"GREEN REGULATION":
A QUANTIFICATION OF REGULATIONS
RELATED TO RENEWABLE ENERGY,
SUSTAINABLE TRANSPORT, POLLUTION
AND ENERGY EFFICIENCY BETWEEN
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Abstract

The achievement of an environmentally sustainable growth model, the development of renewable energies or the adoption of energy efficiency measures are nowadays fundamental issues in economic analysis and are a substantial part of the public debate. However, while there may be an increased social awareness of these issues, a different question is at what pace these social concerns have been translated into regulation, fostering or hindering the development of new markets or "green" technologies.

This paper proposes a rigorous empirical study identifying and quantifying, through text analysis, all regulations related to four different subject blocks associated with "green growth" (renewable energies, sustainable transportation, pollution and energy efficiency), issued by Spanish national or regional governments over the period 2000-2022. This research thus constructs a database in panel data format. Among other results, we identify 3,482 regulations related to renewable energies, 783 regulations dealing with sustainable transportation, 108 on pollution management and 5,116 related to the measurement (and management) of energy efficiency.

The results show that regulation is diverse by subject matter, reflects significant regional diversity and has increased over time, especially in more recent years, after a certain standstill during the Great Recession. This database could help develop future research projects on the impacts of "green" regulation on certain economic or institutional variables (such as "green" innovation or environmental conflict).

The paper concludes with a comparison of renewable energy regulation in France and Spain, also based on text analysis. Spain shows a higher and more disaggregated volume of regulation.

Keywords: energy efficiency, renewable energies, sustainable transport, pollution, regulation, regulatory complexity, text mining.

JEL classification: K32, Q5, O13, O44.

Resumen

La consecución de un modelo de crecimiento sostenible desde el punto de vista medioambiental, el desarrollo de las energías renovables o la adopción de medidas de eficiencia energética son hoy cuestiones fundamentales en el análisis económico y forman parte sustancial del debate público. Sin embargo, si bien es cierto que existe una mayor concienciación social sobre estos temas, otra cuestión muy distinta es a qué ritmo estas preocupaciones se han ido traduciendo en normativa, fomentando o dificultando el desarrollo de nuevos mercados o tecnologías «verdes».

Este trabajo propone un riguroso estudio empírico que identifica y cuantifica, a través del análisis de textos, todas las normas relacionadas con el «crecimiento verde» para cuatro bloques de materias (energías renovables, transporte sostenible, contaminación y eficiencia energética) dictadas por la Administración española (ya sea a escala nacional o para cada comunidad autónoma) durante el período 2000-2022. Esta investigación proporciona así una base de datos en formato de datos de panel. Entre otros resultados, hemos identificado 3.482 normas relacionadas con las energías renovables, 783 normas que se han ocupado del transporte sostenible, 108 relacionadas con la medición o gestión de la contaminación y 5.116 relacionadas con la medición (y gestión) de la eficiencia energética.

Los resultados muestran que la normativa ofrece una gran variedad temática, presenta una importante diversidad regional y ha ido creciendo con el tiempo, especialmente en los últimos años, tras una cierta paralización durante la época de la Gran Recesión. La citada base de datos podría ser de ayuda para desarrollar futuros proyectos de investigación sobre los impactos de la regulación «verde» en algunas variables económicas o institucionales (como los conflictos medioambientales).

El documento se completa con una comparación de la regulación de las energías renovables en Francia y en España a partir del análisis de textos. España muestra un volumen de regulación más alto y desagregado.

Palabras clave: eficiencia energética, energías renovables, transporte sostenible, contaminación, regulación, complejidad normativa, análisis de textos.

Códigos JEL: K32, Q5, O13, O44.

1   Introduction

One of the major debates related to the achievement of an environmentally sustainable growth model is how to accomplish a reduction of greenhouse gases (GHG) large and fast enough to mitigate the negative impacts of climate change. That is, succeeding in the challenge of keeping global warming to 1.5ºC (UNFCCC, 2015). This concern is identified as a "global ambition" according to the World Bank (2023). In addition to strategies directly aimed at reducing GHGs, there are many other initiatives that are highly relevant to preserve the environment e.g., the adoption of air pollution standards and energy efficiency standards.

There are multiple viable alternatives to realize these goals. See for instance the last Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report[1]. Transformational changes need trust, which builds upon a combination of political commitment, science-based targets, international cooperation, public and private sector collaboration, but importantly, ("green") regulation to achieve effective climate action as discussed below. Indeed, for all these objectives, it can be stated that the nature of climate action and environmental sustainability as public goods require special involvement from public administrations to step in reducing barriers to funding technological innovation and sharing the costs and burdens during transition to decarbonized economies. The best strategy for undertaking these actions (and their welfare implications) is already a matter of important academic debate that explores and compares possible alternative paths (see, for instance, Hille et al., 2020; Kortum and Weisbach, 2021; Leach, 2009; or Li and Shao, 2021).

As noted, "green regulations" are crucial to address these issues. Regulation[2] is, in fact, the usual form in which economic policies are expressed in a developed economy (see, among others, the work of North (1981, 1990a and 1999).

Identifying and systematizing all these regulations is useful and informative to measure the progress in the field and to be able to study their real –positive, ineffective or harmful– effects both for the goal to stop climate change or for the efficiency of the economy (Peñasco et al., 2021). "Green" regulation, providing information to citizens and businesses, could mitigate market failures and transaction costs, but if poorly designed, could have counterproductive effects by reducing innovation and investment (Acemoglu et al., 2012; Dechezleprêtre and Sato, 2017). One country's "green" regulations may even be relevant for other countries as well, since it may have an impact beyond its borders (see, for instance, Conte et al. 2021 or 2022).

In this study, our goal is to contribute to the literature on "green" regulations by identifying and quantifying the complete amount of norms adopted by the Spanish administrations in four areas i.e., renewable energies, sustainable transportation, pollution and energy efficiency; over the period 2000-2022. Access to the texts of the total regulatory production of Spain (approximately 12 thousand new norms per year) allows us to develop a detailed analysis of the different matters through text analysis. The database will be useful to carry out future studies

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[1] See: Climate Change 2021: The Physical Science Basis | Climate Change 2021: The Physical Science Basis (ipcc.ch). https://www.ipcc.ch/report/ar6/wg1/

[2] By regulation we mean the written rules adopted by a public administration (such as a government with regulatory capacity or a parliament). More specifically, in this paper, we quantify the number of norms that the central Spanish administration or the regional administrations have adopted in recent years. From the point of view of Spanish law, the definition is broad, including both "general" normative provisions –*disposiciones generales*- (applicable to a generality of situations and persons) and other much more specific provisions, implementing general rules in specific cases. See section 2.

on the evaluation of the effectiveness and success of regulation in achieving environmental objectives.

With this goal in mind, we can also mention a previous exercise aiming at compiling information about climate regulations worldwide. The "Climate Change Laws of the World" (CCLW) database project[3] identified just over 3,000 laws and policies for 193 participating countries (192 countries plus the European Union, which acceded to the 2015 Paris Agreement). Each of those countries has at least one law addressing climate change or the transition to a low-carbon economy.

Our research could be complementary to this initiative, with some similarities and differences (and different aspects in which each one provides added value). The CCLW make comparisons at the country level, based on the main national regulations. Our indicators, thanks to text analysis techniques, aim to capture the total of "green" norms of Spain related to our areas of interest (the objective is to fully capture all the regulations, not only the main or express rules), for all sectors (from agriculture to construction). The CCLW indicators have a coverage of a very limited number of norms (16 legal texts for Spain, at national level only, between 1998 and 2022, while we capture, for instance, 3,482 regulations related to renewable energies or 5,116 related to the measurement of energy efficiency). In addition, our indicators, for Spain, capture the regional perspective, which has actually regulated these matters in greater depth and volume than at the national level (see sections 3 and 4). This also provides us with an interesting panel-data perspective useful for further research projects.

The rest of the article is organized as follows: Section 2 summarizes the methodology used to measure regulation and discusses the economic relevance of this type of measurement. Section 3 provides some clarifications on the Spanish legal framework regarding environmental matters. Section 4 presents the specific results of the measurement of regulation for Spain. Section 5 complements the results with a comparison of Spanish and French regulations. Finally, section 6 provides some conclusions. This study is completed with two annexes: in the first one, we provide detailed graph material on renewable energies. In the second one, we provide more details on the comparison of the Spanish and French regulatory framework.

2 How to measure regulation

2.1 The "economics of regulation"

It is not the aim of this article to analyze the success or failure of the design of regulatory framework of an economy in relation to the matters of interest under investigation (energy efficiency, green transportation, pollution, energy efficiency). Our study provides instead (for first time for Spain) an ordered database in panel data[4] format on the regulatory framework of those matters that may be useful for subsequent research. This subsequent analysis may be able to determine whether positive or negative consequences have indeed been derived from that regulation. However, for the sake of completeness, it seems necessary to contextualize this work (and future research that may follow from it), in the literature on the "economics of regulation".

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[3] See: Law and Policy Search - Climate Change Laws of the World (climate-laws.org) https://climate-laws.org/ . See also a related iniative: Climate Policy Radar. Climate Policy Radar | AI for climate law and policy research
[4] As it is explained below (see section 4), T=2000 to 2022, i=all (17) regional administrations + central Spanish administration, for each subject under study.

The design of the institutional framework is at the center of modern economic analysis. It is worth mentioning the work of at least three Nobel laureates in economics (Coase, 1960, 1992; Williamson, 1985; North, 1981, 1990a, 1999) who have shown that institutions are a key explanatory factor in explaining long-run economic development. One of the pillars of this institutional framework is regulation (written norms). The study of regulation is specifically of interest because it is the vehicle from which the administration formulates its policies in a developed economy (see Jalilian et al. 2007, Mora-Sanguinetti and Soler, 2022, Mora-Sanguinetti et al. 2023a).

