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Distributional and Emission Effects of Temporary Gasoline Subsidies: Evidence from Spain

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Distributional and Emission Effects of Temporary Gasoline Subsidies: Evidence from Spain *

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Abstract

In response to the sharp rise in fuel prices following Russia's 2022 invasion of Ukraine, many governments introduced temporary fuel subsidies to shield households from higher energy costs. This paper evaluates the distributional and environmental effects of Spain's fuel subsidy policy. We combine household-level estimates of gasoline price elasticities from the Household Budget Survey with weekly retail fuel price data to estimate the pass-through of the subsidy to consumers. We find an average short-run gasoline price elasticity of 0.55 and incomplete pass-through, with only 89% of the subsidy reflected in retail prices. As a result, part of the fiscal transfer was captured by fuel retailers, while the benefits accrued disproportionately to higher-income households: the lowest income quartile received 12.4% of total benefits compared with 28.4% for the highest quartile. We also identify substantial regional heterogeneity in this distribution. The subsidy also increased fuel consumption and carbon emissions. Overall, the findings suggest that uniform fuel subsidies are poorly targeted and can conflict with both equity and environmental policy objectives.

Keywords: Fuel subsidy, price elasticity, gasoline prices, distributional equity, emissions

JEL Codes: H22, H23, L11, Q41

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1 Introduction

Following the unprecedented increase in fuel prices triggered by the war in Ukraine, many countries adopted temporary policy measures to mitigate the impact on households and firms, typically through direct subsidies or tax reductions on fossil fuel prices (see World Bank, 2025). In the European Union, most governments introduced exceptional interventions that differed in size, implementation method, and duration (Drolsbach, Gail and Klotz, 2023).[1]

Spain implemented a universal subsidy of €0.20 per liter on motor fuels between April and December 2022. The fiscal cost exceeded €6 billion.[2] The policy was large, temporary, and unanticipated, providing a plausibly exogenous price intervention to study both price transmission and household consumption responses.

Most existing studies of these policies focus on price transmission—i.e., the extent to which subsidies were passed through to retail prices—with evidence for Germany (Kahl, 2024; Schmerer and Hansen, 2023; von Waldow and Link, 2024), Spain (Balaguer and Ripollés, 2024; Jiménez, Perdiguero and Cazorla-Artiles, 2025; Moral, 2023; Hidalgo, Martinez and Collado, 2022), or United States (Tsvetanov, 2024; Doyle and Samphantharak, 2008). While this literature provides important insights, it leaves open how price transmission translates into distributional and environmental outcomes. This paper addresses this gap by combining estimates of pass-through with heterogeneous demand responses within a unified empirical framework to quantify both the fiscal incidence and the emissions effects of a temporary gasoline subsidy.

Our analysis relates to the literature on the distributional incidence of fuel taxation and energy policy (e.g. Cornwell and Creedy, 1996; West and Williams, 2004; Bento, Goulder, Jacobsen and Von Haefen, 2009; Ohlendorf, Jakob, Minx, Schröder and Steckel, 2021; Reaños, Yakut, de Bruin and Meier, 2025) and to studies on tax pass-through and market power in fuel markets (e.g. Silvia and Taylor, 2016; Harju, Kosonen, Laukkanen and Palanne, 2022; Marion and Muehlegger, 2011).[3]

Our empirical strategy proceeds in three steps. First, we estimate a flexible instrumental variables demand model using microdata from the Spanish Household Budget Survey to recover heterogeneous gasoline price elasticities across income, age, and residential characteristics. Second, we estimate the pass-through of the 2022 subsidy using a weekly provincial panel. Third,

[1] For example, France introduced a rebate of 15 cents per liter on gasoline and diesel from April to August 2022, later extended through the end of the year. Germany temporarily reduced fuel excise taxes to the EU minimum, equivalent (after VAT) to reductions of 35.16 and 16.71 cents per liter for gasoline and diesel, respectively. Italy reduced fuel taxes by 25 cents per liter from March to April 2022, subsequently extending the measure until December.

[2] The initial budget for this measure was between €4.9 and €5.5 billion (see Miralles, 2023). The Spanish Court of Audit (*Tribunal de Cuentas*) reports a final cost of €6.288 billion.

[3] More broadly, our work is related with the literature that analyze the channels through which the environmental instruments operate (e.g. Hoang, Benbouzid, Mallick and Stojanovic, 2026; Kotsogiannis and Woodland, 2025; Adetutu, Odusanya, Stathopoulou and Weyman-Jones, 2023).

we combine both components to quantify the fiscal incidence of the subsidy and its effects on CO_2 emissions.

Our main findings can be summarized as follows. First, the median short-run price elasticity of gasoline demand is -0.55, with substantial heterogeneity across households. Demand is more elastic among lower-income, younger, and urban households. Second, pass-through is incomplete, averaging 89%, implying that firms capture part of the fiscal transfer. Third, the distribution of benefits is regressive: households in the lowest income quartile receive 12.4% of the total subsidy, compared to 28.4% for the highest quartile. This pattern reflects both the extensive margin of fuel consumption—since lower-income households are less likely to consume gasoline—and the design of the policy, which links transfers directly to fuel use. Finally, the subsidy increases fuel consumption and CO_2 emissions, with higher-income households accounting for a larger share of the increase.

These results highlight the limitations of uniform fuel subsidies as a policy instrument: while they provide immediate price relief, they may conflict with broader distributional and environmental objectives. More targeted instruments, such as income-based transfers, could improve distributional outcomes while preserving price incentives for fuel consumption.

The remainder of the paper is organized as follows. Section 2 estimates gasoline demand. Section 3 presents the pass-through estimates. Sections 4 and 5 analyze distributional and environmental effects. Section 6 concludes. Additional tables appear in the Appendix.

2 Household response to the fuel subsidy

The effectiveness of the price subsidy depends on understanding how households adjust their fuel consumption in response to price changes, captured by the price elasticity of demand for fuel products. Employing a flexible demand specification enhances the reliability of simulated consumption responses to fiscal policy interventions and, in turn, the robustness of the resulting distributional and fiscal impact assessments.

In Spain, households account for 91% of total gasoline consumption but only 53% of total diesel consumption. Our objective is to assess the policy's effects on aggregate consumption and emissions from households, therefore we focus on gasoline demand because it provides a more generalizable benchmark. An important concern is substitution toward other engine types (such as diesel or electric vehicles). Although many fuel-demand studies treat substitution as given, in the short run a household can substitute only if it owns two vehicles with different engines. The SHBS does not report vehicle holdings directly; however, positive expenditures on both fuels over the year imply ownership of at least two cars with different fuel types. In 2022, only 13.2% of households met this condition, a share more similar to 2021 than to 2019. Consequently, neglecting short-run substitution effects involving diesel vehicles is not a major limitation of the analysis. On the other hand, in 2022, vehicles classified with a "Zero Emissions" label (e.g., battery electric vehicles) accounted just for approximately 0.5% of the total light vehicle fleet.

2.1 Sample and descriptive statistics

To investigate consumer behavior, we use household-level microdata from the Spanish Household Budget Survey (SHBS) compiled by the Spanish Statistical Office (INE in its Spanish acronym). The SHBS provides detailed information on household expenditures and demographic characteristics, allowing us to capture heterogeneity in consumer behavior that is not observable in aggregate data and to measure the distributional and environmental impacts of the fuel subsidy with greater precision. The SHBS reports annual expenditures on a wide array of products, including gasoline, automotive diesel, and various forms of public transportation. However, it does not report whether households own cars. We therefore infer that a household owns at least one car if it reports expenditures on motor fuels. In any case, the SHBS provides a suitable basis for assessing households' spending decisions regarding motor fuel consumption.

The subsidy was in place from April 1 to December 31, 2022. We therefore identify gasoline demand using pre-policy data that exhibit mobility conditions comparable to those observed in 2022. Specifically, we compare gasoline expenditure patterns in 2019 and 2021 with those in 2022 (excluding 2020 due to severe COVID-19–related mobility restrictions) to select the period that best replicates household behavior. The analysis focuses on mainland Spain; that is, we exclude the Canary Islands, the Balearic Islands, Ceuta, and Melilla, as they are subject to distinct tax and fiscal regimes.

An important feature of the SHBS is that each observation is associated with a sampling weight (expansion factor) that ensures representativeness at both the regional (autonomous community) and national levels. Because these weights vary substantially, we always incorporate them throughout the analysis; otherwise evaluation of the fiscal policy will be biased. After removing missing or implausible observations, the sample includes 16.1, 15.8 and 16.0 million households in 2019, 2021, and 2022, respectively.[4] Using this dataset, we apply an initial filter to exclude households at clear risk of severe poverty. We account for expenditure patterns as a proxy for household purchasing power, as is standard in the fuel demand literature (see, e.g., Poterba, 2017, or West and Williams, 2004). Specifically, we compute monthly expenditure net of housing rent (whether imputed or actually paid), and use this measure as our "income" variable to capture purchasing capacity. Hereafter, we refer to this measure as *income*. We then drop households reporting monthly income below €500 or spend less than €450 per month

[4]Between 2019 and 2022, Spain had approximately 18.5 million households, of which about 1.2 million were located in non-mainland territories. Our target population is therefore around 17.3 million households per year. The SHBS provides complete information on income, total expenditures, fuel expenditures, and plausible fuel prices for 15.8 households in 2021, which is broadly representative of Spanish households.

per consumption unit.[5] We further restrict the sample to households whose reference person is between 20 and 80 years old. After applying these filters, the resulting sample includes, on average, 84.7% of our initial sample of Spanish households per year.

Table 1 reports the regional share of households that consume gasoline each year and shows that mobility in 2021 and 2022 remained below 2019 levels, indicating that it had not yet returned to its pre-pandemic pattern. The table also reveals substantial cross-regional heterogeneity, suggesting that controlling for household-level variation within regions improves the precision of elasticity estimates and the reliability of the simulated effects of the subsidy. In terms of income, we also find that behavior in 2021 is more similar to that in 2022, whereas 2019 differs substantially (see Table A.1 in Appendix A). A notable feature is that the share of households that do not consume gasoline is not particularly high relative to the car ownership rate in Spain (around 70%). This reflects the composition of the vehicle fleet: more than half of passenger vehicles run on diesel, and, as noted above, few households consume both fuels. Accordingly, we estimate gasoline demand using only 2021 data, which exhibit similar mobility conditions while remaining exogenous to the price shocks in 2022.

