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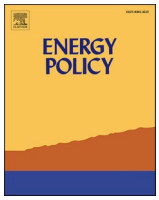

Ensuring a just energy transition: A distributional analysis of diesel tax reform in Spain with stakeholder engagement

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ABSTRACT

Despite the consensus that green taxation is an effective way to accelerate the decarbonization of economies, few countries are implementing ambitious tax reforms. This is the case of diesel for transport in Spain. The arguments against boosting the diesel tax stressed its potential adverse effects on the economy and society, accusing it of being a regressive policy. In this paper, we shed light on the distributional impact of raising the excise tax on diesel to the same level as on gasoline for final consumers in Spain and various compensation schemes jointly designed with several stakeholders. The results confirm that raising the diesel tax without offsets would have slightly regressive effects and that rural and middle-income households would bear the brunt of the increase. However, the effects become progressive when the co-designed offsetting schemes are implemented. These findings may help decision-makers in achieving a just, acceptable, and politically viable energy transition.

1. Introduction

Green taxation is key in speeding up the transition to a sustainable economy and in meeting the climate targets set in the Paris Agreement (Boyce, 2018; Franks et al., 2018). Energy/environmental taxes enable the social costs (externalities) arising from the production and use of goods and services to be internalized. In the short term, they encourage economic actors to reduce their environmental footprint in an efficient and effective fashion. But, in the medium and long term, they also generate significant benefits by fostering innovation, orienting investment decisions towards cleaner technologies, and providing a source of public revenue. That is why various organizations such as the European Commission (EC), the International Monetary Fund (IMF), and the Organization for Economic Cooperation and Development (OECD) have recommended that more environmental taxes be factored into current tax systems (EC, 2019; IMF, 2018; OECD, 2021, 2015).

Spain has recently approved the PNIEC (Integrated National Energy and Climate Plan), which is to run for the next ten years with the goal of cutting greenhouse gas (GHG) emissions by 2030 by a figure of 34% on the baseline level of 2018 (MITECO, 2020). While this can be seen as ambitious (Rodríguez-Zúñiga et al., 2021), Spanish political decision-makers have so far been reluctant to go down the path of energy and environmental taxes to accelerate the decarbonization (Gago et al., 2019).[1] However, such policies are needed to cut emissions, especially in diffuse sectors[2] not covered by the European emissions trading scheme. A case in point is that of road transport, which is responsible for around 27% of the country's emissions (MITECO, 2021a). The decarbonization of this sector (according to the PNIEC) would entail cutting its emissions by 34% on 2018 figures by 2030 (MITECO, 2020). To attain this goal, the country's political

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[1] Of all the environmental taxes currently in place, those on energy are particularly critical for bringing about a rapid decarbonization of the economy, given that they are levied on the production and use of energy, from which around two thirds of the world's GHG emissions are generated (Blanco et al., 2014).

[2] This category breaks down into the following sectors: residential, commercial and institutions; transport; agriculture and livestock farming; waste management; fluorinated gases; and industries in diffuse sectors not subject to emissions trading.

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decision-makers still have plenty of room for maneuver to raise energy and environmental taxes on fuel. Fig. 1 shows that the excise duty on fuel levied in Spain is very low compared to neighboring countries. Specifically, it is 8 euro cents per liter lower[3] than the European Union (EU) average for gasoline and 6 euro cents for diesel.[4] As in most countries, diesel in Spain is treated more favorably than gasoline in terms of taxation, even though there is no justification for this difference in terms of multiple externalities (EEA, 2020; Harding, 2014).

In recent years, various international bodies have highlighted this anomaly and recommended that governments increase taxation on fuel (EC, 2019; IEA, 2015; IMF, 2018; OECD, 2017). Similarly, the Official Committee of Experts for the Reform of the Spanish Tax System also underlined the need to harmonize these taxes in what is known as the Lagares Report (CERSTE, 2014). However, to date, this technical consensus has not been translated into specific and effective reforms. The most recent foray in this direction was undertaken by the current government, which included an increase in the tax on diesel in the draft General National Budget for 2021. Though the reform was intended to eliminate only part of the tax gap in favor of diesel (around one third of the difference with gasoline) and did not affect professional uses, it was not approved due to a lack of political support. Nevertheless, the EC has recently launched a proposal for the reform of the Energy Taxation Directive (EC, 2021), which sets new minimum tax rates for energy goods. In the case of diesel for transport, Spain would be below the minimum set, so it could be expected that a change in the diesel tax would be necessary in the short term.

The arguments against the reform stressed its potential adverse effects on the economy and society, particularly in terms of income distribution, accusing it of being a regressive policy. In this sense, previous literature has shown that the distributional impact of energy/environmental taxation varies considerably from one energy-related good to another and according to consumer spending patterns at different types of household in each country (Flues and Thomas, 2015; Pizer and Sexton, 2019; Temursho et al., 2020). It has also been shown that fuel taxes are in general less regressive than taxes on residential energy goods such as electricity and heating, given that low-income households use less fuel and may not own a private car (Flues and Thomas, 2015; Labandeira et al., 2019; Pizer and Sexton, 2019).

The evidence also suggests that the regressive nature of taxes on fuel depends on consumer spending patterns, which vary widely from country to country. Such taxes are found to be regressive in Austria, Finland and the United States, more or less neutral in the United Kingdom, Germany and France and progressive in Turkey and Mexico (Flues and Thomas, 2015; Pizer and Sexton, 2019). In Spain, taxes on fuel for private transport has been found to be slightly regressive (Álvarez et al., 2013; Flues and Thomas, 2015; Gago et al., 2020, 2021a). Their impact has also been found to vary widely among households that have similar economic circumstances but differ in their social and demographic characteristics, such as location, type of family, access to public transport, etc. (Pizer and Sexton, 2019). Hence, an increase in the diesel tax in Spain can be expected to hit rural households in sparsely populated areas hardest. Nevertheless, various studies have also argued that the harmful effects of energy/environmental taxes can be reversed via offsetting policies funded via the additional revenue generated, which would make such taxes more acceptable in society (Beiser-McGrath and Bernauer, 2019; Böhringer et al., 2019; Gago et al., 2021a, 2021b; Klenert et al., 2018; Nowlin et al., 2020; Pizer and Sexton, 2019).