Regulation could generate positive or negative impacts depending on how well it is designed (Ogus, 2004; Mora-Sanguinetti and Pérez-Valls, 2021). From a positive point of view, North posited the institutional framework as a set of "rules of the game" that can guide economic agents in the face of uncertainty. Regulation could mitigate market failures, reducing transaction costs (Wallis and North 1986, Yang and Borland 1991, Bischoff and Bohnet 2000, Kovac and Spruk 2016). This is precisely the perspective of the First Welfare Theorem that, from the point of view of microeconomic theory, would justify the use of regulation. Moreover, a redistributive regulation could achieve an efficient allocation of resources, according to the Second Welfare Theorem (Peltzman et al. 1989; see also the review of this literature conducted in Mora-Sanguinetti et al. 2023a). The positive impacts of regulation assume that those rules used by economic agents are well designed. However, North himself also recalled that institutions are created in processes (such as politics) also affected by transaction costs and with imperfect information. Even institutions that were well designed could cease to have positive effects over time, i.e. because of their own obsolescence and mismatch with new social or economic conditions (see also Helpman, 2008). Therefore, regulation may increase rather than reduce transaction costs (North 1990b, Gratton et. al. 2021) and hence, following the "modern" theory of regulation, market failures are considered a necessary but not sufficient condition to justify the use and adoption of regulation (Laffont and Tirole (1993).

As mentioned in the introduction, this debate on the potential positive or negative properties of regulation carries over to the case of green regulations specifically, either to discuss their properties in general or for specific cases (such as their effect on patents, Nesta et al. 2014). See, as well, the contributions of Acemoglu et al., (2012) or Dechezleprêtre and Sato, (2017)].

Despite its importance, studies with data on the regulatory framework of an economy from a disaggregated point of view (by subject or territory) are still very scarce. To our knowledge there is only the case of a disaggregated database at the sector (industry) + regional (State) level carried out for the U.S. states (Dawson and Seater, 2013; McLaughlin et al., 2019) and two for Spain [see Mora-Sanguinetti and Soler (2022), Mora-Sanguinetti et al. (2023a) and Mora-Sanguinetti et al. (2023b)]. Both Spanish databases were constructed with the same technique used in this study. In the first one, we classified regulations by sector (industry) of activity. In the second, we identified regulations (in a panel data format) related to the barriers to entry of women inside the labor market of Spain.

The reasons for the lack of progress in the study of regulations at a disaggregated level have to do with the difficulty of accessing the basic information, characterized by very large volumes of information over a long period of time. In the period considered in this study (2008-2022), 33,001 regulations were adopted in the Spanish central administration and 140,898 regulations were adopted by the regional (Autonomous Communities) administrations. Based on this volume of information, the norms of interest for this article have been identified and selected. On the other hand, there has traditionally been little contact between legal and economic

research, which has also hindered the progress of both disciplines. This is despite the fact that the study of regulation, from an interdisciplinary point of view, seems to be a particularly fertile field (Doménech Pascual, 2014).

2.2 Methodology of this study

The aim of this paper is to provide quantifications of the norms that have been adopted in Spain –at the national and regional levels- in a set of specific subjects related to the transition to decarbonized economies i.e., renewable energies, sustainable transport, pollution and energy efficiency. We do so by identifying the specific administrations that have adopted the norms (thus capturing the geographical perspective) and the time of adoption (also providing a time perspective). The objective of the work is exhaustive, thanks to the access to all texts (word by word) of the Spanish norms universe[5].

The standard methodology to rationalize this work is that of measuring the "complexity" of regulation. This literature proposes several methods to objectively measure regulation by referring only to the "formal" characteristics of a regulatory corpus. That is, it does not address the content of the specific measures included in a regulation.[6]. The central point of this methodology is that the formal characteristics of the regulation are measurable.

There are two perspectives from which the formal characteristics of the regulation can be measured: firstly, we could measure the volume of regulations adopted by an administration or a set of administrations (thus also paying attention to the number of administrations publishing regulations). Secondly, we could measure the qualitative characteristics of the regulation (see De Lucio and Mora-Sanguinetti, 2021 and 2022): on the one hand, the linguistic complexity (deficient wording and drafting) or the relational complexity (related to the structure of connection of norms among them) (see Figure 1). It is useful to note that, in Spain, the two perspectives summarized in Figure 1 evolve in the same trend: the Spanish regulatory body over time seems to increase both in volume and in the use of increasingly complex structures [see De Lucio and Mora-Sanguinetti (2022)].

The database constructed in this article provides information from the first perspective (quantity/volumetric), for each subject, as well as for each administration and year. It should be noted that this first perspective, besides being the simplest, is the one mostly developed in the literature[7] (see Kirchner (2012), Econlaw Strategic Consulting (2009), Marcos et al. (2010) in addition to Mora-Sanguinetti (2019) for a previous set of references). This perspective was also advocated by Friedman (2004). This first perspective is the one that has been traditionally used to analyze the misalignments and costs of regulation that may come from regulation adopted by a multiplicity of administrations at the same time (Ellingsen 1998, Di Vita 2018). This potential problem is especially relevant in decentralized countries, as is the case of Spain.

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[5] The final inventory does not summarize a sample but the complete corpus of legislation in Spain at the national and regional levels.

[6] At this point, we do not intend to measure/evaluate the content of the norms, for instance, the degree to which environmental policies put an explicit price on polluting, as the OECD EPS does, but to provide simple objective information that can be used to develop other analyses.

[7] Although it has not normally descended to a level of detail as that developed in the current project and those mentioned above (Dawson and Seater, 2013; McLaughlin et al., 2019; Mora-Sanguinetti and Soler, 2022; and Mora-Sanguinetti et al., 2023a) where the focus was on the sectoral (industry) level.

Figure 1. Perspectives on regulatory complexity.
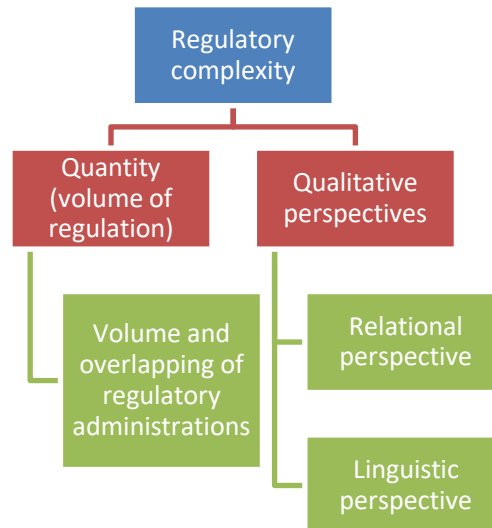
Sources: Mora-Sanguinetti (2019) and De Lucio and Mora-Sanguinetti (2021 and 2022).

2.3 Definition of "regulation" in this work

By "regulation" we mean the written rules adopted by a public administration. We quantify the number of norms that each administration (either the central administration or each of the regional administrations)[8] has adopted for each of the subjects of interest in our research per year. We work with the Aranzadi - La Ley database which collects the primary official sources, as the Official State Bulletin - Boletín Oficial del Estado (BOE) or the official bulletins of the regions (such as the BOJA – Boletín Oficial de la Junta de Andalucía or the DOCG – Diari Oficial de la Generalitat de Catalunya).[9] The adoption of one more regulation in a given area will increase the corresponding indicator. This measure makes it easy to compare the temporal or geographic perspectives.

The norms identified in the indicators correspond to all the normative ranges (whether they have force of law[10] or not) regardless of their generality. Thus, in terms of Spanish law, our indicator captures "general" rules – *disposiciones generales*- (applicable to an indeterminate number of persons and cases) as well as other provisions, of execution of general rules.[11]

This perspective helps to avoid possible choice bias on the part of the authors and is consistent with previous literature on the subject. This literature indicates that an increase in regulations, regardless of their force or generality, may create usage costs for economic agents (Bardhan 2002, Di Vita 2018).

Alternative, much more specific indicators, differentiating, for example, legal ranges, can be easily constructed provided that complete information is available. In section 5, for instance, we constructed an indicator that contains only regulations with force of law for Spain and for France.

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[8] Throughout this study, "central administration" refers, in Spanish legal terms to the "*Administración General del Estado*". The "regions" refer to the "*Comunidades Autónomas*".

[9] Subsequently, we will also work with the French regulations, with a different source (see section 5).

[10] In Spanish: "normas con fuerza (o rango) de ley". In French: « règles ayant valeur de loi ».

[11] As will be made clear in section 3, the regions have the power to enforce environmental regulations.

3   The Spanish institutional framework. Clarifications on Spanish environmental law.

Spain is a highly decentralized country. If we take as a reference the indicators developed in the field of political science, such as the Regional Authority Index (RAI), Spain would be a more decentralized country than the United Kingdom and comparable to federal states such as Canada or the USA [see, among others, Hooghe et al. (2008) or Mora-Sanguinetti and Spruk (2023)]. In simplified terms, Spanish regions (Autonomous Communities) are governed by "Regional Constitutions" (the "Statutes of Autonomy"), which are hierarchically below the Spanish Constitution. The Spanish Constitution establishes a basic common framework, but provides the regions with access to a broad set of powers[12] and allows for certain divergences among them.

Not surprisingly, therefore, the legally decentralized nature of Spain is clearly reflected in the regulatory data. Figure 2 shows the number of regulations adopted (in total) by each level of administration in Spain in the main period of study (2008-2022). In that time, the central administration adopted 33,001 norms and the regional administrations, 140,898 norms. On average, therefore, the central administration adopted 2,200 regulations per year. In contrast, the regional administrations adopted 9393 norms i.e., more than fourfold. In short, in terms of regulation, Spain is a regional country.