Table 1: Fraction of households consuming gasoline

Region	2019	2021	2022
Andalusia (AND)	41.59	36.00	31.52
Aragon (ARA)	44.82	36.65	33.14
Asturias (AST)	29.65	16.73	20.11
Cantabria (CANT)	38.23	24.89	22.60
Catalonia (CAT)	43.78	31.98	31.49
Castile-La Mancha (CLM)	43.97	22.56	25.53
Castile and León (CyL)	33.25	34.13	32.31
Extremadura (EXT)	34.00	28.57	23.15
Galicia (GAL)	29.54	21.55	25.81
La Rioja (LRIO)	35.68	21.35	19.89
Madrid (MAD)	58.13	52.02	46.81
Murcia (MUR)	40.86	33.00	32.90
Navarre (NAV)	47.52	40.57	33.02
Basque Country (PVAS)	36.76	27.87	25.06
Valencian Community (VAL)	43.73	34.61	28.26
Spain	**43.21**	**34.67**	**31.90**

Note: Percentage of total households in each region by year.
Source: Authors' calculations based on the SHBS (INE).

We next restrict the sample to households that consume gasoline and observe substantial heterogeneity in consumption: some households report very low gasoline expenditures, while oth-

[5] Following the OECD equivalence scale calculated as: $1 + 0.7 \times (\text{NMIEM1} - 1) + 0.5 \times \text{NMIEM2}$; where *NMIEM1* denotes the number of household members aged 14 or older, and *NMIEM2* the number of members under 14 years of age.

ers consume large quantities even after controlling for the number of adult household members. At the lower end, households consuming very small amounts of gasoline per year may not use it for mobility but rather for fuel-powered tools (e.g., chainsaws or lawn mowers). At the upper end, households with very high consumption may use gasoline for economic activities, which are subject to a different excise tax regime. Our objective is to analyze household behavior related to mobility and private transport. Accordingly, we exclude extreme observations (Gillingham and Munk-Nielsen, 2019) and retain households with annual gasoline consumption between 50 and 2,000 liters. Assuming an average fuel economy of 8 liters per 100 km, this range corresponds to approximately 625–25,000 km per year. This interval is sufficiently broad to capture the relevant variation in gasoline demand, given that the average distance traveled by gasoline vehicles in Spain in 2022 was 11,708.2 km (DGT, 2023). This filter could raise concerns if it disproportionately excluded self-employed households. However, self-employed households account for 8.85% of consumer-gasoline households, compared to 8.98% after applying the consumption filter. Therefore, the selected sample preserves a very similar distribution along this dimension.

Table 2: Descriptive statistics for gasoline-consuming households

Regions	Number of households	Income by month	Location (*Hidens*)	*Age* (years)	Gasoline expenditure
Andalusia (AND)	2,393.64	2,280.02	43.44	52.10	4.80
Aragon (ARA)	439.12	2,266.65	57.87	50.92	4.20
Asturias (AST)	330.80	2,109.49	60.50	53.89	6.81
Cantabria (CANT)	181.22	2,197.83	31.04	52.46	7.02
Castile and León (CyL)	785.79	2,217.73	38.96	53.88	6.82
Castile-La Mancha (CLM)	509.43	2,144.70	40.87	53.44	4.18
Catalonia (CAT)	2,443.31	2,289.97	62.45	49.88	4.73
Valencian Comm. (VAL)	1,576.55	2,236.91	36.88	50.97	5.85
Extremadura (EXT)	306.65	2,201.25	28.50	52.68	5.84
Galicia (GAL)	879.15	2,324.31	37.11	51.27	5.56
Madrid (MAD)	2,076.77	2,492.76	77.39	52.08	2.81
Murcia (MUR)	414.77	2,392.36	39.42	52.54	4.46
Navarre (NAV)	214.45	2,177.88	27.01	53.71	4.73
Basque Country (PVAS)	739.29	2,490.19	52.91	52.75	4.43
La Rioja (LRIO)	97.52	2,289.38	50.04	51.86	5.07

Note: Sample of 3,449,706 gasoline-consuming households obtained after applying the filters described in the text. *Number of households* reports weighted population totals (expansion factors). Except for this variable, all other variables are regional averages. *Income* (in €) is proxied by total monthly total expenditure excluding housing (both actual and imputed rents). *Income per capita* is computed following the OECD equivalence scale. Location (variable named as *Hidens*) is an indicator for households living in municipalities with more than 50,000 inhabitants and density above 500 inhabitants/km^2. *Age* is the age of the main household earner. The *Gasoline Expenditure* is the share of gasoline spending in monthly income (percent).
Source: Authors' calculations based on the SHBS.

In sum, we have a selected sample for 2021 of 3,449,706 households that is used for estimating demand and counterfactual estimations. Table A.3 reports descriptive statistics for this dataset and Table A.2 in Appendix presents the corresponding statistics for the full sample of gasoline-consuming households (before applying the consumption filter) and confirms that our selected sample is representative of Spanish households that consume gasoline. An important pattern emerging from this table is that lower-income households tend to use private vehicles less, as they are less represented in the lower quartiles. Moreover, gasoline expenditures constitute a relatively larger burden for these households given their lower purchasing power.

Table 2 reports summary statistics for gasoline-consuming households in 2021 after applying the sample restrictions described in Section 2.1, including the liters trimming rule (50–2,000 liters/year). The table highlights marked territorial differences in the socioeconomic profile of gasoline-consuming households across Spanish regions. Catalonia, Andalusia, and Madrid are the largest regions in terms of population, with Madrid and Catalonia also exhibiting the highest population density. Average monthly income also differs substantially across regions, with Madrid and the Basque Country exhibiting the highest levels, whereas Asturias and Castile-La Mancha report comparatively lower household resources. In contrast, the age of the main household earner is relatively homogeneous by region, fluctuating around 52 years.

These regional differences are mirrored in the relative importance of gasoline expenditure within household budgets. For instance, Madrid records the lowest gasoline expenditure share (2.81%), consistent with both its higher income levels and greater urban density. Overall, the descriptive evidence suggests that households located in less urbanized and relatively lower-income regions devote a larger share of their income to gasoline

2.2 Demand model estimation

Fuel demand has been widely examined in the energy economics literature (see, among others, Labandeira, Labeaga and López-Otero, 2017; Brons, Nijkamp, Pels and Rietveld, 2008; Espey, 1998; or Dahl and Sterner, 1991). As data availability improved, estimation methods evolved from aggregate time series (Hughes, Knittel and Sperling, 2008) to panel and microdata approaches.[6] Aggregate studies capture temporal dynamics but assume a representative consumer, while microdata allow control for heterogeneity across households. The latter approach yields richer insights and typically higher (more elastic) price responses (Levin, Lewis and Wolak, 2017). Most studies have been conducted in the United States, where the price elasticity of fuel demand is lower than in Europe, largely because of the more limited availability of public transportation. Aklilu (2020) also evidences this difference in his analysis of 28 EU countries from 1978 to 2013. In addition, more recent evidence for Europe suggests greater price sensitivity

[6] With the expansion of diesel engine cars, especially in Europe and Spain (Miravete, Moral and Thurk, 2018), many studies started to differentiate between gasoline and diesel demand (Dahl, 2012; Liddle and Huntington, 2020; Fridstrøm and Østli, 2021; Aklilu, 2020; Danesin and Linares, 2015).

than earlier research, with Bonnet, Fize, Loisel and Wilner (2025) for France and González and Moral (2026) for Spain reporting short-run elasticities ranges, in absolute value, from 0.6 to 0.8.

Microdata studies rely on different information sources. On the one hand, *Household Travel Surveys* provide detailed data on trip patterns and vehicle kilometers traveled, but limited socioeconomic information (Bento et al., 2009, Knittel and Tanaka, 2021). On the other hand, *Household Budget Surveys* offer the opposite: rich demographic and income data but limited transport detail. Across both approaches, several studies consistently report similar findings on how price elasticity varies with location and population density. Commuting trips are more price-inelastic than leisure trips (Gillingham and Munk-Nielsen, 2019); rural households respond less to price changes (Gillingham, 2014; Gillingham, Jenn and Azevedo, 2015); and households in dense urban areas adjust consumption more readily (Archibald and Gillingham, 1980; Wadud, Graham and Noland, 2009; West and Williams, 2004).

However, the link between income and fuel price elasticity remains ambiguous: while Kayser (2000) and Gillingham (2014) find that high-income households are more responsive, West and Williams (2004) and Wadud, Graham and Noland (2010) report the opposite. Differences likely reflect contextual factors such as access to public transport and evolving vehicle technologies. Rebound effects are also relevant, as higher-income households may adopt more efficient cars yet increase their travel distances (Liu, 2014; Kaneko and Kagawa, 2021). Moreover, wealthier households typically exhibit lower marginal propensities to use public transport, even where available (Buehler, 2011; Wang and Renne, 2023; Arbués, Baños, Mayor and Suárez, 2016).

Another relevant issue for our analysis concerns the existence of different consumer responses depending on whether price changes result from fiscal policy or from firms' pricing decisions. The general finding is that households react more strongly to tax-induced price changes than to market-driven price fluctuations (Davis and Kilian, 2011; Li, Linn and Muehlegger, 2014; Rivers and Schaufele, 2015; Kilian and Zhou, 2024; Andersson, 2019). In most cases, this difference is explained by consumers perceiving tax-related price changes as more persistent than other price movements.

Following the literature reviewed above, we adopt a flexible specification of gasoline demand that allows price elasticity to vary with household characteristics such as income, age, and residential density. The dependent variable is the logarithm of each household's monthly gasoline consumption, regardless of whether the household also purchases diesel or public transportation services. Short-run price elasticities are appropriate for our analysis, as the subsidy was temporary and not announced in advance. Therefore, it is unlikely to have induced vehicle replacement decisions (e.g., scrapping older cars for more efficient models). Recall that mobility conditions in 2022 were comparable only to those in 2021; accordingly, we focus on 2021 data to estimate demand with a total of 3,449,706 households. We estimate a "log–log" demand function in which the price elasticity is linear in the price coefficient and its interactions with household characteristics. The baseline demand equation is:

$$\ln C_i = \beta_0 + \beta_1 \ln P_i + \beta_2(\ln P_i \times \ln Y_i) + \beta_3(\ln P_i \times \mathrm{Hidens}_i) + \beta_4(\ln P_i \times \ln \mathrm{Age}_i) + \delta_i + \varepsilon_i \quad (1)$$

where P_i is the average monthly price paid by household i per liter of gasoline. Total expenditure is used as a proxy for purchasing power, as it better captures economic resources and is generally subject to less measurement error than reported income in household surveys (Poterba, 2017, West and Williams, 2004). Thus, Y_i denotes monthly household expenditure; for simplicity, we refer to it as "income" in the remainder of the text. The variable *Hidens* takes the value 1 if the household resides in a municipality with more than 50,000 inhabitants and the area is classified as high density (500 inhabitants per km^2). These two characteristics are included because, in Spain, Article 26 of Law 7/1985 requires municipalities with more than 50,000 inhabitants to provide adequate public transport infrastructure. However, even in municipalities exceeding this threshold, their large geographic extent may result in suburban areas with insufficient public transport coverage. The variable *Age* measures the age of the main household earner, which ranges from 20 to 80 years.