Here, we look at the impact of a potential increase in fuel taxes in Spain, and more specifically at the effects of bringing the tax levied on diesel up to the same level as that on gasoline. We also examine various offsetting schemes funded from the revenue thus generated. We introduce two major new ideas not found in earlier studies. Firstly, we conduct a granular analysis that not only looks at the potential regressive effects of a tax increase (Gago et al., 2021a) but also seeks to identify who will be most affected by it. This level of detail enables offsetting policies to be designed more effectively. The analysis uses a micro-simulation model covering the more than 20,000 representative households included in the HBS (Household Budget Survey) of Spain for 2019. This survey records household spending patterns in different consumer spending categories (including spending on diesel for transport) and socio-economic characteristics, thus bringing to light distributional impacts from different perspectives. The granular nature of the analysis makes it possible to examine the asymmetrical impacts associated with such policies, i.e. to identify impacts on each type of household in the different scenarios considered. Secondly, the offsetting measures analyzed are designed jointly on the basis of qualitative information obtained from a number of focus groups featuring representatives of different social and economic stakeholders (Beuermann and Santarius, 2006; Clinch et al., 2006; Deroubaix and Lévèque, 2006; Dresner et al., 2006; Kallbekken and Aasen, 2010; Klok et al., 2006). The combination of these two approaches results in a participative modeling system which is fundamental for designing inclusive energy transition policies acceptable to society (Narassimhan et al., 2017; Nikas et al., 2021; Pizarro-Irizar et al., 2020; Ringel et al., 2021; Sorman et al., 2020).

2. Materials and methods

This study combines quantitative and qualitative methods in various stages to jointly design and assess potential tax reforms to do away with the favorable tax treatment of diesel compared to gasoline. It also suggests offsetting schemes funded from the public revenues generated. The baseline scenario used envisages the same tax rates for diesel and gasoline. This quantitative exercise reveals the environmental, economic, and distributional effects of the reform considered. The proposal is then discussed in focus groups comprising representatives of different social and economic institutions, to look at its implications based on the results of the initial simulations run. This provides qualitative information on the perceptions and ideas of group members in regard to the reform and potential ways of using the resources obtained, thus providing feedback for the initial modeling exercise and helping to jointly create new scenarios for analysis. This process is fundamental for designing a fair, acceptable and politically viable reform. The stepwise methodological procedure followed is summarized schematically in Fig. 2.

Within this framework, dialogue with social and economic stakeholders is critical because it helps to design offsetting measures and, at the same time, increases the political significance of the study. The design of offsetting schemes is directly linked to the initial results, given that the main goal is to offset costs to those households most affected by the measure identified in the first analysis. Stakeholder participation in this feedback process also enables the viability of the various scenarios to be tested and enhances the social acceptability of the policies simulated. Details are given below of the quantitative model from which the results are obtained and the focus-group-based social research method used.

2.1. Modeling of policies

As in Gago et al. (2021a), we use a micro-simulation model to analyze the effects of eliminating the favorable tax treatment of diesel and bringing taxation up to the same level as for gasoline. This would entail an increase of just over 9 euro cents per liter of diesel, i.e. a 24.7% tax increase. The following assumptions are used in the simulations run: (i) increases in diesel price only affect end consumers (professional use is excluded), who react in accordance with the price elasticity of demand; (ii) in those scenarios that include the offsetting of costs to households,

[3] This comparison does not take into account the differences in purchasing power between EU-27 countries.

[4] In this paper, "diesel" means Class A gas-oil and "gasoline" refers to 95-octane gas.

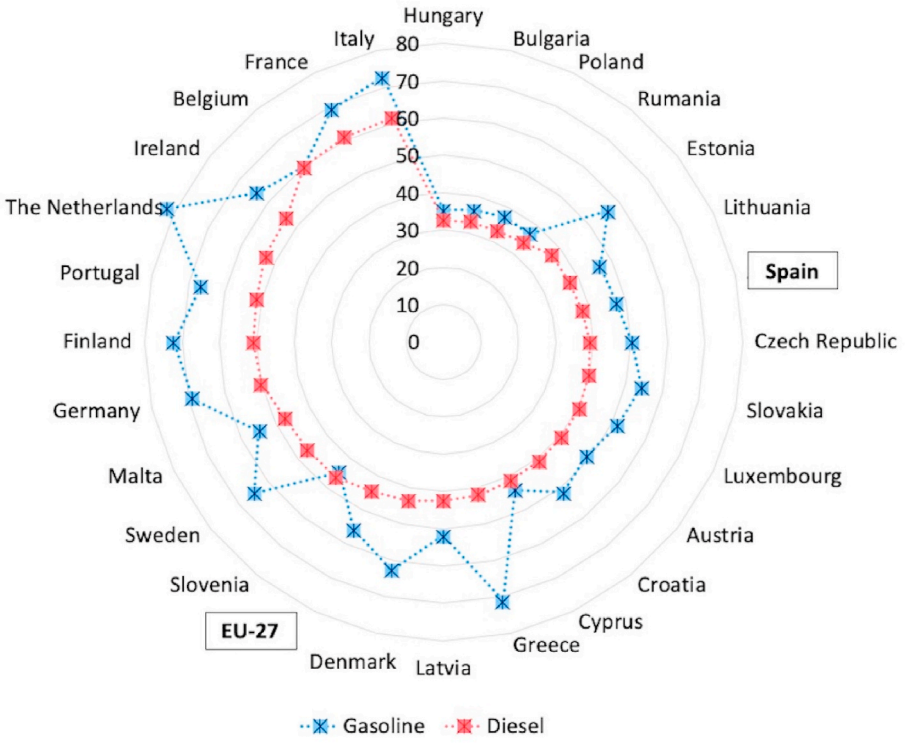

Fig. 1. Excise duty on fuel in euro cents per liter, June 2021. Source: own work based on MITECO (2021b) data.