Figure 2. Total regulation by level of government
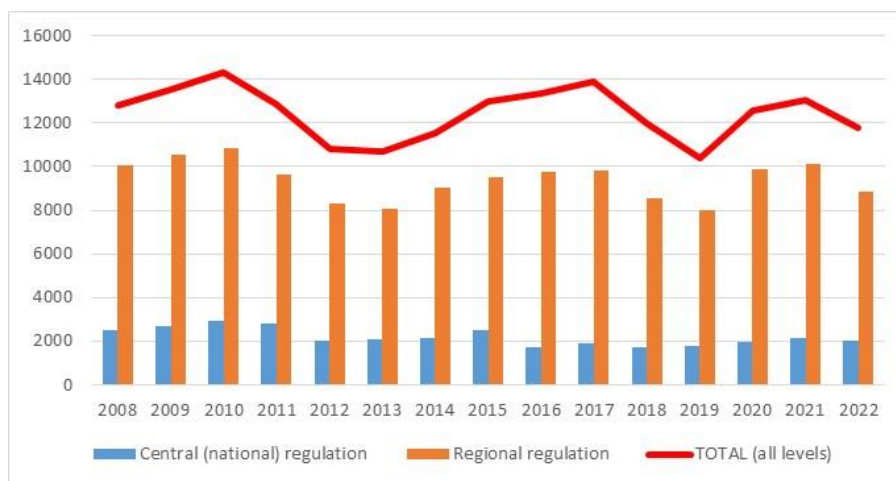
Source: own elaboration based on Aranzadi.

Consequently, the number of rules that we will find both at the national level and at the national level depends partially on the distribution of competences designed by the Spanish Constitution and the jurisprudence of the Constitutional Court. The Constitution may establish exclusive competences of a given level of administration, or competences shared between both levels (something that is usual in the Spanish system, as opposed to the "classical" federal systems) (López Guerra, 1994; López Guerra et al. 2018). With regard to the environment specifically, both state and regional regulations can be found. For a global reference on environmental law, see Betancor Rodríguez (2014).[13]

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[12] Both in the non-economic sphere (such as education or health) and in economic spheres (see Articles 148 and 150.2 of the Spanish Constitution).

[13] Specifically, on the matter of the distribution of powers, see Chapter X thereof.

By way of a simplified summary on the distribution of powers in this area, it should be pointed out that the Spanish Constitution establishes the mandate of the "public authorities" to defend the environment and to ensure the rational use of natural resources (article 45). In addition, the Constitution establishes that the regions can assume powers in "the management of environmental protection" (article 148) and that the central estate establishes the basic legislation on the protection of the environment, forests, forestry and livestock trails (article 149). The Constitution also confirms that the regions can establish additional protection regulations (therefore, divergences), respecting the minimum protection standards established by the central administration regulations [see, among others, the Constitutional Court's Rulings (*Sentencia del Tribunal Constitucional*, STC) 109/2017[14] or 100/2020[15]]. In addition, the regions are competent to execute (enforce) the legislation in this area.

Beyond the relative simplicity with which this distribution of competences seems to be drafted, it should be remembered, first of all, that this framework can be complicated by the existence of several "related" matters in which the Autonomous Regions could take powers. This is the case, for example, of the "protected natural areas", with important interrelations with the more general matter of the environment [see Laza (1996), who analyzes the important STC 102/1995[16]]. Secondly, it should be recalled that the framework of powers of the Constitution is drafted in 1978, so there has been an evolution in the matter in recent decades from the emergence of new problems related to environmental management. For example, as such, the Constitution does not mention the "fight against climate change" (STC, 87/2019[17]), so the subject has been appearing as such in the Statutes of Autonomy and the regulations that have been drafted on the basis of them. [18]

In summary, it seems appropriate to carry out a study of environmental regulations not only for the central administration, but also for each of the regions. There are at least three reasons for this: first, Spain is a legally decentralized country; second, the distribution of powers in environmental matters expressly allows regulations to exist both in the central administration and in the regions, and the latter set of regulations, as confirmed by the TC, may be to some extent different between regions, suggesting an interesting "panel" perspective (from the econometric point of view). Thirdly, the quantitative reality of Spanish regulation already shows a very suggestive basis: regional administrations persistently publish about 4 times more regulations (for all subjects) than the Central administration.

4   Results: "Green regulation" in Spain (2000-2022)

4.1   The database

The database is created by identifying the regulations that deal with the subjects of interest of our study (renewable energies, sustainable transport, pollution and energy efficiency) both from the central administration and from the administrations of all the Autonomous Regions, for all legal ranges (with force of Law and with a force lower than that of Law).

The search for regulations is performed by accessing the full texts of each of the adopted regulations, consisting of a very considerable volume of information (about 12,000 regulations per year), and finding in them the sets of relevant words that identify each subject. As indicated

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[14] STC 109/2017, 21 of september of 2017.
[15] STC 100/2020, de 22 of july of 2020.
[16] STC 102/1995, de 26 of june of 1995.
[17] STC 87/2019, de 20 of june of 2019.
[18] See, for example, Law 6/2022, of 27 December, on climate change and energy transition in the Canary Islands.

above, the norms come primarily from official sources: the Official State Gazette (BOE), the official gazettes of the Autonomous Regions [Official Gazette of the Junta de Andalucía (BOJA), the Official Journal of the Generalitat de Catalunya (DOGC), etc.]. We work with all this material using Aranzadi-La Ley.

The words or sets of words used to identify the regulations, after several rounds of analysis, are grouped into 4 blocks or major topics of interest: renewable energies, sustainable transport, pollution and energy efficiency (see figure 3). Thus, to identify regulations of interest related to renewable energies, we have searched for regulations that specifically regulate "wind energy", "solar energy", "hydrogen", but also the very concept of "renewable energy". Along with this, we list the set of all norms dealing with these concepts, correcting for possible double counting, as "total" in the table. Each concept (or the total) generates a separate panel database, which can be used autonomously in future analyses if desired. We proceed in the same way with the concepts related to sustainable transport, pollution and energy efficiency. Both the concepts and the number of norms found for each case are included in Figure 3. Figure 4 provides some examples of the norms found.

The search is thorough. It is able to identify, by accessing texts, explicit and clear regulations (such as "Law 6/2022, of 27 December. Climate change and energy transition of the Canary Islands"), but also much less explicit norms, such as a budgetary norm of a given administration that includes measures related to a renewable energy (e.g. Law 27/2014, of 27 November. Law on Corporate Income Tax –*Ley del Impuesto sobre Sociedades*-). This second type of rule could easily go unnoticed if we did not analyze the full text of the norms, and yet be very relevant. This thorough selection is deliberate and this is precisely an added value of this research, compared to, for example, the CCLW.[19]

We have carried out 3510 (13X18X15) information searches (one search for each of the 15 years covering the period 2008-2022 plus the year 2000) of regulations for each concept or subject (13 subjects) and for each administration (17 Autonomous Regions + State). The reason for starting the study in 2008 is that Spanish regulatory activity in the areas analyzed does not begin in any significant way until the end of that decade. Specifically, 2008 seems an interesting year to start because it is the beginning of the "great recession". To the main period of analysis, we also add the information for the year 2000. The reason is simply to have a historical reference. Figure 5 summarizes the descriptive statistics of the regulatory activity variables constructed from these annual searches at the regional level. Figure 6 does the same at the level of the central administration.

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[19] Any rule regulating the "green economy", in a more or less intense or extensive way, generates a potential institutional instability that needs to be taken into account. A company or a citizen with an interest in the subject will have to take into account both a regulation such as that on corporate taxation (in particular, the aspects related to "green" activities within a country's taxation) and an explicit regulation on climate change (regulating many other aspects at the same time). All of these can increase the regulatory complexity of a sector, generating, for example, risks of sanction by the administration and, more generally, usage costs of the regulatory framework (see section 2 and the bibliography mentioned there).

Figure 3. Number of norms adopted, by subject and specific topic (2000 and 2008-2022).

SUBJECT	SPECIFIC TOPIC	AUTONOMOUS REGIONS	STATE (CENTRAL GOVERNMENT) NORMS
Renewable energies (*Energías renovables*)	Wind energy (*Energía eólica*)	204	46
	Solar energy (*Energía solar*)	313	66
	Renewable energy (general concept) *[Energía renovable (concepto)]*	2707	535
	Hydrogen (*Hidrógeno*)	32	39
	Total (Renewable energies) *[Total (energías renovables)]*	2876	606
Sustainable transportation (*Transporte sostenible)*	Electric vehicles (*vehículo eléctrico*)	514	214
	Low emission zones (*zonas de bajas emisiones*)	23	19
	Charging points (*puntos de recarga*)	310	68
	Sustainable transportation (total) [*transporte sostenible (total)*]	548	235
Pollution (*Contaminación*)	Pollution (*contaminación*)	70	38
Energy efficiency (*Eficiencia energética*)	Energy efficiency (concept) *["Eficiencia energética" (concepto)]*	3694	761
	Energy rating (*calificación energética*)	487	69
	Enegy efficiency (total) [*Eficiencia energética (total)*]	4281	835

Source: own elaboration based on Aranzadi.

Figure 4. Examples of norms compiled in our database by subject and specific topic