Finally, we include a household-type fixed effect, δ_i, constructed from interactions between head-of-household and household characteristics. For the head of household, we include five *Age* groups (20–39, 40–49, 50–59, 60–69, 70–80). At the household level, we consider region (autonomous community), an indicator of residential type (*Hidens*). And, since multiple car ownership may be an important determinant of household gasoline consumption, but the dataset does not provide this information), we address this concern incorporating the presence of two income earners in the household as part of the household-type fixed effects. This variable serves as a proxy for household economic capacity and mobility needs, both of which are closely related to vehicle ownership. The full set of interactions across these dimensions yields a highly flexible classification of household types, which defines the fixed effects used in the estimation.

Given the log–log specification in equation (1), the elasticity for each household can be computed by a linear expression depending on its characteristics and the estimated demand coefficients:

$$\mu_i \;=\; \beta_1 \;+\; \beta_2 \,\ln Y_i \;+\; \beta_3 \,\mathrm{Hidens}_i \;+\; \beta_4 \,\ln \mathrm{Age}_i \quad (2)$$

Therefore, the specification allows us to test the following hypotheses:

- Higher household income reduces the disutility of paying a given fuel price (i.e., demand is more inelastic).
- Living in municipalities with more than 50,000 inhabitants in high-density areas increases the likelihood of substituting private vehicle use with alternative transport modes, making fuel demand more elastic.
- As the age of the main earner increases, fuel demand becomes more inelastic, reflecting a stronger preference for the use of private vehicles.

Identification. One of the main challenges in estimating fuel demand is price endogeneity: firms may adjust prices in response to demand conditions, while consumers simultaneously adjust their consumption in response to those same prices. This simultaneity bias can be addressed econometrically using instrumental variables (IV), although the main difficulty lies in identifying instruments that are both valid and sufficiently strong to isolate exogenous price variation.

With consumer microdata, the price is computed as the ratio of a household's reported expenditure to the number of liters consumed, and the scope for price endogeneity is arguably smaller (see the discussion in Tilov and Weber, 2023). Although Spain's retail fuel market is not perfectly competitive (e.g., González and Moral, 2023), an individual household's purchases are too small to influence firms' pricing decisions. These reasons lead us to believe that the endogeneity problem is not serious. Nonetheless, to address remaining concerns, we instrument for gasoline prices.

Because our analysis is cross-sectional, standard aggregate instruments (e.g., Brent crude) are unsuitable: they provide virtually no within-country variation and, even with regional fixed effects, would wash out household-level heterogeneity.[7] Following Nevo (2001), we instrument each household's transaction price with the leave-one-out average price paid by ex ante similar households in the same region. The identifying variation is the common marginal-cost component (e.g., wholesale rack prices, regional logistics, brand policies) that co-moves prices across municipalities where similar households purchase gasoline, while remaining orthogonal to the reference household's idiosyncratic demand shock conditional on controls and fixed effects.

A "similar" household is defined as one in the same income quartile,[8] residing in a municipality with the same size (more than 100,000, between 50,000 to 100,000, between 20,000 to 50,000 and less than 20,000 inhabitants) and the same population-density category, exhibiting the same expenditure pattern on alternative transport modes (diesel or public transit), and whose

[7]In time-series or long-panel analyses, crude oil prices—such as Brent or other international benchmarks—are commonly used as instruments for retail fuel prices (see, for example, Levin et al., 2017; Burke and Nishitateno, 2013, or Bardazzi and Grazia Pazienza, 2024), and fuel excise taxes have also been employed (Coglianese, Davis, Kilian and Stock, 2017; Davis and Kilian, 2011).

[8]Hausman and Newey (2016) also uses income-based groupings as a price instrument.

principal earner matches the *Age* group (20–39, 40–49, 50–59, 60–69, or 70–80). The identifying assumption is that income quartiles and transport expenditure patterns proxy local market conditions where the household resides, such as the average income level of the municipality and the availability of alternative transport modes. These characteristics are further interacted with other market attributes (such as population density and municipality size), while the leave-one-out construction always excludes the household's own characteristics. This approach allows us to exploit variation in prices across local markets without compromising identification, as the household characteristics used are broad and therefore unlikely to violate the exclusion restriction. Taken together, these features ensure that the instrument is not mechanically correlated with the individual household's demand shock.

Moreover, we include as instruments 14 autonomous-community fixed effects to absorb regional demand shocks and common pricing policies, so that the remaining cross-household price co-movement reflects costs rather than demand. Finally, because the demand specification includes interactions between price and household characteristics, we also instrument the corresponding interaction terms.

Table 3: Instrumental Variables Estimation of Gasoline Demand

Variable		Coefficient	Robust SE
$\ln P$		-4.2760^{***}	(0.103)
$\ln P \times \ln Y$		0.133^{***}	(0.006)
$\ln P \times \ln \text{Age}$		0.720^{***}	(0.023)
$\ln P \times \text{Hidens}$		-0.205^{***}	(0.022)
FE by household type		Yes	
Households (observations)		3,449,706	(3,298)
Diagnostics:			
Underindentification Test	K-P rk LM (p-value)		0.000
Weak identification Test	Cragg-Donald Wald F statistic		4.4e+05
	K-P rk Wald F statistic		3.2e+05

Note: The dependent variable is $\ln(C_i)$, where C_i is household gasoline consumption (liters per month, computed from annual liters). P_i is the household unit value (€/liter). Estimation uses sampling weights and household-type fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses. *** indicates significance at the 1% level. *Households* reports weighted population totals; *observations* in parentheses report the number of survey households.

Table 3 reports the instrumental variables (IV) estimation for gasoline demand.[9] The estimation takes into account the household sampling weights, which vary across households and autonomous communities, making the results representative at both regional and national levels. Instrument relevance is confirmed supported by the Kleibergen–Paap statistics which

[9]The IV estimation is implemented using the "ivreghdfe" command in Stata, which allows us to efficiently absorb the large number of household-type fixed effects included in the specification.

strongly rejects the null of underidentification ($p < 0.001$). The Kleibergen–Paap rk Wald F statistic is well above conventional thresholds used to detect weak instruments. Coefficient signs align with the prior literature, and all are statistically significant. High-income households, an older principal earner, and residence in smaller or lower-density municipalities are associated with lower price sensitivity (i.e., more inelastic demand).

2.3 Heterogeneous price-elasticity

From the estimates reported in Table 3, we derive the distribution of short-run price elasticities for the population that effectively consumes gasoline. Table 4 reports mean and median elasticities by income quartile. Among households consuming gasoline, the median elasticity is -0.53, consistent with recent evidence for European countries (see Subsection 2.3).

Table 4: Estimated gasoline price elasticity by income quartile

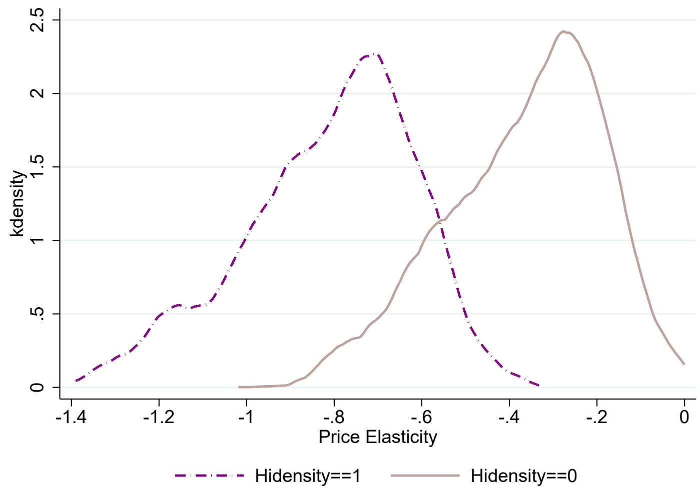
Income quartile	Mean	Median
Q1	-0.659	-0.632
Q2	-0.595	-0.575
Q3	-0.548	-0.523
Q4	-0.468	-0.456
Total	-0.551	-0.531

Note: Elasticities are computed using Equation (2) and the IV estimates in Table 3. Quartiles are defined using the income proxy in the full 2021 SHBS sample.

To assess the robustness of the results, we re-estimate the same specification using the 2019 wave of the Spanish Household Budget Survey, applying the same sample filters and restrictions. The estimated median price elasticity for 2019 is -0.66, indicating a somewhat more elastic response than the estimate obtained with the 2021 data (-0.55). This difference is consistent with the substantial changes in mobility patterns observed following the COVID-19 pandemic. In particular, the use of public transportation declined markedly during 2020-2022, while many households relied more heavily on private vehicles, thereby reducing the availability of short-run substitutes for gasoline consumption. As a consequence, gasoline demand appears more elastic in 2019, when substitution possibilities were greater. The 2021 estimate can therefore be regarded as a conservative benchmark for the policy simulations, since a more elastic demand would imply a larger consumption response to the subsidy and, consequently, larger emission effects.

Another relevant aspect is that elasticity declines with income: higher-income households are less responsive to price changes. For the first income quartile, the estimated median price elasticity is -0.63, while for the fourth quartile it decreases in absolute value to -0.46. Moreover, residential location also matters, then Figure 1 plots the elasticity distribution for households in large, high-density municipalities (Hidens = 1) versus all others (Hidens = 0). The former distribution is shifted leftward (i.e., more elastic), reflecting greater scope to substitute private vehicle use with public transportation.