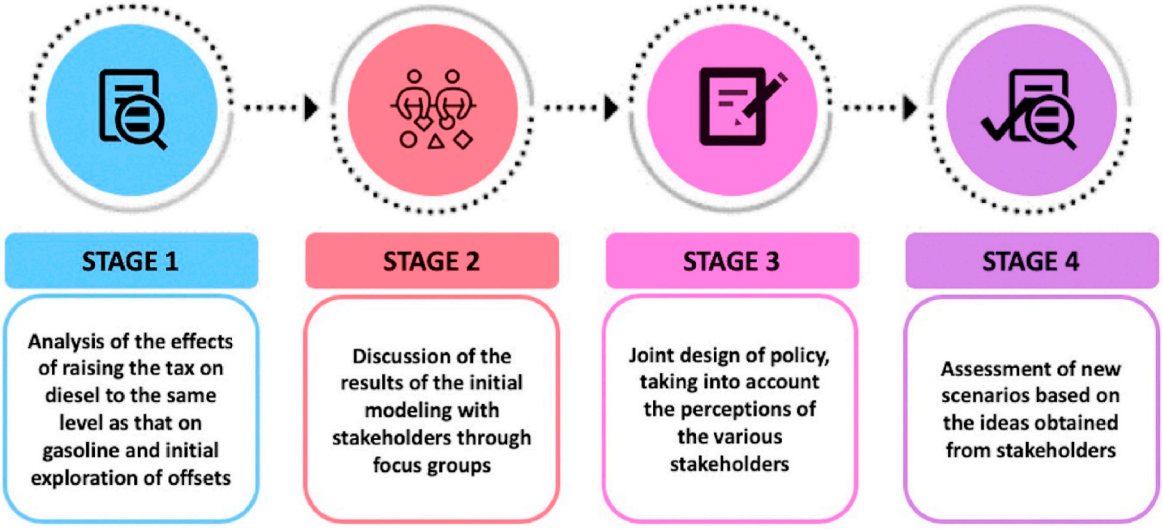

Fig. 2. Methodological procedure. Source: own work.

the total increase in spending arising from the compensation does not include income elasticities of demand or increases in emissions as a result of associated consumer spending; (iii) households in the Canary Isles, Ceuta and Melilla (regions of Spain) are not included in the analysis, as excise duty on fuel does not apply in their territories.

All the scenarios assessed use information from sources for 2019.[5] We use data on total diesel consumption in liters by Spanish households, as reported by CORES (Spain's Corporation for Strategic Oil Reserves) (CORES, 2021). Changes in household emissions from diesel combustion for private transport are calculated using household emission data (INE,

[5] By using consumer spending patterns from 2019, we avoid the distortions introduced by the COVID-19 pandemic. However, the scenarios modeled are based on current circumstances as reported by the National Fund for the Sustainability of the Electricity Sector, which is financed by energy trading companies from all energy sectors in proportion to their sales and implies an increase in the price of diesel.

2021a) and diesel emission factors from the road transport air pollution accounting methodology used by the Spanish authorities (MITECO, 2021c). Annual average prices for diesel and gasoline are obtained from the reports published by the National Stock Exchange and Competition Commission (CNMC, 2021). Based on these pre-reform prices, we calculate a new price for diesel that takes into account the effect of matching the tax rates for the two fuels. To determine the short- and long-term effects of this shock, we use the price elasticities for diesel (−0.201 and −0.739, respectively) estimated by Labandeira et al. (2016). The micro-simulation model is built up with micro-data from the Spanish Household Budget Survey (HBS) for 2019 provided by Spain's National Statistics Office (INE, 2021b). The HBS reports detailed data on consumer baskets (including spending on fuel, i.e. diesel and gasoline for cars) at 20,817 households representative of the Spanish population as a whole.[6] This approach has some limitations that should be mentioned. Firstly, it considers only a part of consumer behavior since only the price elasticity of demand for diesel is used, leaving out cross-price and income elasticities. Secondly, a homogeneous diesel price elasticity is used (i.e., the same for all households), while consumers' response to a change in diesel prices could vary depending on their socio-demographic characteristics. Finally, although the price shock on diesel would reduce its consumption and, therefore, its associated emissions, the offsets to households might generate a rebound effect causing additional emissions not quantified in this study.

As in earlier studies, changes in the level of welfare and progressiveness of the policy are determined on the basis of total household spending (Flues and Thomas, 2015; Gago et al., 2021a). Consumption expenditure is taken as a variable rather than income, as it fluctuates less in the medium and long term and is thus a better proxy for the permanent income of households (Goodman and Oldfield, 2004). To show the distributional impact of the various policies and scenarios considered, results are analyzed at a granular level, considering both vertical inequality (between households with different spending levels) and horizontal inequality (between households with the same level of spending but different socio-demographic characteristics). Three well-known indicators are used to assess the distributional effects and the progressive/regressive nature of the policies: the Gini index (Gini, 1912, 1921), the Palma index (Palma, 2011, 2014), and the Reynolds-Smolensky index (Reynolds and Smolensky, 1977).[7]

2.2. Discussions with stakeholders

Quantitative information was obtained from focus groups (Bloor et al., 2001) set up to find out the opinions of the main stakeholders[8] on the diesel tax increase in Spain and on the different ways of using the public revenue generated by this reform. Unlike other social research approaches (such as observation, interviews, and surveys), focus groups can capture stakeholders' attitudes, thoughts, experiences, and reactions concerning the subject under investigation (Gibbs, 1997). Focus groups are also particularly useful when the idea is to gauge the level of consensus concerning the application of specific policies and the fears and concerns that they may raise in various segments of the population (Morgan and Krueger, 1993). That is why the method has been widely used in scientific literature to obtain empirical evidence that can be used to design and assess measures in many different fields, including energy/environmental taxes (Beuermann and Santarius, 2006; Clinch et al., 2006; Deroubaix and Lévèque, 2006; Dresner et al., 2006; Kallbekken and Aasen, 2010; Klok et al., 2006).

Focus groups were held in April and May 2021 in an online format, given the COVID-19 pandemic. Twenty-two people took part, representing various institutions classed under the following headings in line with their institutional contexts: consumers, trade unions, businesses, NGOs and small municipal authorities (Table 1). The institutions taking part were selected in an effort to assure the broadest possible heterogeneity and diversity of opinions. It should, however, be mentioned that although the focus group with businesses included representatives of the energy industry, it was not possible to bring in leading representatives of fuel producers and distributors. In addition, the trade union representatives present came from the environmental sections of their unions, but did not include union leaders from sections that might have other sensitivities in regard to measures such as the one proposed here. These caveats need to be borne in mind when the results of the focus groups are interpreted.

In all, five discussions were held (one session for each focus group), involving between three and six people and lasting a maximum of 90 min. All these sessions were held under the Chatham House rule of non-attribution, which establishes that any comments made may not be attributed to specific individuals or institutions outside the session (Chatham House, 2021). This ensured a comfortable atmosphere for discussion, in which participants were able to express their ideas freely and confidently. A researcher acted as moderator, setting up, fostering, and delimiting discussions and ensuring that speaking time was more or less evenly distributed across participants.