SUBJECT	SPECIFIC TOPIC	EXAMPLES WITHIN EACH TOPIC
Renewable energies (*Energías renovables*)	Wind energy (*Energía eólica*)	• **Decreto-ley (Aragón) 2/2016, de 30 de agosto.** Medidas urgentes para la ejecución de las sentencias dictadas en relación con los concursos convocados en el marco del Decreto 124/2010, de 22-6-2010 (LARG 2010\294), y el impulso de la producción de energía eléctrica a partir de la energía eólica en Aragón • **Ley 27/2014, de 27 de noviembre.** Ley del Impuesto sobre Sociedades. • **Orden (Andalucía) de 24 de febrero 2011.** Modifica la de 29-2-2008 (LAN 2008\148), que regula el procedimiento para la priorización en la tramitación del acceso y conexión a la red eléctrica en Andalucía para la evacuación de la energía de las instalaciones de generación que utilicen como energía primaria la energía eólica, contempladas en el Real Decreto 661/2007, de 25-5-2007 (RCL 2007\1007), que regula la actividad de producción de energía eléctrica en régimen especial
	Solar energy (*Energía solar*)	• **Ley 6/2022, de 27 de diciembre.** Cambio climático y transición energética de Canarias • **Ley (Cantabria) 5/2022, de 15 de julio.** Normas reguladoras de Ordenación del Territorio y Urbanismo de Cantabria • **Resolución (Castilla y León) de 3 de abril 2009.** Establece criterios para la facturación mensual del consumo de energía eléctrica para las tarifas de suministro de energía eléctrica social y doméstica (hasta 10 kW de potencia contratada)
	Hydrogen (*Hidrógeno*)	• **Resolución (Islas Baleares) de 30 de noviembre 2022.** Convocatoria pública de subvenciones para el fomento de instalaciones de generación renovable en puertos de las Illes Balears con tecnología fotovoltaica, eólica, undimotriz o marina, de almacenamiento eléctrico, de infraestructura de recarga eléctrica o de hidrógeno renovable destinada a embarcaciones eléctricas o de hidrógeno dentro de las actuaciones previstas en el Plan de Inversiones para la Transición Energética de las Illes Balears, en el marco del Plan de Recuperación, Transformación y Resiliencia financiado por Unión Europea (NextGenerationEU) • **Resolución (País Vasco) de 12 de mayo 2022.** Procede a la aprobación, convocatoria y publicación de las bases reguladoras del programa de ayudas a inversiones en eficiencia energética, energías renovables, transporte y movilidad eficiente • **Orden (Madrid) 2993/2021, de 6 de octubre.** Aprueba el plan estratégico para la concesión directa de ayudas vinculadas a los fondos Next Generation EU
Sustainable transportation (*Transporte sostenible*)	Electric vehicles (*vehículo eléctrico*)	• **Real Decreto-ley (Estatal) 29/2021, de 21 de diciembre.** Adopta medidas urgentes en el ámbito energético para el fomento de la movilidad eléctrica, el autoconsumo y el despliegue de energías renovables • **Orden (Murcia) de 9 de diciembre 2022.** Modifica la Orden de 20-12-2021 (LRM 2021\555) por la que aprueban las bases reguladoras del programa de ayuda para la dotación y rehabilitación de parques empresariales • **Resolución (Andalucía) de 13 de noviembre 2019.** Modifica los catálogos de actuaciones energéticas de las líneas de incentivos Construcción Sostenible y Pyme

		Sostenible acogidas a la Orden de 23-12-2016 (LAN 2016\429)
	Low emission zones (*zonas de bajas emisiones*)	• **Real Decreto 983/2021, de 16 de noviembre (Estatal).** Aprueba la concesión directa a las comunidades autónomas y a las ciudades de Ceuta y Melilla de ayudas para la transformación de flotas de transporte de viajeros y mercancías de empresas privadas prestadoras de servicios de transporte por carretera • **Orden (Aragón) VMV/544/2022, de 20 de abril.** Aprueba la convocatoria de ayudas para la transformación de flotas de transporte de viajeros y mercancías de empresas privadas prestadoras de servicios de transporte por carretera, así como de empresas que realicen transporte privado complementario en el marco del Plan de Recuperación, Transformación y Resiliencia -Financiado por la Unión Europea- Next Generation EU • **Orden (Castilla – La Mancha) 51/2021, de 9 de abril.** Aprueba las bases reguladoras para la concesión de ayudas contempladas en los Planes de Impulso al Medio Ambiente Cambio Climático (PIMA-CC) para la puesta en marcha de acciones de lucha contra el cambio climático, que integran a su vez, la política de cambio climático con las políticas de calidad ambiental
	Charging points (*puntos de recarga*)	• **Real Decreto 1078/2015, de 27 de noviembre (Estatal).** Regula la concesión directa de ayudas para la adquisición de vehículos de energías alternativas, y para la implantación de puntos de recarga de vehículos eléctricos en 2016, MOVEA. • **Resolución (Cataluña) EMC/2399/2019, de 12 de septiembre.** Hace pública la convocatoria del año 2019 para la concesión de subvenciones a la instalación de infraestructuras de recarga rápida para el vehículo eléctrico en el marco del Plan de Acción para el desarrollo de infraestructura de recarga para los vehículos eléctricos en Cataluña (PIRVEC 2016-2019) • **Resolución (Extremadura) de 30 de diciembre 2020.** Aprueba la convocatoria de subvenciones destinadas al fomento de movilidad eficiente y sostenible (Programa MOVES II) en Extremadura
Pollution (*Contaminación*)	Pollution (*contaminación*)	• **Decreto (Comunidad de Madrid) 140/2017, de 21 de noviembre.** Aprueba el protocolo marco de actuación durante episodios de alta contaminación por dióxido de nitrógeno (NO2) en la Comunidad de Madrid • **Ley (Comunidad Valenciana) 5/2022, de 29 de noviembre.** Ley de residuos y suelos contaminados para el fomento de la economía circular en la Comunitat Valenciana • **Resolución (Asturias) de 7 de febrero 2018.** Cuarta modificación de la Resolución 10-11-2014 (LPAS 2014\359), de la Consejería de Fomento, Ordenación del Territorio y Medio Ambiente, que crea el Comité de Coordinación y Seguimiento de las actuaciones contra la contaminación que se desarrollen en ejecución del Plan de mejora de la calidad del aire en la zona ES 0302 Asturias-Central

	Energy efficiency (concept) ["Eficiencia energética" (concepto)]	• **Ley (Estatal) 19/2009, de 23 de noviembre.** Medidas de fomento y agilización procesal del alquiler y de la eficiencia energética de los edificios • **Decreto (Andalucía) 169/2011, de 31 de mayo.** Aprueba el Reglamento de Fomento de las Energías Renovables, el Ahorro y la Eficiencia Energética en Andalucía • **Decreto (Aragón) 46/2014, de 1 de abril.** Regula actuaciones en materia de certificación de eficiencia energética de edificios y crea su registro, en el ámbito de la Comunidad Autónoma de Aragón
Energy efficiency (*Eficiencia energética*)	Energy rating (*calificación energética*)	• **Resolución (Canarias) de 12 de noviembre 2021.** Dispone la publicación del Convenio de Cooperación entre la Consejería de Transición Ecológica, Lucha contra el Cambio Climático y Planificación Territorial y la sociedad mercantil pública Gestur Canarias, SA (GESTUR) para la gestión de la convocatoria de subvenciones para el programa de ayudas para actuaciones de rehabilitación energética en edificios existentes y regula la concesión directa de las ayudas de este programa a las Comunidades Autónomas y ciudades de Ceuta y Melilla (Programa PREE) • **Orden (Cantabria) EPS/30/2020, de 4 de noviembre.** Convoca ayudas del programa para actuaciones de rehabilitación energética en edificios existentes, en el territorio de la Comunidad Autónoma de Cantabria. • **Orden (Castilla y León) EYE/2160/2008, de 11 de diciembre.** Establece las bases reguladoras de las subvenciones dirigidas a la realización de inversiones en la mejora de la envolvente térmica de edificios existentes y para la mejora de la calificación energética de edificios de nueva construcción de la Comunidad Autónoma de Castilla y León

Source: own elaboration based on Aranzadi.

Figure 5. Descriptive statistics of regulatory variables by specific topic for the Autonomous
Regions (2000 and 2008-2022)

Variable	Panel dimension *(16 years of data X 17 regions = 272)*	Mean	Std. dev.	Minimum number of norms found	Maximum number of norms found
Wind energy (*Energía eólica*)	272	0,7500000	0,9888679	0	5
Solar energy (*Energía solar*)	272	1,1433820	1,5740140	0	9
Renewable energy (general concept) [*Energía renovable (concepto)*]	272	9,9264710	6,3352030	0	42
Hydrogen (*Hidrógeno*)	272	0,1176471	0,6020730	0	8
Total (Renewable energies) [*Total (energías renovables)*]	272	10,5441200	6,6364390	0	47
Electric vehicles (*vehículo eléctrico*)	272	1,8566180	2,5939240	0	16
Low emission zones (*zonas de bajas emisiones*)	272	0,0808824	0,3339387	0	2
Charging points (*puntos de recarga*)	272	1,1286760	1,8147570	0	13
Sustainable transportation (total) [*transporte sostenible (total)*]	272	1,9779410	2,7260310	0	16
Pollution (*contaminación*)	272	0,2573529	0,5951380	0	5
Energy efficiency (concept) [*"Eficiencia energética" (concepto)*]	272	13,5404400	8,8546180	0	68
Energy rating (*calificación energética*)	272	1,7794120	2,0908910	0	13
Enegy efficiency (total) [*Eficiencia energética (total)*]	272	15,6911800	9,7208380	0	80

Source: own elaboration.

Variable	Time series *(16 years of data)*	Mean	Std. dev.	Minimum number of norms found per year	Maximum number of norms found per year
Wind energy (*Energía eólica*)	16	2,8750	2,604483	0	10
Solar energy (*Energía solar*)	16	4,1250	2,655184	0	8
Renewable energy (general concept) *[Energía renovable (concepto)]*	16	33,4375	2,416325	0	92
Hydrogen (*Hidrógeno*)	16	2,4375	6,592609	0	24
Total (Renewable energies) *[Total (energías renovables)]*	16	37,8750	25,353170	13	101
Electric vehicles (*vehículo eléctrico*)	16	13,3750	10,190680	3	42
Low emission zones (*zonas de bajas emisiones*)	16	1,1875	2,786126	0	10
Charging points (*puntos de recarga*)	16	4,2500	6,287554	0	25
Sustainable transportation (total) *[transporte sostenible (total)]*	16	14,6875	1,249383	3	48
Pollution (*contaminación*)	16	2,3750	1,454877	0	5
Energy efficiency (concept) *["Eficiencia energética" (concepto)]*	16	39,125	25,70571	3	113
Energy rating (*calificación energética*)	16	4,3125	3,807339	0	13
Enegy efficiency (total) *[Eficiencia energética (total)]*	16	52,1875	34,080730	10	143

Source: own elaboration.

4.2 Evolution of "green" regulation in Spain and the Autonomous Regions

Some of the results of the database are presented below in the form of graphs. Figure 7 shows the frequency with which each level of administration (regional or national) has regulated each subject over time. In this graph, all the regional regulations for each subject are added together (orange line). Next, Figures 8 to 18 show the frequency of regulation for each subject using maps for 4 years of the sample (2000, 2008, 2015, 2022), which allows us to compare the evolution of the activism of each administration over time. The 4 maps are not always presented if there is not regulatory activity in that specific year. The graphical material is completed with 3 detailed graphs provided in "Annex A" regarding renewable energies.