Figure 1: Estimated gasoline price elasticities



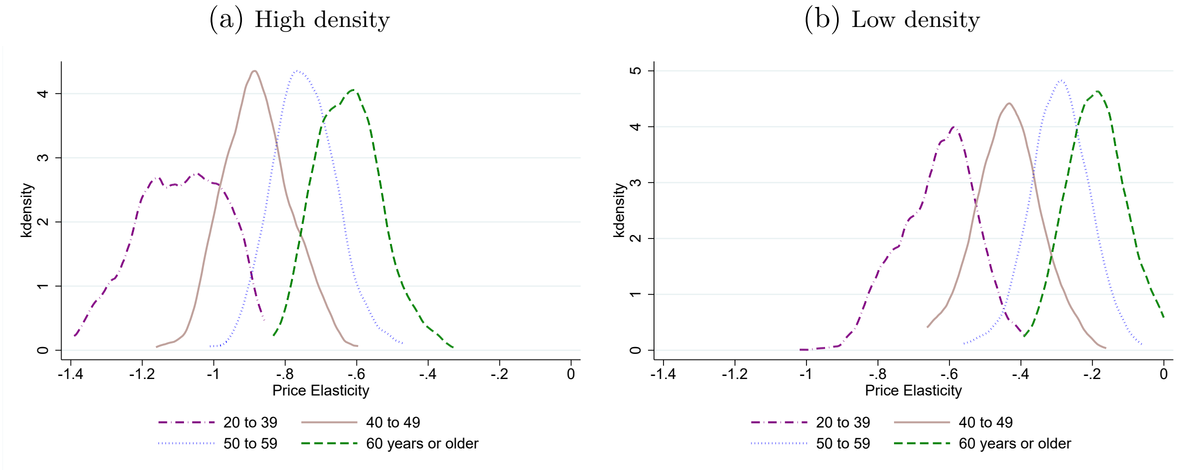
Note: Estimated using the demand model from Table 3.

The *Age* of the head of the household also shapes the intensity of households' responses to price changes. Figure 2 represents the distribution of price elasticities by the main earner's age distinguishing the following intervals: 20–39, 40–49, 50–59, and 60 or older. It is clear the highest sensitivity among the youngest group versus the lowest sensitivity for consumers with 60 years and older. This reflects both age effects and income effects because the youngest group presents, on average, lower incomes as well as a greater propensity to use public transportation than older cohorts, increasing the scope for substitution (Brown, Blumenberg, Taylor, Ralph and Voulgaris, 2016).

Figure 3 reports median price elasticities by autonomous community, further indicating that responsiveness varies not only with income but also with age composition and access to public transport. For example, households in the Community of Madrid—despite relatively high average incomes—do not exhibit the most inelastic demand, consistent with the region's high propensity to use public transportation. Furthermore, Castilla and León shows a highly inelastic response to price changes, largely driven by its aging population, which in our data is reflected in the high average age of the household head.

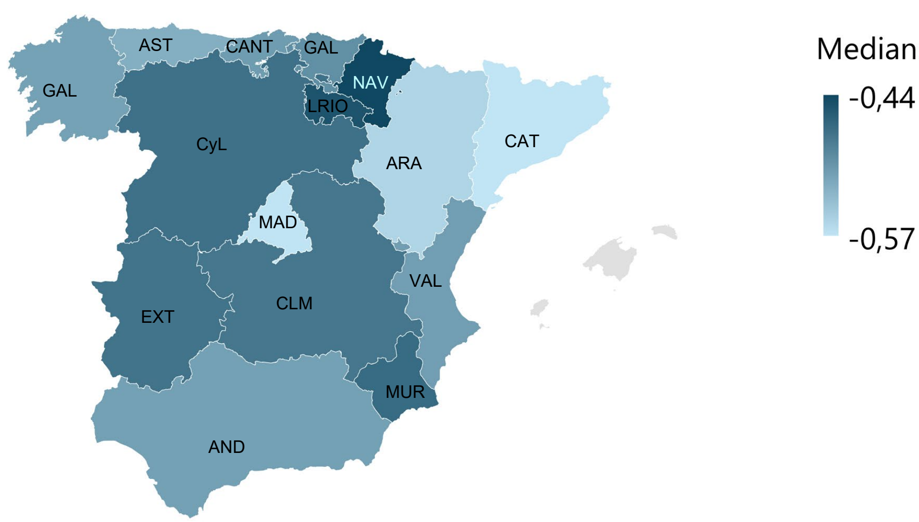
Overall, the heterogeneity observed across household characteristics and regions highlights the limitations of relying on a single national average elasticity, particularly when assessing

Figure 2: Estimated gasoline price elasticities by household characteristics



Estimated using the demand model from Table 3.

Figure 3: Estimated price elasticity of gasoline by region



Note: Estimated price elasticity of gasoline using the demand model from Table 3.

the redistributive effects of fiscal policy. The credibility of our policy evaluation improves when this heterogeneity is explicitly incorporated into the estimation of the elasticity distribution.

3 Transmission of subsidy to prices

Having established how households adjust their gasoline consumption in response to price changes, we now turn to the supply side of the policy mechanism, namely, the transmission of the subsidy to consumer prices (the pass-through rate). A simple benchmark would assume full pass-through, that is, a one-for-one reduction of €0.20 per liter in consumer prices. However, economic theory and empirical evidence suggest that this is not necessarily the case.

Under perfect competition, the degree of pass-through depends on the elasticities of demand and supply. When firms possess market power, however, the relationship becomes more complex. A substantial theoretical literature analyzes how market power and other market characteristics shape the extent of pass-through (e.g., Anderson, De Palma and Kreider, 2001; Weyl and Fabinger, 2013; Adachi and Fabinger, 2022; Ritz, 2024). These theoretical insights have, in turn, motivated extensive empirical work estimating tax pass-through rates across a range of industries, with particular focus on the retail fuel market.[10]

Recent evidence from the 2022 European interventions shows substantial variation in pass-through across and within countries. Cross-country studies find substantial heterogeneity in pass-through rates. For example, Drolsbach et al. (2023) find pass-through rates in Germany,[11] around 100% for gasoline and 85% for diesel; in France, about 75% for both fuels; and in Italy, close to 100% for gasoline and somewhat lower for diesel. In Spain, findings are mixed and sensitive to data and methodology. Balaguer and Ripollés (2024) and Jiménez et al. (2025) report full pass-through for gasoline and partial pass-through for diesel, whereas Hidalgo et al. (2022) and Moral (2023) document incomplete transmission for both fuels. In the United States, Tsvetanov (2024) analyze temporary gasoline tax suspensions in 108 cities in 2022, finding less than full pass-through of 79%. Overall, the evidence indicates that the 2022 subsidies reduced consumer prices, but not fully—underscoring the need to account for incomplete pass-through when assessing the policy's distributional and environmental effects.

3.1 Evolution of retail fuel prices and subsidy period

To quantify the effective discount received by consumers, we use the Petroleum Products Statistics compiled by Spain's National Commission on Markets and Competition (CNMC). The dataset provides weekly, province-level averages of retail motor-fuel prices, as well as

[10] See, for example, Chouinard and Perloff (2004); Doyle and Samphantharak (2008); Alm, Sennoga and Skidmore (2009); Marion and Muehlegger (2011); Kopczuk, Marion, Muehlegger and Slemrod (2016); Yilmazkuday (2017); Bajo-Buenestado and Borrella-Mas (2019); Muehlegger and Sweeney (2022); Bajo-Buenestado and Borrella-Mas (2022); Harju et al. (2022); Montag, Mamrak, Sagimuldina and Schnitzer (2023).

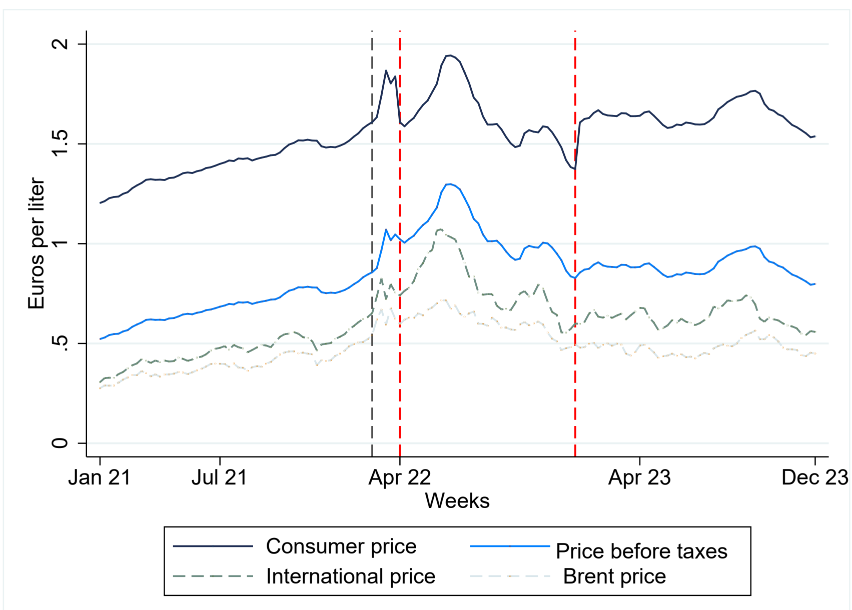
[11] Germany has also received much attention as the effectiveness of these measures has been widely debated (see Schmerer and Hansen, 2023; Dovern, Frank, Glas, Müller and Ortiz, 2023; Kahl, 2024; Bernhardt, Breiderhoff and Dewenter, 2023; von Waldow and Link, 2024).

official wholesale gasoline prices and international Brent crude benchmarks. Our sample spans January 2021 to December 2023, covering more than a year before and after the policy window (April–December 2022). This panel structure allows us to identify shifts in retail price levels during the subsidy period relative to adjacent pre- and post-policy windows, while controlling for common shocks using wholesale price controls and fixed effects.

Figure 4 displays average gasoline prices at service stations, along with pre-tax retail prices, international wholesale gasoline prices, and Brent crude. As widely documented (see Borenstein and Shepard, 1996; Tappata, 2009), retail prices closely follow international wholesale prices and their volatility. Crude oil—primarily Brent—constitutes the main input into gasoline and diesel production, and its price is highly responsive to global demand conditions, OPEC production decisions, geopolitical developments, and supply chain disruptions.

Since early 2021, international fuel prices have increased alongside the post-pandemic recovery in global demand. Following Russia's invasion of Ukraine, heightened uncertainty and market disruptions—including sanctions, trade rerouting, refining bottlenecks, and logistics constraints—caused retail prices to rise more rapidly than crude prices.

Figure 4: Average weekly gasoline prices



Notes: The figure shows average weekly retail fuel prices between January 2021 and December 2023. The red shaded area indicates the subsidy period, while the vertical line marks the onset of the Ukraine war. Prices are averaged across provinces. Data from the Petroleum Product Statistics (National Commission on Markets and Competition, CNMC).