The discussions comprised the following stages:

- **Stage 1: Welcome, introductions and rules.** The moderator introduced the participants and the topic to be discussed, and explained the stages and rules of the discussion (5 min).
- **Stage 2: Presentation of the policy.** A member of the research team explained the reform to be discussed, set out the reasons for it and its main effects, and suggested various ways in which the revenue thus generated could be used (20 min).
- **Stage 3: Discussion.** The members of each group discussed the topic and reflected on the application of the reform proposed and on different policies that could be funded with the resources generated. This included, for instance, direct transfers to some or all households, subsidies for purchasing electric vehicles or installing charging stations, providing multi-energy discounts to combat energy poverty, promoting public transport and making changes to the transport sector (60 min).
- **Stage 4: Conclusion.** The moderator brought the discussion to an end by setting out the main conclusions noted and some key ideas drawn from the opinions of participants, so that a group consensus on conclusions could be reached (5 min).

All five sessions produced detailed qualitative information on the ideas, reflections and opinions concerning the policy analyzed on the part of the various stakeholders involved. Such information is typically compiled via recordings which are then transcribed, but in this case it was decided not to record the sessions, so that participants would feel more comfortable and could express their positions securely. Instead, members of the research team took notes during the discussions which then served as the primary inputs for drawing conclusions. Everything

[6] All the results obtained in our sample are extrapolated to the population of Spain as a whole using the raising factors provided by the Spanish Statistical Office (INE) for the sample households.

[7] The Gini index measures the extent to which income distribution between the households in an economy deviates from a perfectly equitable distribution. The Palma index considers the ratio of that part of total income which goes to the wealthiest 10% of households to the part which goes to the poorest 40%. Finally, the Reynolds-Smolensky index determines the overall progressive/regressive nature of a policy by subtracting the post-reform Gini index from its pre-reform counterpart.

[8] Stakeholders are actors affected by the decisions and actions of politicians, as well as those with the capacity to influence the outcomes of approved policies (Freeman, 1984).

Table 1
Organizations taking part in group discussions.

Group	Consumers	Trade unions	Businesses	NGOs	Small municipalities
Institutions*	CECU[a], OCU[b] and Unión de Consumidores (Consumers' Union)	CCOO[c], UGT[d] and UPA[e]	Iberdrola, Acciona, Endesa and Enagas	Transport and Environment, ECODES[f], Greenpeace, SEO/BirdLife[g] and Ecologistas en Acción (Environmentalists in Action)	Soria, Teruel, Zarautz, Menorca and Pontevedra

Notes: [a]Confederación de Consumidores y Usuarios (Confederation of Consumers and Users); [b]Organización de Consumidores y Usuarios (Organization of Consumers and Users); [c]Confederación Sindical de Comisiones Obreras (Workers' Commissions Trade Union Confederation); [d]Unión General de Trabajadores (General Union of Workers); [e]Unión de Pequeños Agricultores y Ganaderos (Union of Small Arable and Livestock Farmers); [f]Fundación Ecología y Desarrollo (Ecology and Development Foundation); [g]Sociedad Española de Ornitología (Spanish Ornithological Society). *Only those associations that agreed to take part are shown. Source: own work.

that the stakeholder representatives said during the focus group sessions was recorded in the form of notes.[9]

3. Discussion of results

This section analyzes the results of the various stages of our research. First, the effects of reforming the tax on diesel are outlined (Subsection 3.1). Next, stakeholders' opinions on the measure and the possible uses of the revenues generated are analyzed (Subsection 3.2). Finally, the findings drawn from the participative discussion process are used to jointly design, assess, and compare new scenarios (Subsection 3.3).

3.1. Baseline scenario: increase in the diesel tax

The baseline scenario (*Ref-Diesel*) assumes an increase in the tax on diesel, bringing it on a par with the tax on gasoline but only for end users[10]. This entails a 24.7% increase in the tax on diesel, raising the price per liter by just over 9 euro cents. The price of diesel thus rises by 8.7%. Table 2 shows the effects of the reform in the short and long term, assuming a price elasticity of demand for diesel of −0.201 and −0.739 respectively (Labandeira et al., 2016).

In the short term, the price shock would reduce diesel consumption by only 1.7% because of the limited adaptability of consumers. This would reduce CO_2 emissions by 572,415 tons (i.e., 0.8% of households' emissions). At the same time, harmful air pollutants such as PM2.5, NO_x and SO_2 would also fall by 88 tons, 2136 tons, and 2 tons respectively (i.e., reductions of 0.2%, 1.2%, and 0.03% with respect to the pre-reform levels). Besides, even though demand and emissions would be lower, the higher price paid would increase household expenditure on diesel by 4.8%. As a result, government would increase its revenues by €1.242 billion, 84.8% from excise duties on diesel and 15.2% from value added tax (VAT).

On the other hand, it is also interesting to consider the possible long-term effects of the measure. In the long term, consumers can adjust their investment decisions and therefore choose technologies not affected by the reform (e.g., opting for gasoline or electric vehicles). Therefore, diesel consumption would be significantly lower, declining by 6.4%. The environmental gains from the reform are therefore substantial: households' CO_2 emissions would be down by 3,125,490 tons, PM2.5 by 478 tons, NO_x by 11,662 tons, and SO_2 by 13 tons (i.e., reductions of 4.5%, 1%, 6.3%, and 0.1%, respectively, with respect to the pre-reform levels). These benefits could be even greater over time, especially if households adopt clean technologies such as electric vehicles or other mobility options. Furthermore, the additional revenue generated would decrease over time as more people switch to other technologies. In fact, they would amount to €754.8 million in the long term, 60% less than in the short term, of which 94.2% would come from excise duties on diesel and 5.8% from VAT.

The distributional impact of the measure would also be different in the short and long term, as not all consumers could afford to switch to other technologies in the same way. In any case, an analysis of the long-term distributional effects of the measure under study is beyond the scope of this paper. Therefore, we focus on the short-term effects. In this regard, we find that the overall distributional effect of the measure would be slightly regressive (but practically neutral), with an increase of just 0.03% in the Gini index (−0.0001 in the Reynolds-Smolensky index) and 0.06% in the Palma index. These results confirm previous findings for the case of Spain (Álvarez et al., 2013; Gago et al., 2019, 2021a, 2021b). In Tables S.1 and S.2 of the Supplementary Information, we provide detailed results of both vertical and horizontal distributional impacts of the measure. We find that impacts would be asymmetrical across the deciles, with households in the middle of the distribution range being hardest hit.