The graphs show that in the year 2000 very few regulations were adopted by the Spanish administrations in any of the areas studied. In 2008, a timid take-off of environmental regulations began, which tended to consolidate over time (especially at the end of the observation period, after the years of the great recession). The regional diversity is, in any case, very large, giving the database an interesting panel perspective. These objective data confront us with the perspective that, although there has been an important social debate on the environment in recent decades, regulatory intervention has been recent. This insight is, in itself, useful.

In contrast to a general analysis, in which a certain slowness in the adoption of regulations can be observed, it is worth highlighting some exceptions for specific areas. Thus, with regard to

renewable energies, the data do show a vigorous movement since 2008 (see also the detailed graphic analysis provided in the appendix). However, in the year 2022, this subject has once again become of significant interest to administrations.

In the 2022 horizon, a more general interest in practically all the subjects studied can already be confirmed. In addition to the interest in renewable energies, it is worth highlighting the presence in the regulations of other problems and concerns such as electric vehicles and sustainable transport or, in another order of things, the regulations on energy rating.

Taking the four most populated Autonomous Regions (Andalusia, Catalonia, Madrid and Valencia) as an example, it is possible to observe some trends that could be related to the economic cycle and general economic development. Thus, there has been regulatory activism in everything related to renewable energies and energy efficiency between 2000 and 2008, to stagnate and retreat during the great recession. Subsequently, in recent years there has been a recovery of these issues on the regulatory agenda.

With regard to central government regulations specifically, we can make a similar observation to the one presented in the previous paragraph. Although there is a high diversity by subject, it should be noted that there was a great increase in regulatory interest in renewable energies and energy efficiency at the beginning of the period under analysis. This interest relaxed during the great recession and has increased again in more recent years. The same behavior can also be observed in the case of sustainable transport (electric vehicles and sustainable transport in general).

Figure 7. Frequency of regulation by specific topic for both the central and the regional (all regions) administrations
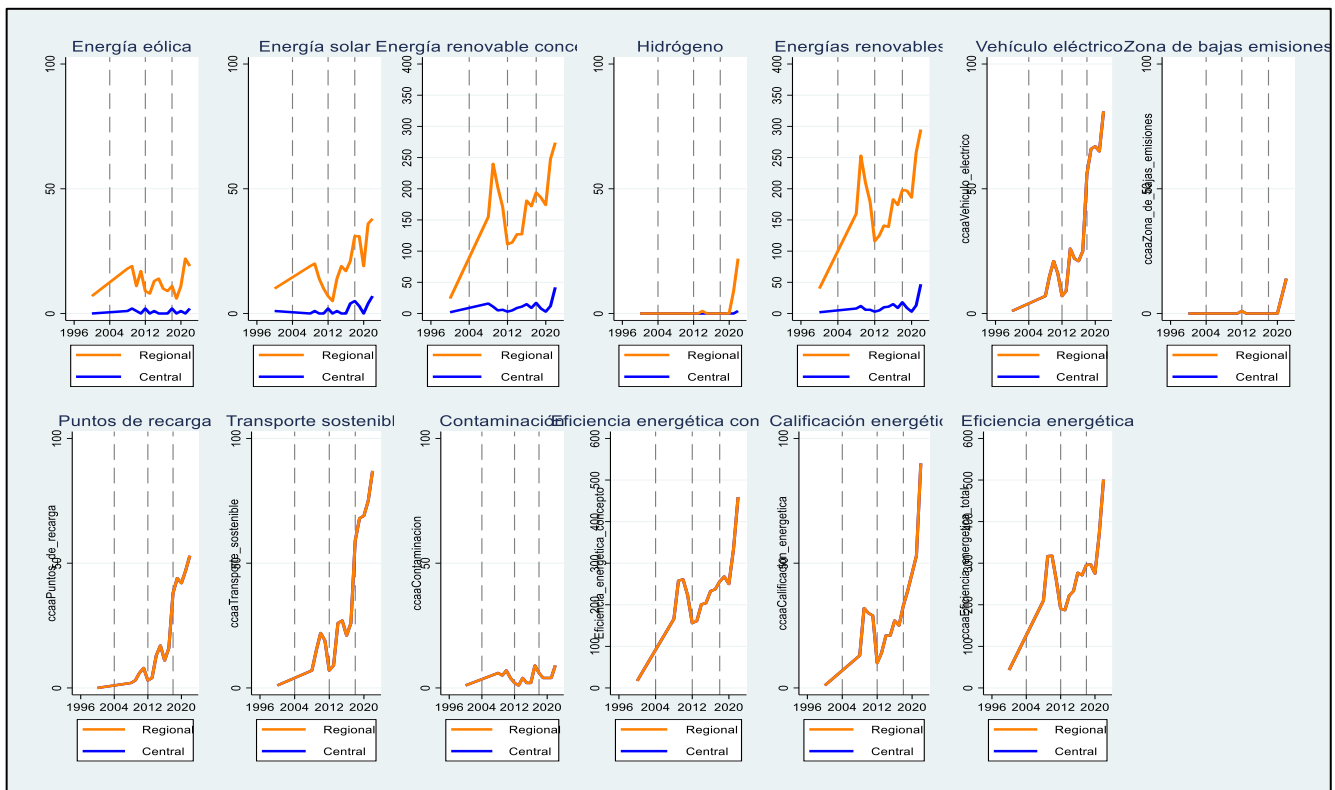
Source: own elaboration based on Aranzadi

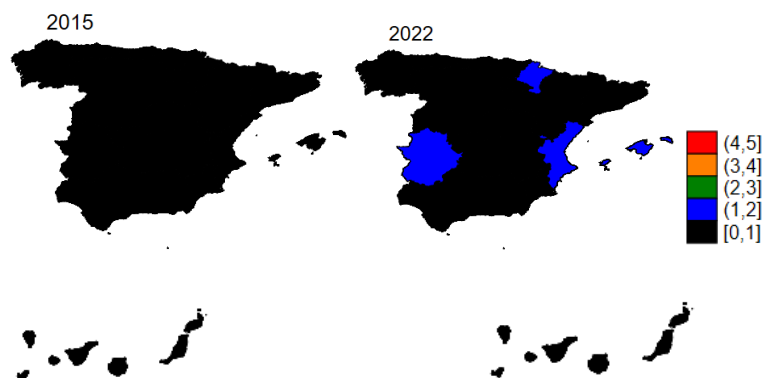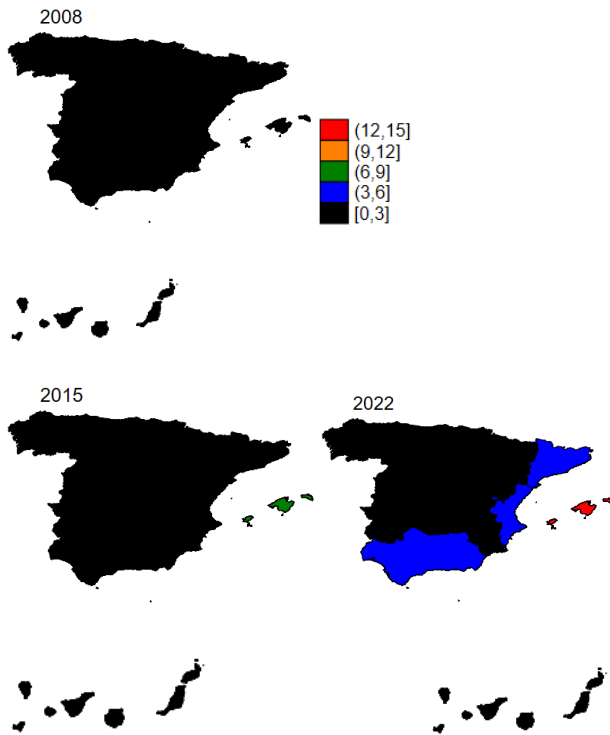**Figure 8**. Frequency of wind energy regulation in the autonomous regions
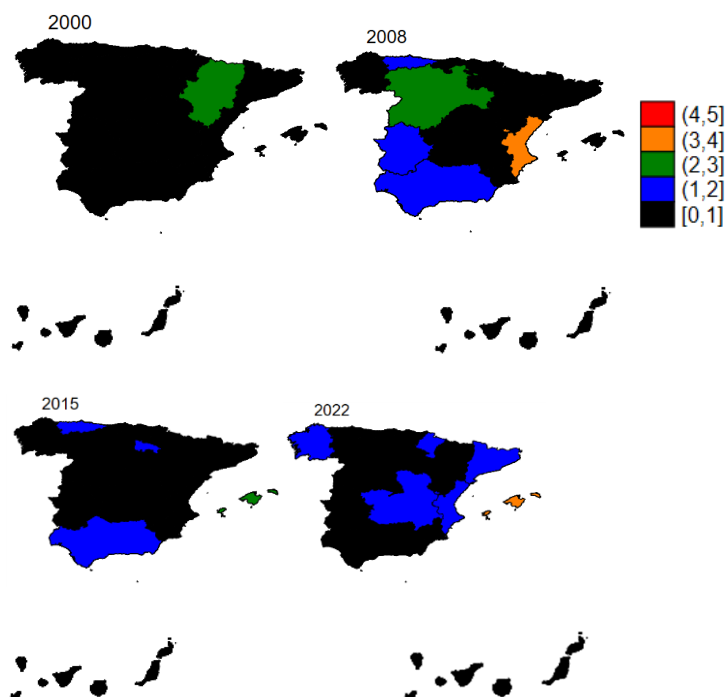
Source: own elaboration based on Aranzadi.