This shift in market dynamics is reflected in a notable decline in the comovement of international gasoline prices: their correlation fell from 0.957 prior to the war in Ukraine to 0.764 thereafter. Several factors help explain this decoupling. First, the European Union is considerably more reliant on diesel imports than on gasoline. Second, at the beginning of 2022, Russia was a major supplier of the EU's diesel imports. In anticipation of sanctions and amid the redirection of global trade flows, market participants accelerated diesel purchases during the second half of 2022.

3.2 Estimation of pass-through

To quantify the impact of the subsidy on retail fuel prices, we exploit the temporal discontinuity created by its introduction and subsequent removal. Since the measure was implemented uniformly across all provinces, it induces a clear break in the time series of retail prices. This setting lends itself to a time-based regression discontinuity design embedded in a provincial–week panel structure. Formally, we estimate the following regression model.

$$P_{rt} = \beta_0 + \beta_1 T_1 + \beta_2 T_2 + \beta_3 T_3 + \delta' z_{tr} + \varepsilon_{rt} \tag{3}$$

where P_{rt} denotes the final retail price of gasoline (in euros per liter).[12] in province $r = 1, \ldots, 47$ and week $t = 1, \ldots, 157$. The explanatory variables of interest are four indicator variables that correspond to distinct policy periods. Specifically, T_1 covers the interval between the onset of the conflict in February 2022 and the introduction of the subsidy in April 2022; T_2 identifies the weeks during which the subsidy was in effect (April–December 2022); and T_3 corresponds to the post-subsidy period (January–December 2023). The excluded category (T_0) is the pre-war period (from early 2021 until the outbreak of the war in Ukraine).

In addition, we include several control variables to account for factors that may influence retail fuel prices. First, we incorporate wholesale gasoline prices for weeks $t-1$, $t-2$, and $t-3$ to capture cost volatility. Second, we add indicator variables for major holiday periods to control for seasonal demand increases associated with higher mobility. These periods typically coincide with sharp travel peaks: Easter, Christmas, and the beginning and end of the summer holiday season (the first and last weeks of July and August). Third, we capture the local market structure using two variables: the provincial share of service stations affiliated with the main vertically integrated operators (Repsol, Cepsa, and BP) and the share of low-cost or automated

[12] The gasoline final price includes the station-set price (P^I_{rt}), fixed excise taxes (τ)—which are constant across provinces and over time—and the value-added tax (VAT). During the subsidy period, service stations applied a uniform discount of €0.20 per liter, Therefore, the final price is given by: $P_{rt} = (P^I_{rt} + \tau)(1 + VAT) - T_2 \times 0.2$.

stations. Finally, we include fixed effects of the autonomous community to absorb time-invariant unobserved regional heterogeneity.

Table 5 reports the results of the estimation of the econometric model (3). The coefficients of interest (β_2) indicate that the subsidy did not fully pass through to the final consumer prices, consistent with findings from previous studies. Specifically, retail prices declined by €0.178 per liter—short of the €0.20 reduction stipulated by the policy—implying an incomplete pass-through rate of approximately 89%. This estimate is slightly lower than those reported by Moral (2023), Balaguer and Ripollés (2024), and Jiménez et al. (2025), who find pass-through rates between 90% and 100% for gasoline.

Table 5: Estimated pass-through of the subsidy to retail prices

Explanatory Variables	Coefficient	Robust SE
T_1 Post-war pre-subsidy	0.035^{***}	(0.001)
T_2 **Subsidy period**	-0.178^{***}	(0.002)
T_3 Post-subsidy	0.024^{***}	(0.000)
Wholesale price lag1	0.666^{***}	(0.011)
Wholesale price lag2	0.242^{***}	(0.005)
Wholesale price lag3	0.316^{***}	(0.005)
Constant	0.828^{***}	(0.015)
Other controls:		
% Repsol-Cepsa-BP	Included	
% Low-cost / automated	Included	
Autonomous community FE	Included	
Summer period (dummy)	Included	
Easter week (dummy)	Included	
R^2	0.99	
Observations	7,191	

Note: This table reports the results of the baseline pass-through regression. The dependent variable is the weekly retail price of gasoline averaged at the provincial level. Standard errors clustered at the provincial level are reported in parentheses. *** indicates significance at the 1% level. The regression also includes the following control variables: 17 Autonomous Community fixed effects; two dummy variables for the summer period and Easter week; and two variables measuring the share of refined brands and automated and low-cost stations at the provincial level. Finally, three lags of the wholesale price are included.

We use the pre-war period as the reference category to avoid contamination from the sharp price adjustments that followed the outbreak of the war in Ukraine. As a robustness check, we estimate two alternative specifications reported in Table B.1 of the Appendix. In the first specification, we exclude from the sample the weeks between the start of the war and the introduction of the subsidy. The estimated pass-through is virtually identical to the one reported in Table 5. In the second specification, we use the full sample and take as the reference period all weeks prior to the subsidy. In this case, the estimated coefficient is 0.193, which corresponds to a pass-through of about 97%, closer to the full pass-through estimates reported in the previous literature. Nevertheless, we consider it more appropriate to exclude from the control period the few weeks between the outbreak of the war and the introduction of the policy. This interval was characterized by exceptional volatility in fuel markets and unusually large price fluctuations. While policy evaluations typically compare outcomes before and after the intervention, in this case the weeks immediately preceding the subsidy were already affected by the large price shock triggered by the war. Including this period in the control group may therefore distort the counterfactual price dynamics. For this reason, our preferred specification uses the pre-war period as the reference category.

4 Distributional incidence of the subsidy

Having estimated both the price response to the subsidy and the consumption response to price changes, we now assess its impact on fuel consumption and its redistributive implications. This framework allows us to link price transmission and heterogeneous demand responses to the distribution of fiscal benefits across households.

A first consideration regarding distributional effects is that not all households own a vehicle. According to Laborda and Moral (2019), in 2015 about 76% of households owned at least one vehicle, 6% could not afford one, and 17.9% chose not to own one. In practice, the share of households that regularly use a private vehicle is lower, as many older vehicles remain registered but are no longer in use. Consistent with this, in 2022, only 31.9% of households purchased gasoline. Therefore, only this share of households benefited directly from the gasoline subsidy. Moreover, the likelihood of purchasing gasoline increases with income. Overall, Table A.3 indicates that the subsidy did not reach all population groups equally, with higher-income households more likely to benefit.

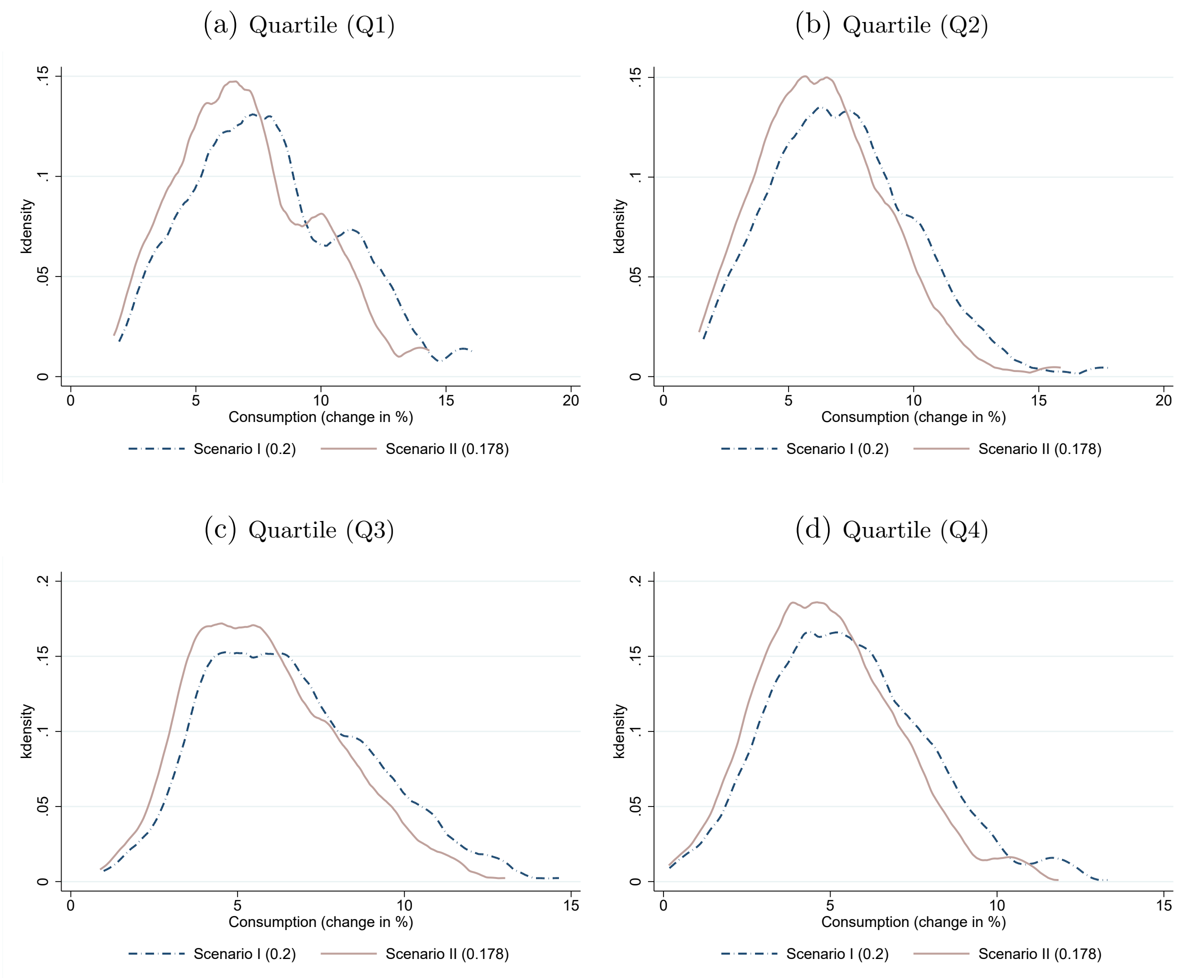
4.1 Effect on consumption

Conditioning the analysis on households that actually received the subsidy, we use the estimates from Sections 3 and 2 on price pass-through and price elasticity, respectively, to first quantify the effects of the €0.20-per-liter gasoline subsidy on consumption.

