux_{AR} \times Post$	(0.0260)	(0.0250)	(0.0246)	(0.0249)	(0.0246)				
	(0100222)	(0.00220)	(0100201)	(01001)0)	(0.001)))				
$Tax_{EX} \times Post$	0.0112***	0.0103***	0.0102***	0.0104***	0.0106***				
	(0.00176)	(0.00173)	(0.00155)	(0.00155)	(0.00158)				
R ²	0.331	0.662	0.896	0.904	0.906				
P-Value $H_0 = 0.058$	0.470	0.279	0.239	0.613	0.380				
P-Value $H_0 = 0.029$ (AR)	0.183	0.0725	0.0309	0.0388	0.0298				
P-Value $H_0 = 0.012$ (EX)	0.656	0.323	0.257	0.313	0.388				
N. Observations	23,222	23,222	23,222	23,222	23,222				
N. Gas Stations	328	328	328	328	328				
Panel B. Outcome variable: Ga	Panel B. Outcome variable: Gasoline price (€/l)								
Tax imes Post	0.0611***	0.0601***	0.0597***	0.0604***	0.0590***				
	(0.00276)	(0.00260)	(0.00245)	(0.00250)	(0.00250)				
T D(0.0004***	0.0077***	0.0002***	0.0004***	0.007(***				
$Iax_{AR} \times Post$	(0.0284)	(0.0277^{+++})	(0.0283°)	(0.0284°)	(0.0276°)				
	(0.00551)	(0.00323)	(0.00200)	(0.00294)	(0.00287)				
$Tax_{EX} \times Post$	0.0152***	0.0144***	0.0142***	0.0142***	0.0144***				
	(0.00345)	(0.00330)	(0.00314)	(0.00314)	(0.00309)				
Week FE		\checkmark	\checkmark	\checkmark	\checkmark				
Gas Station Characteristics		\checkmark	\checkmark						
Brand Dummies			\checkmark						
Gas Station FE				\checkmark	\checkmark				
State×Brent					\checkmark				
	0.196	0.695	0.890	0.890	0.895				
P-Value $H_0 = 0.058$	0.270	0.413	0.490	0.347	0.693				
P-Value $H_0 = 0.029$ (AR)	0.850	0.695	0.798	0.829	0.620				
P-Value $H_0 = 0.012$ (EX)	0.362	0.469	0.479	0.488	0.444				
N. Observations	16,513	16,513	16,513	16,513	16,513				
N. Gas Stations	237	237	237	237	237				
Note: The outcomes are diesel prices (Panel A) and unleaded gasoline prices (Panel B), in euros per liter. We									
add two partially treatment states: Tax_{AR} (Aragón) and Tax_{EX} (Extremadura). We test the null hypothesis of									
full pass-through of each state in comparison with our control group. It is 2.9 cents for Aragón and 1.2 cents									
for Extremadura. Column (1): simp	le <i>DiD</i> estimate	or, controlling	for the announ	cement period	(June-December				
2018) and its interaction with Treated. Column (2): same as the previous column but with Post replaced by week-									

2018) and its interaction with *Treated*. Column (2): same as the previous column but with *Post* replaced by weekmonth fixed effects and the addition of control variables at the gas station level. Column (3): same as the previous column but also including brand dummies. Column (4): *TWFE* estimator, including gas station and week-month fixed effects, with no other controls. Column (5): same as the previous column but also including State dummies interacted with the Brent crude oil price. All the point estimates are obtained through OLS, and standard errors are clustered at the zip code level (in parentheses). The significance levels are as follows: * p < 0.10, ** p < 0.05, *** p < 0.01.