Along with income levels, other socio-demographic characteristics such as the location of households, the household type or the age of their members are significant in analyzing the distributional impact of taxes on fuel (Flues and Thomas, 2015). Rural households would be more affected by the reform, since residents of areas with low population densities tend to make more use of private vehicles in their day-to-day lives, as they have no public alternative travel options (Flues and Thomas, 2015; Gago et al., 2019; Tomás et al., 2020). Household size and type also significantly influence car use, so that households with more members and dependent children would be more affected by the reform. Flues and Thomas (2015) found that this trend is particularly marked in countries such as Spain and Greece, and much less in Austria and Slovenia. Households with more working members are also more affected by the measure, as they have to commute to work and therefore have greater mobility needs (Bill et al., 2006; Flues and Thomas, 2015). A look at vulnerable and highly vulnerable households reveals that they would have little impact, because their economic situation means that they use private vehicles less frequently (and may not even own a car) for cost reasons.

Finally, we find that while it is important to consider asymmetric impacts across unequal income groups, the large heterogeneity in vehicle use patterns makes impacts across households within the same group substantial as well (Pizer and Sexton, 2019).

3.2. Insights from discussions with stakeholders

The results and ideas shown in Subsection 3.1 were discussed with stakeholders. Fig. 3 summarizes their positions on the main issues discussed.[11]

In general, stakeholders saw energy/environmental taxation and the convergence of the duty payable on diesel with that on gasoline as a reasonable and necessary measure in the current context of the energy

[9] These notes can be provided by the authors as supplementary material on request, always maintaining the Chatham House rule of non-attribution, which establishes that any comments made may not be attributed to specific individuals or institutions outside the session (Chatham House, 2021).

[10] Exempting professional use means that the policy is assumed to have no effect on business competitiveness.

[11] The opinions outlined must be taken with caution, as they come from focus groups of representatives of certain organizations. Therefore, Fig. 3 does not seek to establish the positions of the organizations in question but merely to reflect the level of consensus reached by representatives of social and economic stakeholders in the discussions as recorded by the authors of this study.

Table 2
Main results for the baseline scenario (*Ref-Diesel)*.

Effect	Change in consumption	Reduction in emissions				Additional revenue		
		CO_2	PM2.5	NO_x	SO_2	Excise duty	VAT	Total
Short term	−1.7%	572,415 t	87 t	2135 t	2 t	€1.0258 B.	€189.5 M.	€1.242 B.
Long term	−6.4%	3,125,490 t	478 t	11,662 t	13 t	€754.8 M.	€46.1 M.	€842.9 M.

Note: CO_2 (carbon dioxide), PM2.5 (fine particulate matter - 2.5 μm or less), NOx (nitrogen oxides) and SO_2 (sulfur dioxide). Source: own work.

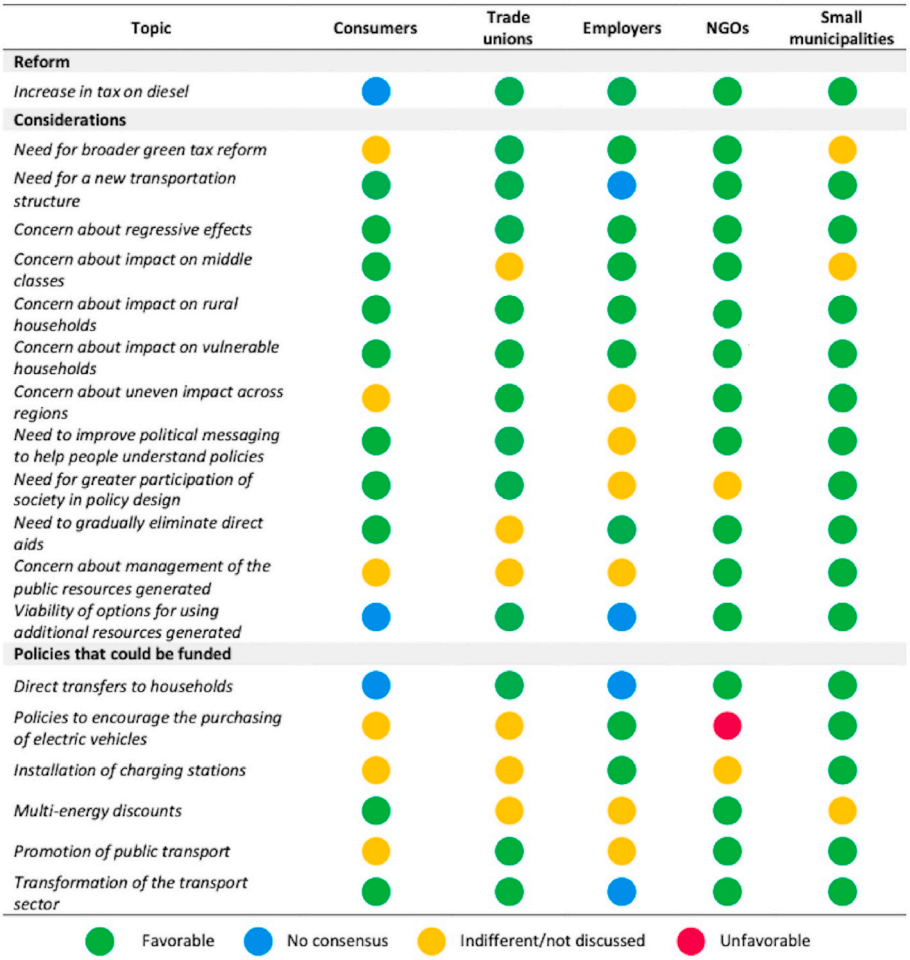

Fig. 3. Opinions of stakeholders concerning the main points discussed at focus groups. Source: own work based on notes taken of statements by stakeholder representatives during focus group discussions. These notes are available from the authors on request, provided that the anonymity of the participants is maintained.

transition, in which it is crucial to discourage the use of fossil fuels and shift towards sustainable mobility, provided that the transition is based on fair criteria. Some representatives of consumers were an exception, being reluctant to accept the reform because of its impact on middle-income households. The discussions centered on issues concerned with increasing the tax on diesel, but some participants highlighted the need for more far-reaching policies on mobility and taxation. Representatives of consumers, trade unions, NGOs and small municipal authorities suggested that policies to transform the current system of mobility were needed, over and above specific tax reforms such as that analyzed here. Moreover, representatives of trade unions, businesses and NGOs stressed the need for broad-ranging green tax reforms that did not only affect the tax on fuel.

About the specific increase in the tax on diesel, stakeholders pointed out various issues that they believed were key for the proper design of the measure and, by extension, for its practical viability and acceptability in society. There are many points to consider (for a detailed review, see Maestre-Andrés et al., 2019), but here we focus on distributional impacts, procedural issues and offsetting.