We consider two scenarios as a bounding exercise: (i) Scenario I (0.20), corresponding to full pass-through of the subsidy to consumers; and (ii) Scenario II (0.178), corresponding to partial pass-through based on our baseline estimate, in which firms retain €0.022 per liter sold and consumers effectively receive €0.17

For each scenario, we compute the implied increase in gasoline consumption resulting from the subsidy using the household-specific estimated elasticities. To do so, we first recover each household's initial consumption level, which depends on the pre-subsidy price (i.e., the price prevailing just before March 2022). We construct the pre-subsidy price vector by taking the observed 2021 prices and adding the average retail price increase recorded between 2021 and March 2022. We then compute, for each household and scenario, the corresponding change in fuel consumption implied by the estimated elasticities.

Figure 5: Consumption response to the subsidy by pass-through



Note: Each panel plots the distribution of the predicted percentage change in household gasoline consumption induced by the subsidy, by income quartile. Scenario I assumes full pass-through (effective price reduction of 0.20 euros/liter). Scenario II uses the baseline pass-through estimate (effective reduction of 0.178 euros/liter). Predicted changes are computed using household-specific elasticities from Section 2 and the pre-subsidy price vector described in Section 4.1.

Figure 5 presents the results by income quartile.[13] Under full pass-through, consumers face a larger effective price reduction, leading to a stronger consumption response and a rightward shift of the distribution. In contrast, under partial transmission, the smaller price reduction limits the demand response, resulting in a smaller increase in fuel consumption.

4.2 Heterogeneous incidence across income distribution

The differential impact on consumption across income groups has distributional implications. Table 6 reports the distribution of the subsidies across households and firms under two scenarios. In Scenario I, which assumes full pass-through, the entire subsidy accrues to households. Even in this case, the distribution is clearly regressive: higher-income households capture a disproportionately large share of the transfer, with the top quartile receiving 31.9% compared to only 14.0% for the bottom quartile. Scenario II incorporates incomplete pass-through, reflecting our baseline estimate. In this case, firms capture 11% of the total subsidy, reducing the share received by households across all income groups. The regressive pattern remains largely unchanged, with higher-income households continuing to capture a larger share of the subsidy.

Table 6: Distribution of the subsidy across households and firms
(Percent of Total Transfer)

	Scenario I (€0.20)	Scenario II (€0.178)
Households, Q1	13.98	12.43
Households, Q2	24.94	22.18
Households, Q3	29.22	26.04
Households, Q4	31.86	28.39
Firms	–	11.00

Notes: The table reports the share of the total subsidy captured by each income quartile and by firms under two scenarios. Scenario I assumes full pass-through of the subsidy to retail prices. Scenario II incorporates incomplete pass-through based on the baseline estimates. Household shares are computed using the full sample of gasoline-consuming households. Percentages sum to 100 across households and firms.

These results highlight two key mechanisms. First, the distribution of benefits across households is influenced by the extensive margin: a larger fraction of lower-income households do not consume gasoline and therefore receive no subsidy. As a result, the pool of beneficiaries is skewed toward higher-income groups, leading to a disproportionate allocation of public resources to richer households. Second, incomplete pass-through introduces an additional margin of incidence, whereby part of the fiscal transfer is captured by firms. Taken together, these mechanisms imply that uniform per-liter subsidies not only distribute benefits unevenly across

[13] Figures B.1 to B.3 in the Appendix display the distribution across regions.

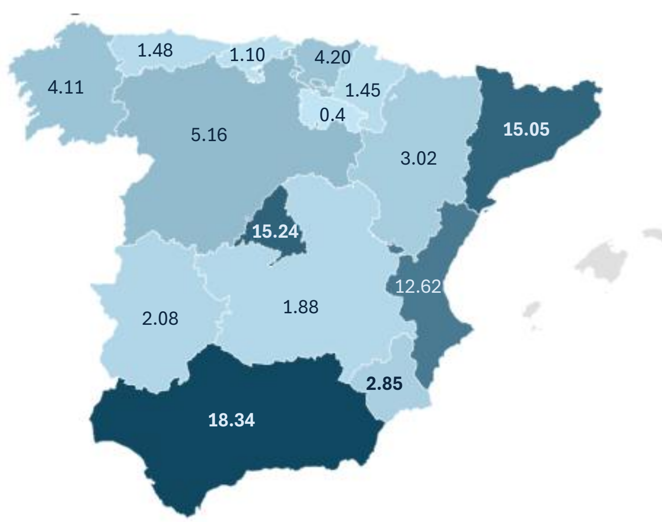
households, but also transfer a non-negligible share of public resources to firms under imperfect competition.

4.3 Heterogeneous incidence across regions

Mainland Spain is divided into 15 regions (*Comunidades Autónomas*), which differ substantially in terms of income levels, but also in population density, urban structure and population aging (see Table 2). These differences are also reflected in household demand responsiveness (see Figure 3), suggesting that the incidence of fuel subsidies may vary considerably across regions.

To explore this dimension, Figure 6 first reports the regional distribution of the fuel subsidy under Scenario II. The results reveal substantial regional heterogeneity in the aggregate share of subsidy expenditure received mainly due to the population size. Andalusia, Madrid, Catalonia, and the Valencian Community together account for around 61% of the total subsidy, while also containing 63% of households in mainland Spain.

Figure 6: Distribution of the Subsidy across Regions



Note: Percentage of Total Transfer for Households under Scenario II (see Table 7).

Secondly, the within-region distribution of the subsidy differs substantially across territories. The high-income regions such as Madrid and the Basque Country exhibit a stronger

Table 7: Distribution of the subsidy across regions and households

Regions	Subsidy	Q1	Q2	Q2	Q4	Total
Andalusia (AND)	18.38	11.36	29.86	29.49	29.29	100.00
Madrid (MAD)	15.24	11.61	19.51	28.47	40.41	100.00
Catalonia (CAT)	15.05	11.44	23.38	32.22	32.95	100.00
Valencian Comm. (VAL)	12.62	16.60	24.78	30.41	28.22	100.00
Castile and León (CyL)	5.16	21.79	23.43	25.37	29.41	100.00
Basque Country (PVAS)	4.20	10.13	23.67	27.29	38.91	100.00
Galicia (GAL)	4.11	14.64	21.02	34.09	30.25	100.00
Aragon (ARA)	3.02	18.09	28.98	23.87	29.05	100.00
Murcia (MUR)	2.85	9.33	24.20	30.86	35.60	100.00
Extremadura (EXT)	2.08	20.37	24.89	32.76	21.99	100.00
Castile-La Mancha (CLM)	1.88	25.30	27.84	22.16	24.70	100.00
Asturias (AST)	1.48	17.80	34.58	29.82	17.80	100.00
Navarre (NAV)	1.45	23.81	33.42	20.17	22.60	100.00
Cantabria (CANT)	1.10	18.54	32.33	14.97	34.16	100.00
La Rioja (LRIO)	0.39	20.85	11.96	28.02	39.16	100.00

Note: Column 1 reports the share of the total effective subsidy received by households in each mainland Spanish region under Scenario II. Columns 2–5 report the distribution of the regional subsidy across household income quartiles within each region. Percentages in each row sum to 100. Since pass-through is incomplete, households receive approximately 89% of total public expenditure, while the remaining 11% is absorbed by firms through incomplete transmission of the subsidy to consumer prices.

concentration of subsidy benefits among upper-income households, with the fourth income quartile capturing close to 40% of the regional subsidy. This pattern largely reflects a composition effect, since higher-income households are disproportionately concentrated in these regions. By contrast, lower-income regions such as Castile and León, Castile-La Mancha and Extremadura display a substantially more even distribution across quartiles.

Overall, the results suggest that regional heterogeneity and income heterogeneity are closely interconnected dimensions of fuel subsidy incidence. Regional differences in the distributional effects of the subsidy arise not only from differences in population size, but also from heterogeneity in income composition, population density, and access to public transportation across regions.

4.4 Comparing fuel subsidies and cash transfers

To assess the redistributive properties of price-based subsidies relative to alternative cash-transfer schemes, we first compute the gross fiscal cost of the €0.20 per-liter subsidy, defined as total public expenditure (i.e., total fuel consumption multiplied by the statutory subsidy rate). Because pass-through is incomplete, the statutory subsidy differs from the effective consumer subsidy. While the government pays €0.20 per liter, consumers receive on average only €0.178 per liter. We therefore compute both the gross fiscal cost and the effective consumer subsidy and express these in per-household terms. We construct two counterfactual cash-transfer scenarios that redistribute the same total fiscal cost. In the first scenario, total expenditure is allocated uniformly across income quartile and within each quartile among all gasoline-consuming households. In the second, we consider a progressive allocation, assigning 40% of total expenditure to the lowest income quartile, 30% to the second quartile, and 20% and 10% to the third and fourth quartiles, respectively.

This allocation is intended as an illustrative exercise rather than a normative recommendation, as the distribution of public transfers ultimately reflects policy choices made by the regulator. The counterfactual exercises should be interpreted as illustrative comparisons rather than as full evaluations of alternative transfer policies, since we abstract from broader expenditure adjustments that may arise from exogenous increases in disposable income. This consideration is particularly relevant for unconditional cash transfers. By contrast, the framework would be more informative for compensation schemes directly linked to fuel purchases, such as fuel vouchers.

Table 8: Average cash transfers under alternative policy scenarios

	Benchmark policy		Cash transfer I	Cash transfer II
	Fiscal cost	Effective subsidy		
Q1	98.0	87.3	175.5	280.8
Q2	96.3	85.7	96.6	115.9
Q3	98.1	87.3	83.9	67.1
Q4	103.7	92.3	81.3	32.5

Note: First column reports the average fiscal cost and the subsidy received by each household that consume gasoline (in €) in the current policy and an incomplete pass-through. The second and third columns present the average subsidy under two different counterfactual cash transfers with the same fiscal cost.

Table 8 shows that current policy delivers similar average benefits across income quartiles despite large differences in total transfers. This reflects two offsetting mechanisms. On the one hand, the share of households that consume gasoline increases with income, as lower-income households are less likely to own or regularly use a vehicle. However, conditional on consuming gasoline, average fuel use does not differ markedly between quartiles, partly because lower-income households are more likely to reside in rural areas with higher car dependency. As a result, average benefits per household are similar across income groups, and the policy generates little redistribution per household.

By contrast, cash transfers break the link between benefits and fuel consumption. Under the uniform transfer (Cash Transfer I), lower-income households receive higher average transfers because they represent a smaller share of gasoline consumers. A progressive allocation (Cash Transfer II) further amplifies this effect, substantially increasing transfers for the lowest quartile while reducing them for the highest.