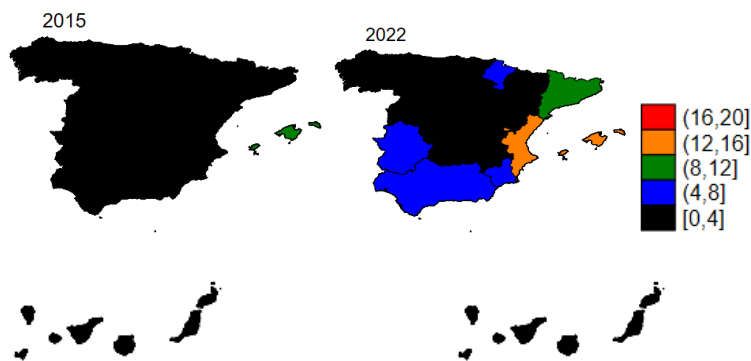**Figure 9**. Frequency of solar energy regulation in the autonomous regions
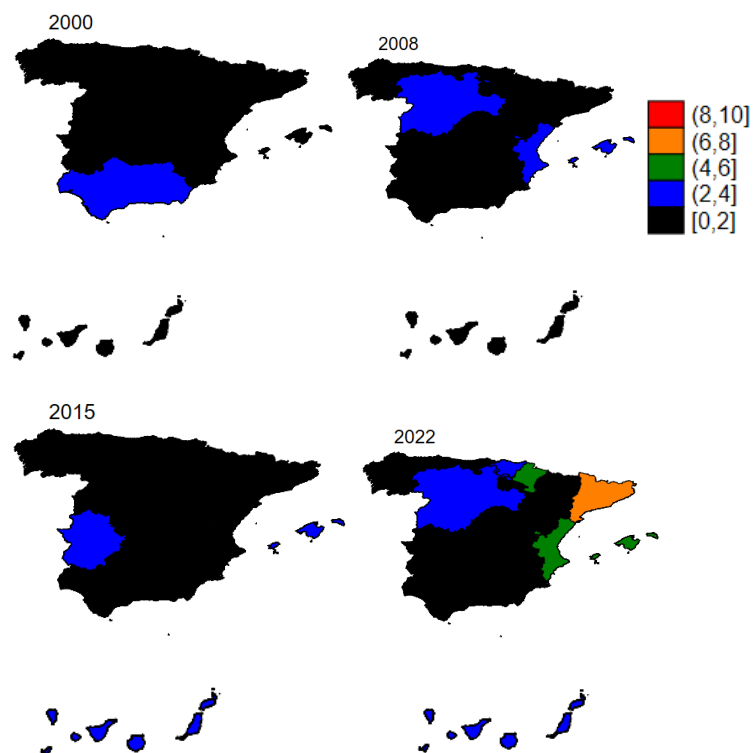
Source: own elaboration based on Aranzadi.

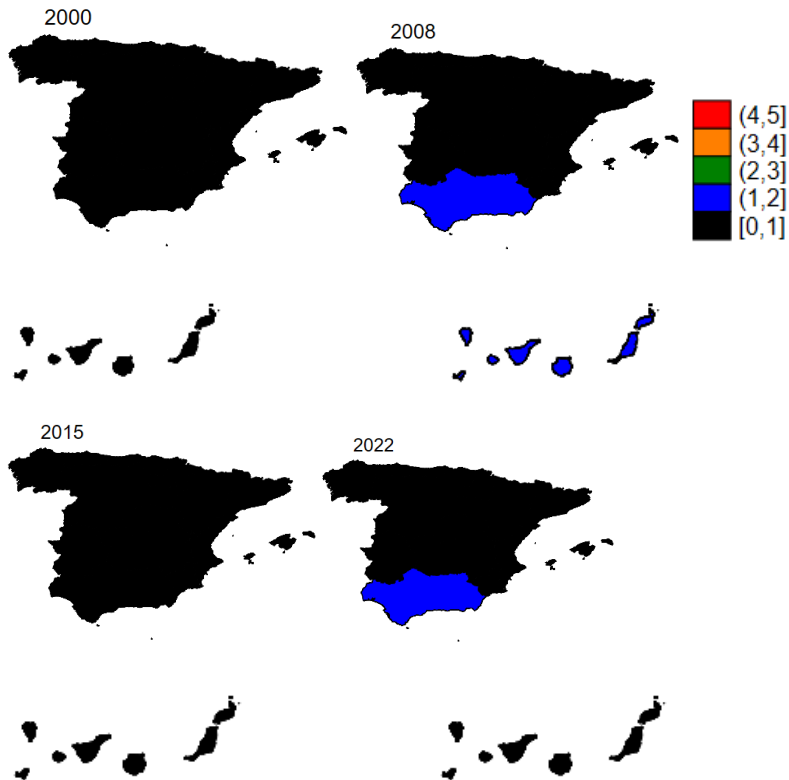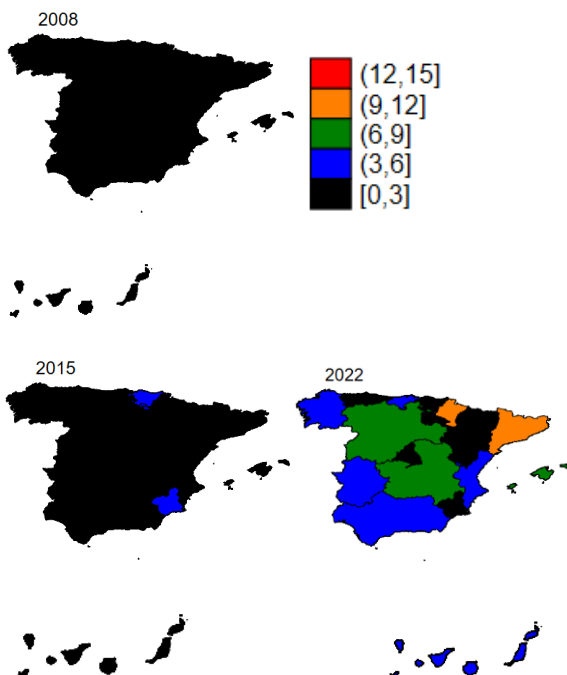**Figure 10.** Frequency of hydrogen regulation in the autonomous regions

2015

2022

🟥	(4,8]
🟧	(3,4]
🟩	(2,3]
🟦	(1,2]
⬛	[0,1]
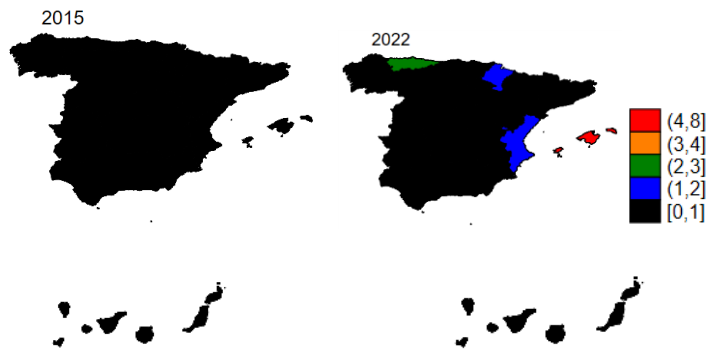
Source: own elaboration based on Aranzadi.

Figure 11. Frequency of regulation of renewable energies (total) in the autonomous regions

2000

2008

🟥	(40,50]
🟧	(30,40]
🟩	(20,30]
🟦	(10,20]
⬛	[0,10]

2015

2022
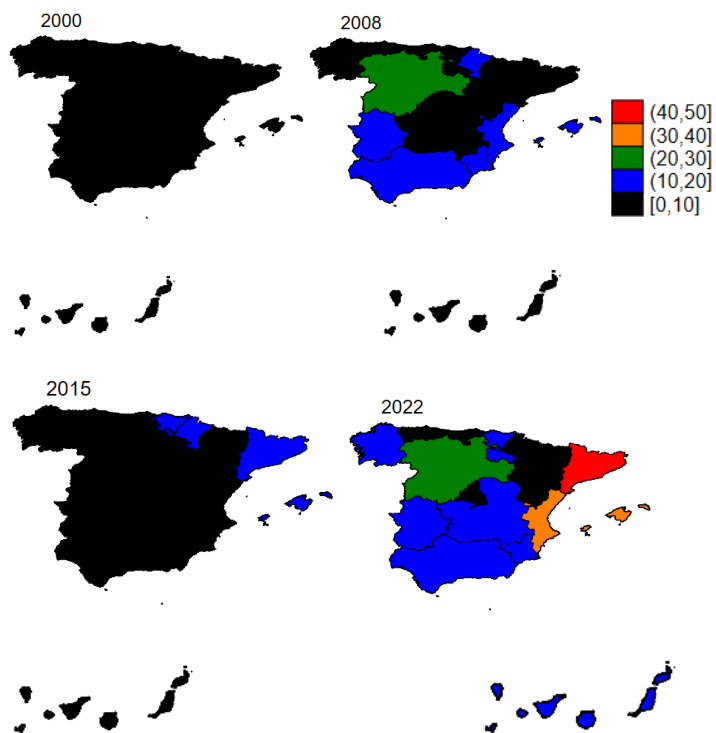
Source: own elaboration based on Aranzadi.

Figure 12. Frequency of regulation of electric vehicles in the autonomous regions

2008

(16,20]
(12,16]
(8,12]
(4,8]
[0,4]

2015

2022
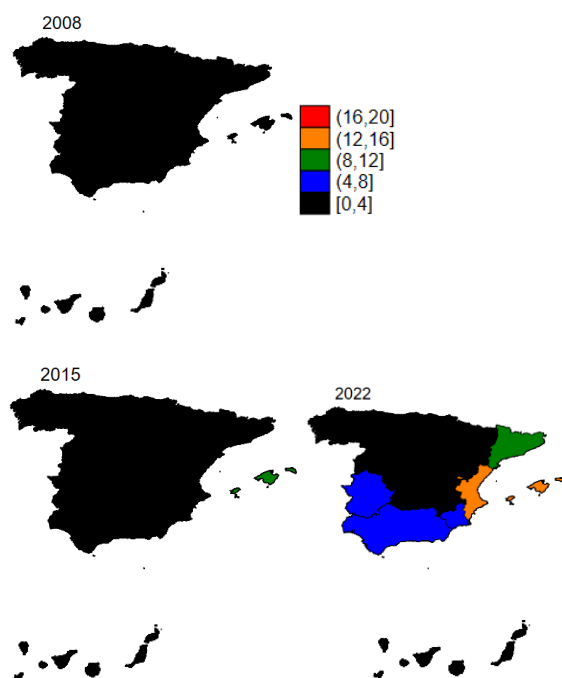
Source: own elaboration based on Aranzadi.