In regard to the distributional impact of the reform, all stakeholders expressed concern that the effects of the policy might be regressive, albeit only slightly, and that this could be used in policy debates as an argument against its implementation. Consumers and NGOs believed that it was unfair that the reform had hardly any impact on the wealthy but hit the middle classes much harder. Its impact on households in rural areas with lower population densities were also a concern for all groups. The representatives of small municipal authorities pointed out that members of such households need to travel to larger towns to do business and cater for some of their needs, and that this generally involves using private cars, as there are few public transport options available in rural areas. NGOs representatives stressed the need to look for ways of reducing the impact of the measure, to prevent it from damaging policies to repopulate sparsely populated areas of Spain.

There was consensus that measures needed to be taken to protect

vulnerable households,[12] because although such households make less use of (or do not own) private cars, their situation is so delicate that they deserve priority attention (Beuermann and Santarius, 2006; Clinch et al., 2006; Kallbekken and Aasen, 2010). The representatives of trade unions, NGOs, and small municipal authorities suggested that differences in impact across territories could also be a significant factor to be considered in designing both the convergent of fuel taxes and potential offsetting actions.

The focus groups also discussed some procedural aspects of the design and application of the reform. Some participants saw these aspects as fundamental for the success of the policy proposed. Representatives of consumers, trade unions, NGOs and small municipal authorities argued that educational measures should be taken to help people understand the purpose of and need for the measure, and see its benefits; and at the same time to foster active public participation in the design of policies of this type so as to avoid controversy and rejection. Representatives of NGOs and small municipal authorities expressed concern about how the tax was to be managed. For their part, NGOs stated that offsetting actions could have environmental costs due to the possible rebound effect on consumer spending and, by extension, on emissions if the actions are not accompanied by further environmental policies. On the other hand, small municipal authorities stressed that the resources obtained should be managed at the municipal level, where knowledge of local problems is greatest.

Most of the groups agreed that the public revenue generated by the reform should be put to practical use, though there was no consensus among the consumer and business groups. The arguments against such uses were based mainly on the belief that earmarked taxes (those levied to fund a specific activity) lack credibility, and that such taxes are little used in Spain. All the groups except the trade unions stressed the need to gradually do away with direct transfers or funding for policies from energy/environmental taxes, as such taxes are intended to be transitory.

As mentioned above, the revenue from the tax increase could be used for numerous purposes, with a range of implications for fairness, for emissions, and for final support for the reform (Carattini et al., 2018; Maestre-Andrés et al., 2019). The transformation of the transport sector was the option most widely supported by all groups, though there was no specific discussion as to how this should happen. Direct transfers to the households hardest hit by the measure were the second most widely discussed option. There was broad consensus on this, except among some representatives of businesses and consumers. Other options which received support, albeit with a lower level of consensus, were subsidies for purchasing of electric vehicles and installing charging stations, broader coverage for multi-energy discount schemes and the promoting of public transport.

3.3. Analysis of jointly-designed scenarios

One of the key elements in the design of the policy is the potential use of the additional revenues collected by the government. This issue was discussed in the focus groups, which analyzed a wide range of options including direct transfers to households, subsidies for purchasing electric vehicles or installing charging stations, multi-energy discounts, promotion of public transport, and the financing of the transformation of the transport sector. Alternatively, the Spanish government could also use these revenues to reduce its financing needs or debt, which would also have relevant economic and distributional implications. This possibility cannot be ignored. However, the government has strong incentives to use some or all of the additional revenue to offset household losses, especially in the short term. Indeed, the extent to which energy/environmental taxes are deemed acceptable tends to increase when the revenue generated is used for specific purposes rather than being put into the general coffers of the state (Maestre-Andrés et al., 2019), especially if those purposes are aligned with the policy options preferred by the public (Baranzini and Carattini, 2017). Thus, a major advantage of direct payments to households over the other options is that they would enable the negative distributional effects to be mitigated (Böhringer et al., 2019; Gago et al., 2021a).

Modeling the economic and distributional implications of all the potential uses of the additional revenue generated is an arduous task beyond the scope of this paper. Therefore, through the discussion with stakeholders, we can focus on those that have attracted the most consensus: the transformation of the transport sector and direct transfers to households. However, the lack of consensus on how the transport sector should be transformed led to the scenarios analyzed being based exclusively on the possibility of direct transfers to households to offset impacts. Thus, the various scenarios jointly designed and simulated in this section look at how the proposed tax reform on diesel can be applied and how the resulting revenue can be used to fund direct transfers to certain households. The three scenarios designed and the types of household selected as recipients of aid were determined in line with the preferences and opinions of the stakeholders. They expressed a broad consensus in terms of concern about potential regressive impacts and negative impacts of the measure on specific households such as those in rural areas, those classed as vulnerable and, to a lesser extent, middle-income households. Table 3 presents the three scenarios designed to respond to those concerns and offset impacts.

In the three scenarios that involve offsetting (*Rec-D4*, *Rec-D7* and *Rec-V&R)* the additional public revenue generated by applying *Ref-Diesel* is used to transfer fixed amounts of €166, €95, and €178, respectively, to households. This direct aid would take up all the public revenue obtained from matching taxation on diesel and gasoline, i.e. around €1.242 billion. The decision as to which households would receive direct transfers is made taking into account the opinions and concerns of the stakeholders as expressed in the focus groups. Scenario *Rec-D4* covers all households in deciles D1 to D4. This scenario seeks to offset adverse impacts on low-income households that depend on diesel vehicles, and at the same time to help reduce inequality and poverty in the country. Scenario *Rec-D7* seeks to make the reform more inclusive and therefore more acceptable. To that end, it envisages transfers not just to the poorest households (D1–D4) but also to middle-income households (D5–D7), which, as indicated by some representatives of social and economic stakeholders in the discussions held, make up a critical group for public acceptance, stability, and political consensus in regard to the reform. Finally, scenario *Rec-V&R* seeks to protect those groups which are particularly sensitive to changes in diesel prices, such as rural and vulnerable households. Its goal is to prevent any widening

Table 3
Overview of scenarios jointly designed and simulated.

Scenarios	Change in diesel price	Transfer	Transfer per household	Description
Ref-Diesel	8.7%	No	€0	Baseline scenario matching tax on diesel to tax on gasoline
Rec-D4	8.7%	Yes	€166	Baseline scenario + proportional transfer to all households from D1 to D4
Rec-D7	8.7%	Yes	€95	Baseline scenario + proportional transfer to all households from D1 to D7
Rec-V&R	8.7%	Yes	€178	Baseline scenario + proportional transfer to all rural and vulnerable households

Note: Definitions of "rural" and "vulnerable" households are given in the Appendix. D1 is the poorest decile and D10 is the wealthiest. Source: own work.