While targeted cash transfers offer clear advantages in terms of progressivity, they are not without limitations. Price-based measures are easier to implement and provide immediate relief at the point of purchase, which helps explain their use during recent fuel price spikes in Europe. However, such measures distort price signals by lowering the cost of fossil fuel consumption, weakening incentives to reduce fuel use or adopt cleaner alternatives. As a result, although they provide short-term relief, they are poorly aligned with environmental objectives and may increase emissions.

5 Policy implications on emissions

From an environmental perspective, fuel taxation acts as a Pigouvian instrument: by increasing retail prices, it internalizes part of the social cost of CO_2 emissions and reduces fuel consumption Q through the (negative) price elasticity of demand. This provides a useful benchmark for evaluating policies that move prices in the opposite direction, such as fuel subsidies or tax reductions. Because emissions E are monotonically increasing in Q, these policies lead to higher fuel consumption and, consequently, higher emissions. Assuming emissions are proportional to consumption, we can write $E = \theta Q$, where $\theta > 0$ denotes the emission factor (kilograms of CO_2 per liter). Conversely, a per-unit subsidy lowers the consumer price and weakens the price signal, leading to an increase in fuel consumption ($\Delta Q > 0$) relative to a no-policy baseline and, through this channel, to higher emissions. Formally,

$$\Delta E \; = \; \theta \, \Delta Q \; > \; 0. \tag{4}$$

Equation 4 shows that higher fuel consumption translates directly into higher CO_2 emissions. Accordingly, any fiscal policy that stimulates fuel use has adverse environmental consequences. Based on this framework, we compute the increase in emissions induced by the subsidy.

For the emissions factor θ, we follow standard practice in the literature (see, e.g., Davis and Kilian, 2011; Pang, An and Shen, 2023) by assigning a constant level of CO_2 emissions per liter of gasoline consumed. According to the Spanish Environmental Agency (IDAE, *Instituto para la Diversificación y el Ahorro Energético*), this parameter is set at 2.35 kilograms of CO_2 per liter. Using the estimated increase in gasoline consumption for each household and this emissions factor ($\theta = 2.35$), we compute the corresponding increase in CO_2 emissions at the household level.

To assess the distribution of emissions across households, we compute total emissions over the nine-month period during which the subsidy was in effect (April to December 2022), both under the observed policy and under a counterfactual scenario without the subsidy. Table 9 reports total emissions in each case, their difference, and the corresponding shares across income quartiles. The results show that lower-income households contribute less to the aggregate increase in emissions, primarily due to the lower share of car owners. In contrast, higher-income households account for a disproportionately larger share of the increase: households in the top income quartile generate 26.8% of total additional emissions, compared with 16.1% for those in the bottom quartile. This joint pattern reflects the design of the subsidy, which scales transfers with consumption. By lowering the marginal cost of gasoline, the policy weakens price signals and disproportionately stimulates demand among high-consuming households. In this sense, the environmental and distributional effects are closely aligned: the same mechanism that generates regressivity also drives higher emissions. As a result, the policy simultaneously increases emissions and amplifies the concentration of emissions among richer households. Importantly, these results should be interpreted as short-run effects, as longer-term adjustments in consumption and technology adoption may alter the magnitude of the environmental impact.

Table 9: Estimated total CO_2 emissions during the subsidy period (tons)

Households	With subsidy	Without subsidy	Difference	Share (%)
Q1	562,254	527,752	34,502	16.10
Q2	1,003,203	944,591	58,612	27.35
Q3	1,176,281	1,112,532	63,749	29.75
Q4	1,284,078	1,226,658	57,420	26.80

Note: Columns (1) and (2) report total CO_2 emissions (in tons) by income quartile under the observed subsidy and the counterfactual scenario without subsidy, respectively. Column (3) reports the increase in emissions attributable to the subsidy, and column (4) shows the corresponding share across quartiles.

These estimates may be subject to additional bias for several reasons, which are not directly testable due to data limitations. The most important concern relates to the composition of the vehicle fleet: differences in vehicle age and engine type affect the emissions factor θ, i.e., the average amount of CO_2 emitted per liter of fuel consumed (Zachariadis, Ntziachristos and Samaras, 2001).

There is evidence that lower-income households are more likely to own older vehicles (EIA, 2018). Vehicles acquired according to earlier—and less stringent—environmental standards and subject to efficiency losses due to age emit more CO_2 per liter of fuel consumed. It is therefore plausible that, if vehicle age were taken into account, the subsidy-induced increase in emissions would be even greater among households in the first and second income quartiles. On the other hand higher-income households may adopt more efficient cars (Liu, 2014; Kaneko and Kagawa, 2021). However, the Spanish Household Budget Survey does not provide data on vehicle ownership at the household level.

6 Conclusions

This paper evaluates the distributional and environmental effects of Spain's 2022 fuel subsidy in a setting with heterogeneous consumers and imperfectly competitive retail fuel markets. By combining household-level demand elasticities with estimates of pass-through to retail prices, we provide a unified framework to evaluate both fiscal incidence and environmental effects.

Four main findings emerge. First, the short-run price elasticity of gasoline demand is -0.55 on average, with substantial heterogeneity across households and regions. Spanish regions differ markedly in terms of income composition, population density, transport alternatives, and fuel dependence, leading to heterogeneous consumption responses and distributional effects across territories. Second, pass-through is incomplete: on average, only 89% of the intended €0.20 reduction reached consumers, implying that firms captured part of the fiscal transfer. Third, the distribution of benefits is regressive: households in the lowest income quartile receive 12.4% of total fiscal support, compared to 28.4% in the highest. This pattern reflects both the extensive margin of fuel consumption as lower-income households are less likely to consume gasoline. Richer regions such as Madrid and the Basque Country display a stronger concentration of subsidy benefits among upper-income households. Counterfactual exercises show that reallocating the same fiscal cost through targeted transfers would substantially improve progressivity. Finally, the increase in fuel consumption led to higher carbon emissions, with higher-income households accounting for a larger share of the increase.

These findings suggest that per-liter fuel subsidies are poorly suited to achieving distributional and environmental objectives. Although they provide immediate price relief, they impose substantial fiscal costs, disproportionately benefit higher-income households, and weaken incentives to reduce emissions, which highlight the limitations of price-based interventions.

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APPENDIX

A Additional Descriptive Statistics

Table A.1: Fraction of households consuming gasoline by income quartile

Age	2019	2021	2022
Q1	24.65	16.73	15.08
Q2	39.58	31.48	27.51
Q3	50.58	40.58	37.84
Q4	58.02	49.87	47.19
Spain	43.21	34.67	31.90

Source: Authors' calculations based on the SHBS (INE).

Table A.2: Descriptive Statistics for Gasoline-Consuming Households* (by income quartile)

Income Quartile	Expenditure by month (total)	(per capita)	Location (*Hidens*)	*Age* (years)
Q1	950.41	687.99	50.98	51.35
Q2	1,502.93	817.78	48.65	51.41
Q3	2,165.97	1,035.28	52.88	51.40
Q4	3,966.39	1,667.83	56.54	52.39

Note: Income quartiles computed over the 15.8 million households in 2021. Both expenditures are averages in €, the expenditure *per capita* is computed following the OECD equivalence scale. Location (variable named as *Hidens*) represents the percentage of households residing in municipalities with more than 50,000 inhabitants and high population density (more than 500 inhabitants per km^2). *Age* is the age of the main household earner.

Source: Authors' calculations based on the SHBS.

Table A.3: Descriptive statistics for gasoline-consuming households for the Selected sample

Income Quartile	Number of households	Income by month (total)	(per capita)	Location (*Hidens*)	*Age* (years)	Gasoline Expenditure
Q1	488,052	945.46	672.65	52,20	51,97	9.19
Q2	886,561	1,498.52	804.40	49,73	51,25	5.32
Q3	1,020,991	2,168.75	1,010.14	55,21	51,55	3.79
Q4	1,054,102	3,840.30	1,589.84	58,55	52,32	2.33

Note: Sample of 3,449,706 gasoline-consuming households obtained after applying the filters described in Section 2.1. *Number of households* reports weighted population totals (expansion factors); The *Gasoline Expenditure* is the share of gasoline spending in monthly income (percent). All other variables are defined in the note to Table A.2.

Source: Authors' calculations based on the SHBS.

B Additional Results

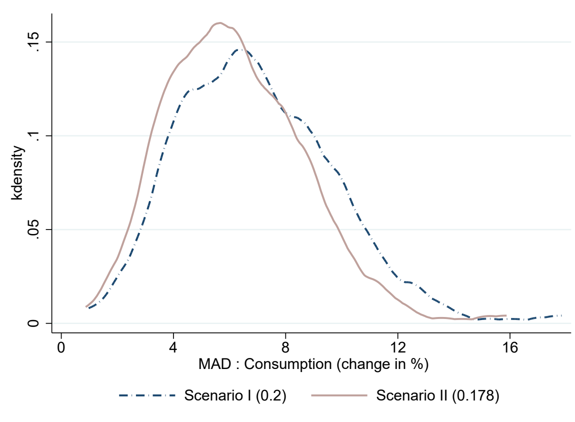
Table B.1: Estimated pass-through under alternative control periods

	I		II	
	Coefficient	Robust SE	Coefficient	Robust SE
T_2 **Subsidy period**	-0.178^{***}	(0.0021)	-0.193^{***}	(0.001)
T_3 Post-subsidy	0.024^{***}	(0.000)	0.018^{***}	(0.001)
N. observations	6,909		7,191	

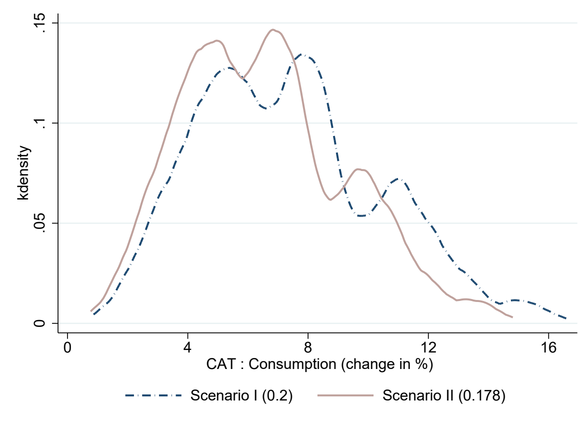
Note: The dependent variables is the weekly retail price of gasoline averaged at provincial level. Robust standard errors clustered at provincial level are reported in parentheses. First column represent the results of the pass-through when remove from the data all the observations from the period that goes between the begining of the war and the starting of the subsidy. Second column, includes all sample, but the control period is the pre-subsidy period *** indicates significance at 1%.