Figure 13. Frequency of low emission zone regulation in the autonomous regions

2015

2022

(4,5]
(3,4]
(2,3]
(1,2]
[0,1]

Source: own elaboration based on Aranzadi.

Figure 14. Frequency of regulation of recharging points in the autonomous regions

2008

(12,15]
(9,12]
(6,9]
(3,6]
[0,3]

2015

2022

Source: own elaboration based on Aranzadi.

Figure 15. Frequency of regulation of sustainable transport in the autonomous regions

2015

2022

(16,20]
(12,16]
(8,12]
(4,8]
[0,4]

Source: own elaboration based on Aranzadi.

Figure 16. Frequency of pollution regulation in the autonomous regions

Source: own elaboration based on Aranzadi.

Figure 17. Frequency of regulation of energy rating in the autonomous regions

Source: own elaboration based on Aranzadi.

Figure 18. Frequency of energy efficiency regulation (total) in the autonomous regions
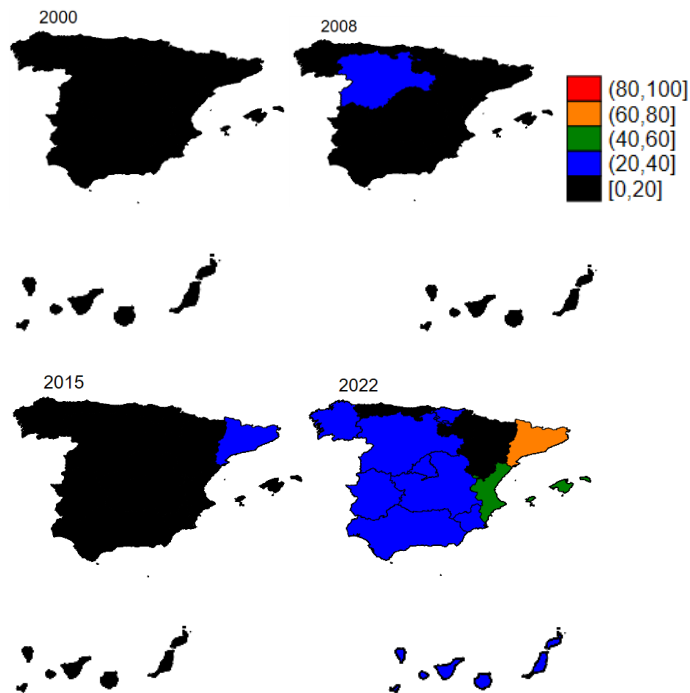
Source: own elaboration based on Aranzadi.

5   A comparison of green regulation (in terms of renewable energy) in Spain and France

In the same way that we have explored the texts of the Spanish regulations, we could analyze the texts of the regulations of other countries, if the texts of their regulatory corpuses are available in a complete form. In this section, an analysis of French regulations is carried out, using the same text analysis techniques applied to Spanish regulations. Our objective is to provide a comparison of the evolution of both countries in terms of "green regulation".[20]

The exercise is innovative and, partly for this reason, necessarily restrictive and conservative to ensure that the comparisons offered are correct. Thus, we have decided to compare only the norms with force of law for Spain and France, which guarantees homogeneity. We have expressly taken into account that, in Spain, regulations with force of law can be adopted either by the central administration or by the regions. In France, the norms with force of law only

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[20] Annex B provides a comparison of all regulations with force of law (the total volume of "green" and non-green regulation) for Spain and France.

originate from the central administration.[21] Likewise, we restrict the comparison to only the subject of renewable energies, to reduce possible problems of incorrect equivalences between a French legal term and one in Spanish (for example, we may think that references to "hydrogen" in both bodies of law refer to a similar item).

By way of clarification of the reason for caution, it should be recalled that, although Spain and France share the same legal family and a similar conception of public administration, they do not share a common constitutional law. Neither do they share a common language (there is no official version of French norms in Spanish or vice versa). On the contrary, in section 4 we made comparisons of Spanish regional data because they share a common basic legal framework (Spanish constitutional law) and a common language. In short, the way in which a norm is adopted and the effects of that norm are similar in all Spanish regions. On the other hand, we guaranteed the linguistic consistency of the work by analyzing the official Spanish version of all the laws (even if there is, for example, a version in Catalan or Basque).

Figure 19 summarizes our comparison exercise. If we take the example of wind energy, from the 204 Spanish regional norms and the 46 norms of the Spanish central administration identified in the first exercise (carried out in section 4), we are now left with only the 35 regional norms and the 24 "central" ones that had force of law. We then compare these laws with the 17 norms that were adopted in France, also with force of law, in the same period (year 2000 + years 2008-2022). For completeness, Annex B provides a graph comparing Spanish and French law for all subjects (not only the "green" ones).

Figure 19. French and Spanish norms with force of law relating to renewable energies

SUBJECT	SPECIFIC TOPIC	SPECIFIC TOPIC (IN FRENCH)	SPANISH CENTRAL ADMINISTRATION (STATE/CENTRAL GOVERNMENT)	SPANISH AUTONOMOUS REGIONS	FRANCE
Renewable energies (*Energías renovables*)	Wind energy (*Energía eólica*)	énergie éolienne (énergie mécanique du vent)	24	35	17
	Solar energy (*Energía solar*)	énergie solaire (énergie du soleil)	15	108	25
	Hydrogen (*Hidrógeno*)	hydrogène	14	125	14

Source: own elaboration based on Aranzadi-La Ley and Lamyline.

Figure 20 (in parallel to Figure 4, for Spain) provides some examples of the norms extracted, which come from official sources (Journal Officiel de la République Française) and which we studied using Lamyline.

Figures 21, 22 and 23 show a comparison of the volume of regulation adopted for Spain (both by the central and regional administrations) and for France. Each figure shows a bar chart (on

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[21] For the case of France, in addition to the laws, we include the "ordonnances" (article 38, Constitution du 4 octobre 1958).

Figure 20. Examples of (French) norms (with force of Law) compiled in our database by specific topic

SUBJECT	SPECIFIC TOPIC	EXAMPLES WITHIN EACH TOPIC
Renewable energies	énergie éolienne (énergie mécanique du vent)	• **Loi nº 2021-1104 du 22 août 2021** portant lutte contre le dérèglement climatique et renforcement de la résilience face à ses effets • **Loi nº 2015-992 du 17 août 2015** relative à la transition énergétique pour la croissance verte • **Ordonnance nº 2017-80 du 26 janvier 2017** relative à l'autorisation environnementale
	énergie solaire (énergie du soleil)	• **Loi nº 2019-1147 du 8 novembre 2019** relative à l'énergie et au climat • **Loi nº 2010-788 du 12 juillet 2010** portant engagement national pour l'environnement • **Loi nº 2017-227 du 24 février 2017** ratifiant les ordonnances nº 2016-1019 du 27 juillet 2016 relative à l'autoconsommation d'électricité et nº 2016-1059 du 3 août 2016 relative à la production d'électricité à partir d'énergies renouvelables et visant à adapter certaines dispositions relatives aux réseaux d'électricité et de gaz et aux énergies renouvelables
	hydrogène	• **Loi nº 2017-1839 du 30 décembre 2017** mettant fin à la recherche ainsi qu'à l'exploitation des hydrocarbures et portant diverses dispositions relatives à l'énergie et à l'environnement • **Loi nº 2009-967 du 3 août 2009** de programmation relative à la mise en œuvre du Grenelle de l'environnement • **Loi nº 2019-1428 du 24 décembre 2019** d'orientation des mobilités

Source: own elaboration based on Lamyline.

the left) with the 3 administrations (central and regional for Spain versus France) and another (on the right) comparing only the Spanish and French central administrations. It should be clarified that, in Spain, a regional law is equivalent to a law adopted by the central administration (one cannot repeal the other).

These graphs reveal several findings. From an overall point of view, the volume of regulation adopted by France and the Spanish central administration is quite comparable (graphs on the right). The differential fact occurs when adding the Spanish regional level (orange bars), which publishes much more regulations at all times and for all subjects than the Spanish or French central administrations. In other words, from a business point of view, the two countries would pose two very different regulatory scenarios: one highly centralized (France) and the other highly decentralized (Spain), where most of the regulations with force of law have regional differences. The question remains for future research as to whether this greater disaggregation could have a positive or negative effect for these businesses. From a positive point of view, the "competition" in regulation between regions can lead to test and optimize the best solution to promote renewable energies. From a negative point of view, excessive complexity in the regulatory framework may generate market discontinuities at the regional level, being a constraint to market size. This could reduce the growth of companies and hinder their specialization [Becker and Murphy (1992), Vallés and Zárate (2012) or Mora-Sanguinetti and Valls (2021)].

At the time level, it is possible to observe a slight upward trend in regulation, the case of hydrogen being the clearest. From 2015-2019, there is a certain "standstill" in the Spanish regulation, compared to the French one.