[12] The criteria applied for eligibility for special discounts on electricity and heating was used to identify vulnerable households in the HBS micro-data. For more details see https://www.bonosocial.gob.es/#quees.

of gaps in society and avoid harming families in areas with low population densities suffering from population loss, where there is no alternative to private vehicles.

Although increasing the tax on diesel would have slightly regressive effects, as indicated above, suitable offsetting policies would make the reform progressive (Gago et al., 2019, 2021a, 2021b). Table 4 shows the inequality indicators before and after the application of the reform under the different scenarios considered. All indicators improve in all three scenarios with offsetting, resulting in progressive policies (i.e., positive Reynolds-Smolensky indexes). In this sense, scenario *Rec-D4* is the fairest, with a drop in the Gini index of 0.54% (0.0017 in the Reynolds-Smolensky index) and 1.14% in the Palma index. These results are in line with those of earlier studies. For instance, Gago et al. (2021b) indicate that it is possible to make the convergence of the tax rates on diesel (for end and intermediate users) and gasoline in Spain progressive by introducing direct transfers to households in the first five income deciles (D1–D5) to the tune of €234 million, i.e. just 8.9% of the revenue generated by the reform. The same authors find that using €1.839 billion, i.e. 70% of the additional revenue generated, to pay fixed amounts to all households below the poverty line would reduce the national poverty rate by 10% and again make the reform progressive. All these findings show that energy/environmental taxes can be raised to speed up the energy transition while at the same time ensuring that suitable standards of social justice are maintained and even reducing the problem of increasing inequality in Spain (Ayala and Cantó, 2018). This is a clear example of the concept of "just transition" included, for example, in the Paris Agreement, in the European Green Deal, and in Spain's Climate Change Act.

Fig. 4 shows that the falls in income[13] (welfare) observed across the deciles of equivalent expenditure[14] in scenario *Ref-Diesel* shift to more progressive shapes, varying depending on the designs for the allocation of aid used in each scenario. Scenario *Rec-D4* shows quite marked positive variations in the first four deciles (D1–D4), while scenario *Rec-D7* results in more moderate welfare gains at the lower levels but prevents the weight of the tax reform from falling mainly on the middle classes by extending aid to the seventh decile (D1– D7). In both these scenarios, welfare levels at rural households remain stable and vulnerable households benefit substantially. In scenario *Rec-V&R*, the criteria for aid

Table 4
Distributional indicators in the various scenarios.

Scenario	Gini index	Palma index	Reynolds-Smolensky index
As is	0.313	0.886	–
Ref-Diesel	0.313	0.886	−0.0001
Rec-D4	0,311	0876	0.0017
Rec-D7	0.312	0.880	0.0012
Rec-V&R	0.312	0.880	0.0011

Source: own work.

[13] The term "income" is used for the sake of simplicity, but the actual reference variable is total household expenditure. Negative changes in income are associated with increased expenditure due to changes in the price of diesel, which means a loss of welfare for households. On the other hand, positive changes in income are associated with rewards for households, and translate into greater welfare.

[14] Equivalent expenditure of households is determined by taking household size and correcting it for the economies of scale generated in each household. This correction uses the modified OECD scale, which assigns a value of 1 to the reference person in the household, 0.5 to other members over 14 years of age and 0.3 to those under 14 years of age. The deciles of equivalent expenditure are thus calculated based on household spending relative to the modified OECD equivalence scale. Spending is used because it fluctuates less than income in the long run and is thus a better proxy for permanent income (Goodman and Oldfield, 2004).

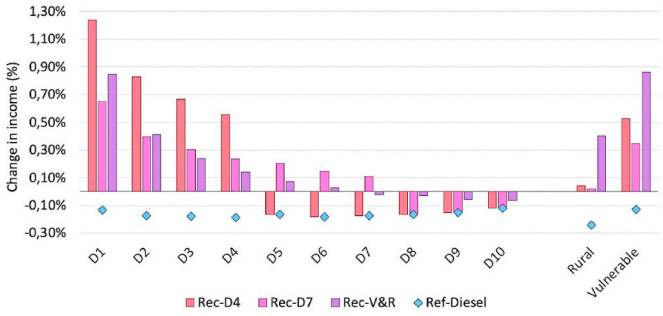

Fig. 4. Average percentage variation in income for each decile of equivalent expenditure, rural location and vulnerability in the various scenarios. Note: Definitions of "rural" and "vulnerable" households are given in the Appendix. D1 is the poorest decile and D10 is the wealthiest. Source: own work.

distribution are not based on income deciles. The result is a more even distribution of aid, with a positive impact up to the sixth decile (D1–D6). Scenario *Rec-V&R* seeks to help rural and vulnerable households, and results in greater improvements for them than scenarios *Rec-D4* or *Rec-D7*.

Fig. 5 shows the impacts for the four types of household most affected (Fig. 5.a) and least affected (Fig. 5.b) by the diesel tax increases. Those impacts are broken down by quintiles of equivalent expenditure for the different scenarios considered. It can be observed that the various transfers correct the possible negative impacts (and even give rise to improvements in welfare) at the households most affected in the first quintiles (Fig. 5.a). The scenarios with offsetting also improve welfare in the households least affected by the reform, especially in the first quintiles. This is particularly helpful for groups such as the elderly or the unemployed (Fig. 5.b). These and other results concerning distributional effects under the different scenarios considered are detailed in Tables S.1 and S.2 of the Supplementary Information.

4. Conclusions and policy implications

This study analyzes the impact of a hypothetical rise in the tax on diesel to the same level as gasoline in Spain and assesses possible aid payments to offset its impact funded from the additional public revenue generated through the tax reform. The offsetting schemes considered come from the ideas and perceptions of various relevant Spanish stakeholders. The results confirm that increasing the tax on diesel would be slightly regressive (but practically neutral) in its effects and that rural and middle-income households would bear the brunt of the burden.

Discussing these results in focus groups, stakeholders expressed unanimous concern about the distributional aspects of the reform, which they felt would exacerbate other structural problems in the country, such as inequality and loss of population in rural areas. Some stakeholders called for a more participative design, involving messages to educate people concerning the reform and more local, proximity-based management. There was broad consensus among stakeholders that the public revenue generated by this reform should be earmarked for offsetting its negative distributional impacts, in the shape of direct transfers to households, provided that such aid was transitory.