Figure B.1: Consumption response to the subsidy by pass-through (Regions ordered by Hidensity (I))

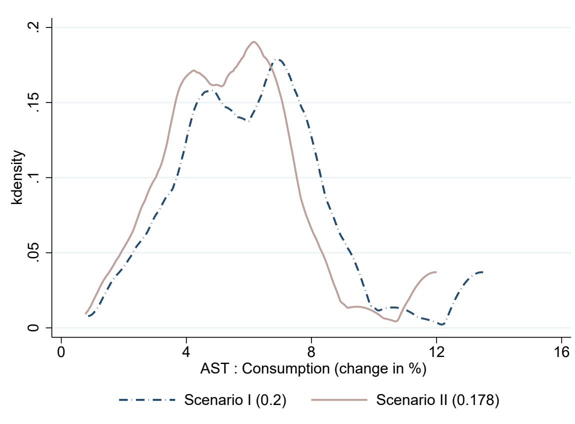
(a) Madrid



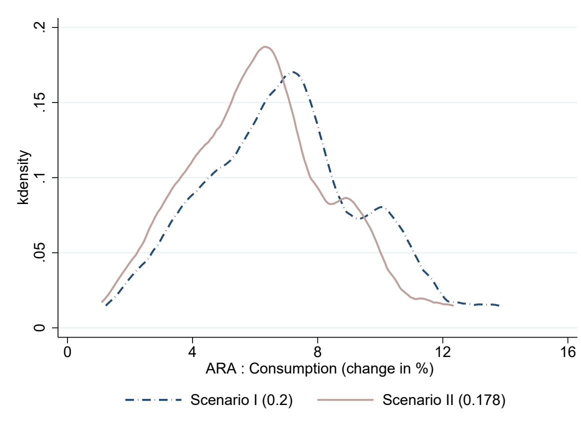
(b) Catalonia



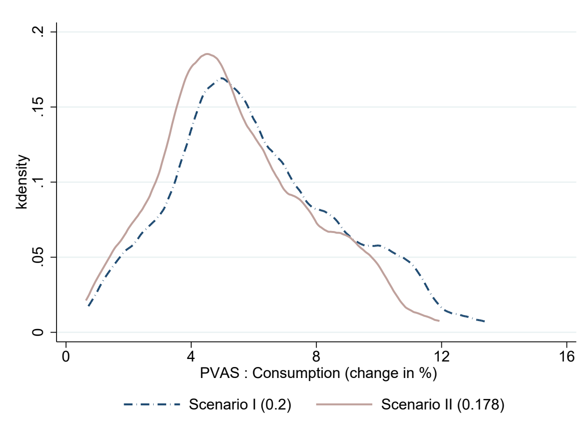
(c) Asturias



(d) Aragon



(e) Basque Country



(f) La Rioja

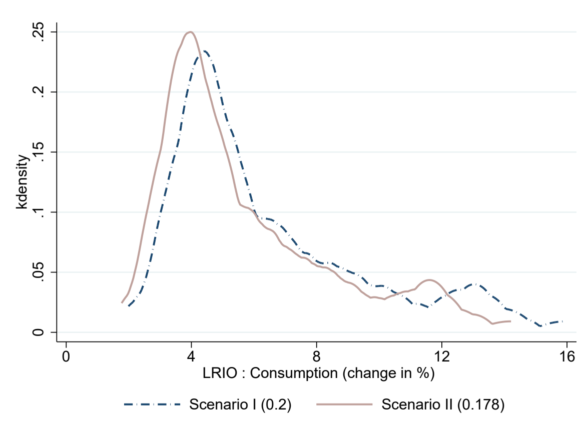
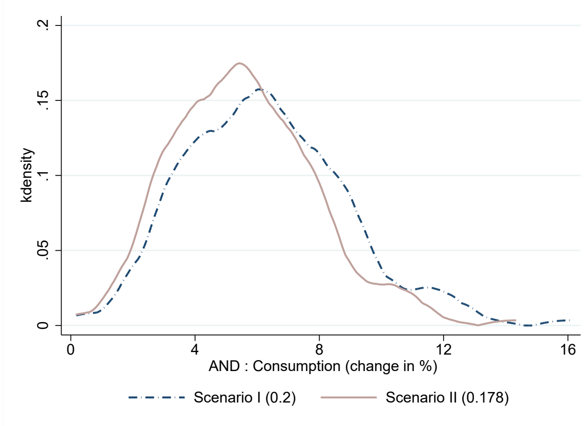
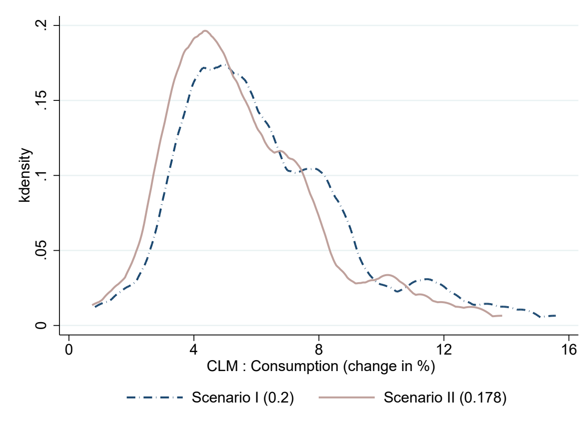


Figure B.2: Consumption response to the subsidy by pass-through (Regions ordered by Hidensity (II))

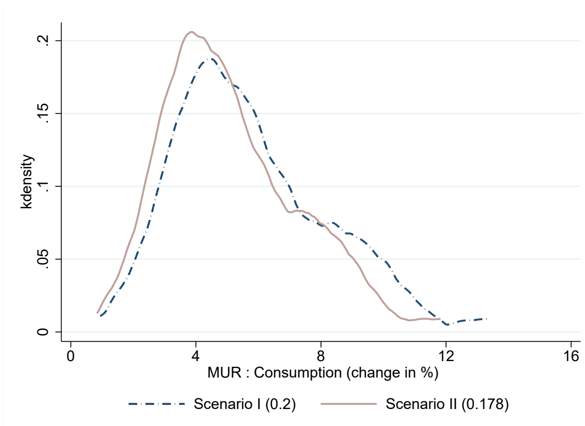
(a) Andalucia



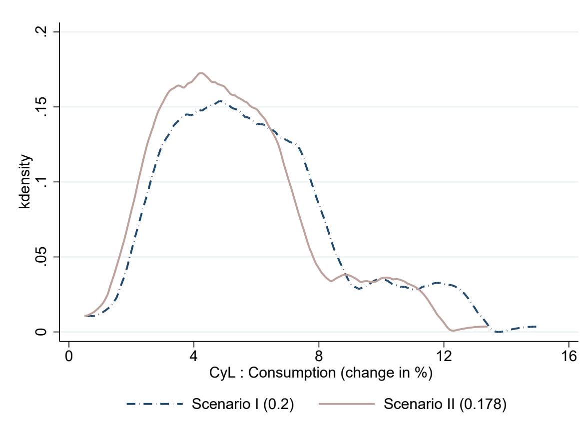
(b) Castilla La Mancha



(c) Murcia



(d) CAstilla Leon



(e) Galicia

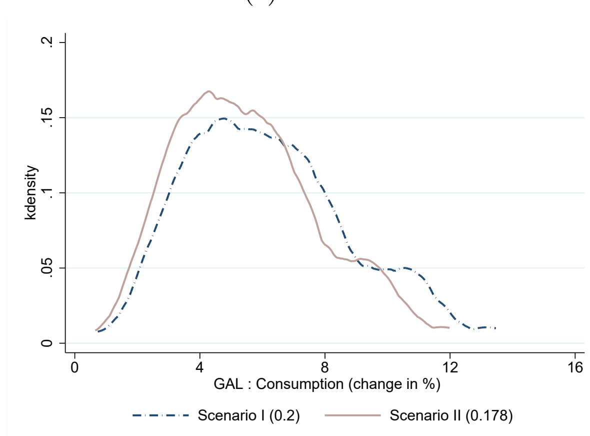
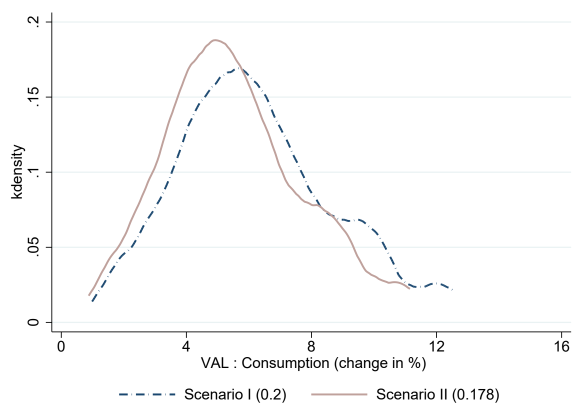
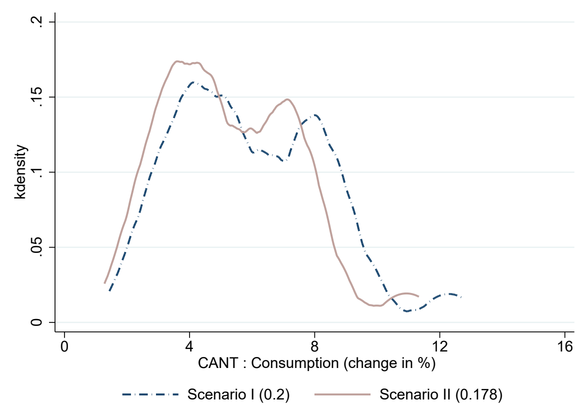


Figure B.3: Consumption response to the subsidy by pass-through (Regions ordered by Hidensity (III))

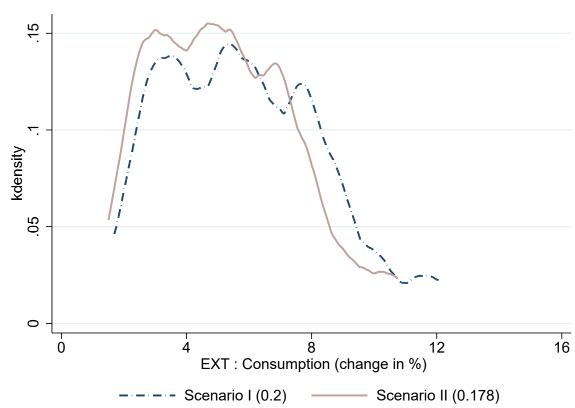
(a) C. VAlenciana



(b) CAntabria



(c) Extremadura



(d) Navarra