Based on these opinions, three scenarios were jointly designed involving offsetting schemes funded with the additional revenue obtained from the reform, to be implemented through direct aid payments to those households identified as the hardest-hit. All indicators are found to improve in all three offsetting scenarios analyzed, with the final distributional effect of the policy being progressive. Scenario *Rec-D4*, which sets a payment of €166 for all households from deciles 1 to 4, is the fairest given that it reduces the Gini index by 0.54% (Reynolds-Smolensky index of 0.0017). Scenario *Rec-D7* proposes offsetting payments of €95 up to decile 7. The application of this scenario would make the reform progressive and prevent the burden falling mainly on middle-

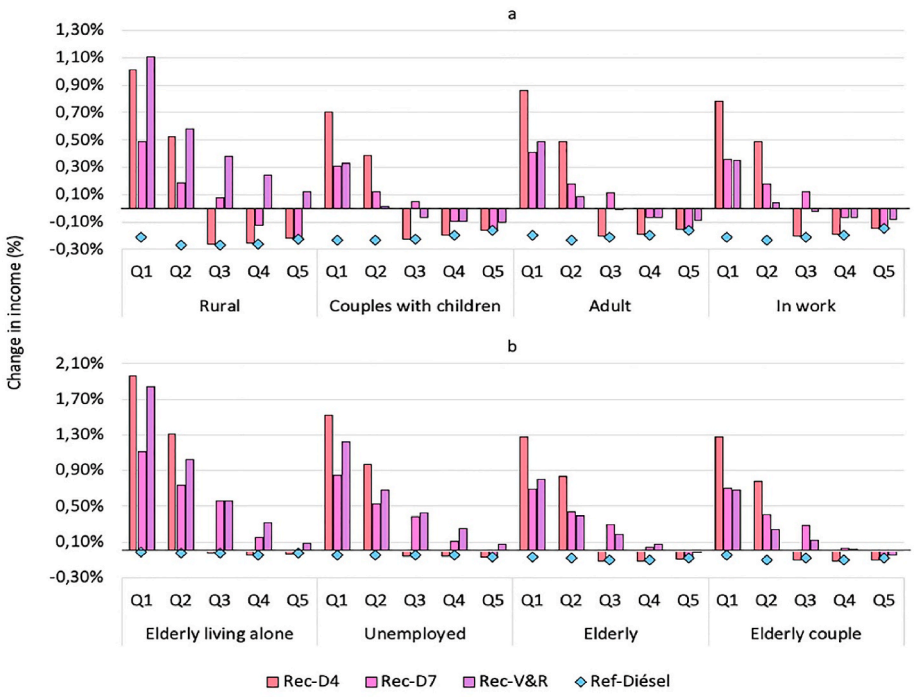

Fig. 5. Distributional impact for the four types of household most (5.a) and least (5.b) affected by quintiles of equivalent expenditure in the various scenarios. Note: Household characteristics are detailed in the Appendix. Q1 is the poorest quintile and Q5 is the wealthiest. Source: own work.

income households, but would result in more moderate welfare gains among low-income households. Finally, scenario *Rec-V&R* envisages direct transfers of €178 for vulnerable and rural households. Its implementation would result in a good blend of more progressive effects and protection for the hardest-hit groups.

In short, this study demonstrates that although the effect of increasing tax on diesel in Spain is slightly regressive, it can be turned progressive if it is combined with suitable offsetting schemes. The identification here of the households which are hardest hit enables highly targeted actions to be designed to offset impacts among them. These findings may be highly useful to political decision-makers and may help to bring about a fair, acceptable and politically viable transition to a carbon-neutral economy.

CRediT authorship contribution statement

Manuel Tomás: Conceptualization, Methodology, Validation, Data curation, Writing – original draft, Writing – review & editing. **Xaquín García-Muros:** Conceptualization, Methodology, Software, Validation, Data curation, Writing – review & editing, Funding acquisition. **Eva Alonso-Epelde:** Conceptualization, Methodology, Validation, Writing – review & editing. **Iñaki Arto:** Conceptualization, Validation, Writing – review & editing, Funding acquisition. **Alejandro Rodríguez-Zúñiga:** Conceptualization, Validation, Data curation, Writing – review & editing. **Cristina Monge:** Conceptualization, Validation, Writing – review & editing. **Mikel González-Eguino:** Conceptualization, Methodology, Validation, Writing – review & editing, Funding acquisition, Project administration, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2023.113558.

Appendix. Household characteristics

Characteristics related to the level of expenditure:

- Deciles (D1–D10): decile to which the household belongs based on total expenditure per equivalent consumption unit of the household.
- Quintiles (Q1–Q5): quintile to which the household belongs based on total expenditure per equivalent consumption unit of the household.

Characteristics related to population density:

- Urban: densely populated areas.
- Semi-urban: intermediate density areas.

- Rural: thinly populated areas.

Characteristics related to household type:

- Unmarried: household of a single person older than 16 and younger than 65.
- Elderly living alone: household of an elderly person living alone aged 65 or older.
- Couple without children: household of a couple without children with both members aged under 65.
- Elderly couple: household of a couple without children with at least one of the members aged 65 or older.
- Couple with children: household of a couple with children aged under 16.
- Single parent: single parent household with at least one child aged under 16.
- Other: other households.

Characteristics related to the occupation of household members:

- In work: the reference person of the household and his/her spouse are employed, the rest of the persons belonging to the household may or may not be employed.
- One member in work: the reference person of the household or his/her spouse is employed, the rest of the persons belonging to the household may or may not be employed.
- Unemployed: neither the reference person of the household nor his/her spouse is employed, the rest of the persons belonging to the household may or may not be employed.

Characteristics related to the age of the household reference person:

- Young: person aged 35 or younger.
- Adult: person aged 35 or older and under 63.
- Elderly: person aged 63 or older.

Characteristics related to the sex of the household reference person:

- Female.
- Male.

Characteristics related to the country of birth of the household reference person:

- Spanish nationals: person born in Spain.
- EU nationals: person born in the rest of the EU.
- Other European non-EU nationals: person born in the rest of Europe.
- Non-Europeans: person born in the rest of the world.

Characteristics related to the studies completed by the household reference person:

- No formal education.
- Primary education.
- Secondary education.
- Upper secondary education.
- University education.

Characteristics related to the vulnerability of the household:

- Vulnerable: household considered as such under the criteria of the Spanish Government's electricity voucher.
- Highly vulnerable: household considered as such under the criteria of the Spanish Government's electricity voucher.

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