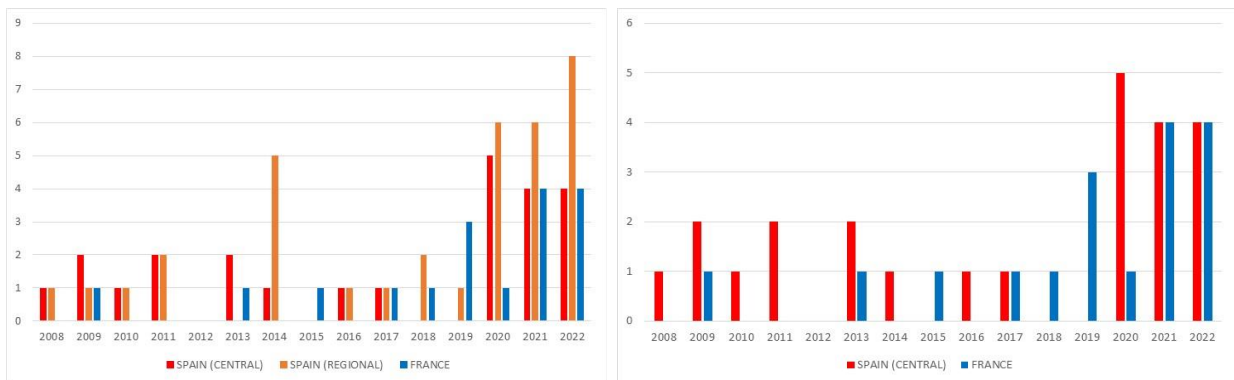**Figure 21.** Wind energy regulations (with force of law) in France and Spain
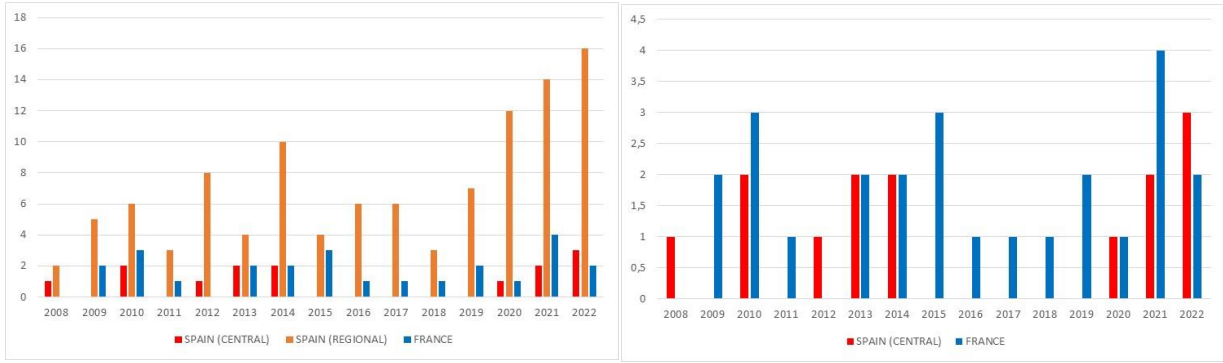
Note: The blue and red columns represent the same information in both panels. *Source:* own elaboration based on Aranzadi-La Ley and Lamyline.

Figure 22. Regulations (with force of law) on solar energy in France and Spain
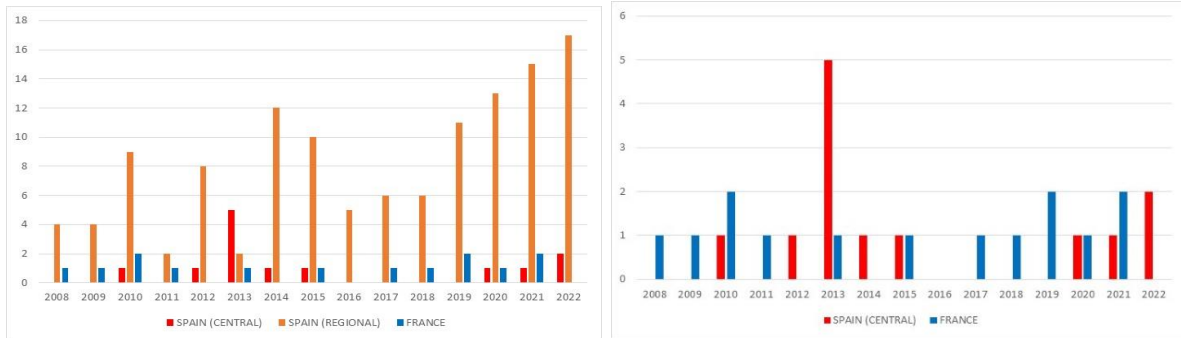
Note: The blue and red columns represent the same information in both panels. *Source:* own elaboration based on Aranzadi-La Ley and Lamyline.

Figure 23. Hydrogen regulations (with force of law) in France and Spain

Note: The blue and red columns represent the same information in both panels. *Source:* own elaboration based on Aranzadi-La Ley and Lamyline.

6 Conclusions

In this study, our goal is to contribute to the literature on climate regulations by identifying and quantifying the complete amount of norms adopted by the Spanish administrations (at the central and the regional levels) in four areas under study related to climate change and environmentally sustainable growth models. These areas are renewable energies, sustainable transportation strategies, measures related to pollution mitigation and measures aimed at achieving greater energy efficiency.

We conducted this exercise using textual analysis for the total number of regulations adopted by Spain for the period 2008-2022 (in addition to the year 2000, which we used as a historical reference). Specifically, for our core period of analysis (2008-2022) the body of regulations for which we apply the analysis is composed of 173,899 regulations (a set of new regulations of about 12,000 per year).

The detailed analysis of these regulations allows us to extract and identify for the first time the 4281 regulations that have been dedicated to energy efficiency at the autonomous region level (or the 835 that have done so in the case of the general state administration). The advantage of this analysis of the texts, carried out word by word, is that it allows us to identify both "known" or "express" regulations related to climate change, as well as regulations that could go unnoticed without this analysis, such as a small reform related to the subject of interest in, for example, a budget law. This same strategy has already been followed in previously published regulatory databases (Mora-Sanguinetti and Soler, 2022 or Mora-Sanguinetti et al. 2023b). Thirteen panels have been constructed (for 13 subjects of analysis), which vary for the 18 administrations (territories) analyzed over time.

The collected information allows us to verify the real degree of regulation (and therefore, of activism) on the part of the administrations in climate change or "green" growth. Thus, surprisingly, still in the year 2000 very few regulations were adopted by the Spanish administrations in any of the areas studied. We have to wait until 2008 to observe a timid take-off of environmental regulations. The regional diversity is, in any case, very large. Of all the areas analyzed, the greatest interest has always been concentrated on renewable energies. However, it should be noted that in more recent years it is possible to find regulations extending into "new" areas, such as sustainable transport.

From a time perspective, it seems relevant to note that, although concern for the environment is a "constant" issue (climate change does not necessarily follow the economic cycle of a single country), its regulation is not. It is possible, in fact, to observe a cyclical profile, with interest in the matter having been abandoned during the years of the great recession. In other words, regulatory preferences and activism change over time.

The analysis of texts also allows us to make progress in the comparison of Spanish and French regulations. Overall, Spain has published between 3.5 and 10 times more laws than France in matters related to renewable energies. However, this difference is caused by the regulatory activity of the Autonomous Regions, not by the central state administration. In fact, the French and Spanish states regulate at a very comparable rate.

The analysis of the effects of "green" regulation (and what strategy, more centralized or less) on both climate change mitigation and economic efficiency is an area for future research. The panel format of the data (with variation between regions and years and comparing Spain with France) will allow the development of new research.

In fact, the literature on the economic analysis of regulation puts different debates into perspective. For example, on whether the large increase in regulation, especially if it is highly disaggregated at the regional level (as in the case of Spain), is a fertile and successful testing ground for the development of innovative regulatory policies. Or, on the contrary, frequent regional differences only lead to market failures with negative results for the specialization of firms and their growth [Becker and Murphy (1992), Vallés and Zárate (2012) or Mora-Sanguinetti and Valls (2021)].

On the other hand, from a "Law & Economics" point of view, it is worth analyzing whether regulatory change, far from its potential good properties to facilitate technological progress or to mitigate pollution, may cause, at least temporarily, an increase in conflict as a result of institutional instability (Palumbo et al., 2013; Kaufmann et al., 2010; Bielen et al., 2015).

Finally, the work carried out can provide useful data to analyze whether the "better regulation" policies (Royal Decree 931/2017, of October 27) are well oriented in this matter and are being effective. On this debate, more generally, see, among others, Betancor (2009), European Commission (2015) or Doménech Pascual (2005).

Annex A. The regulatory developments of new renewable energies in detail

Figure A1. Frequency of regional regulation (for each Autonomous Region) of wind energy
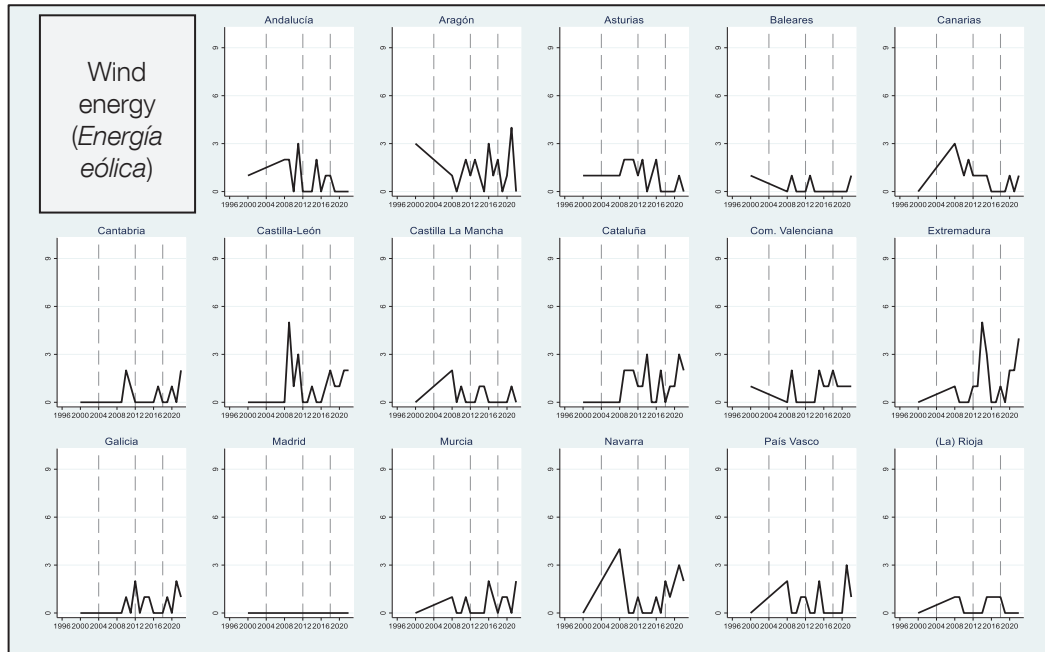
Source: own elaboration based on Aranzadi

Figure A2. Frequency of regional regulation (for each Autonomous Region) of solar energy
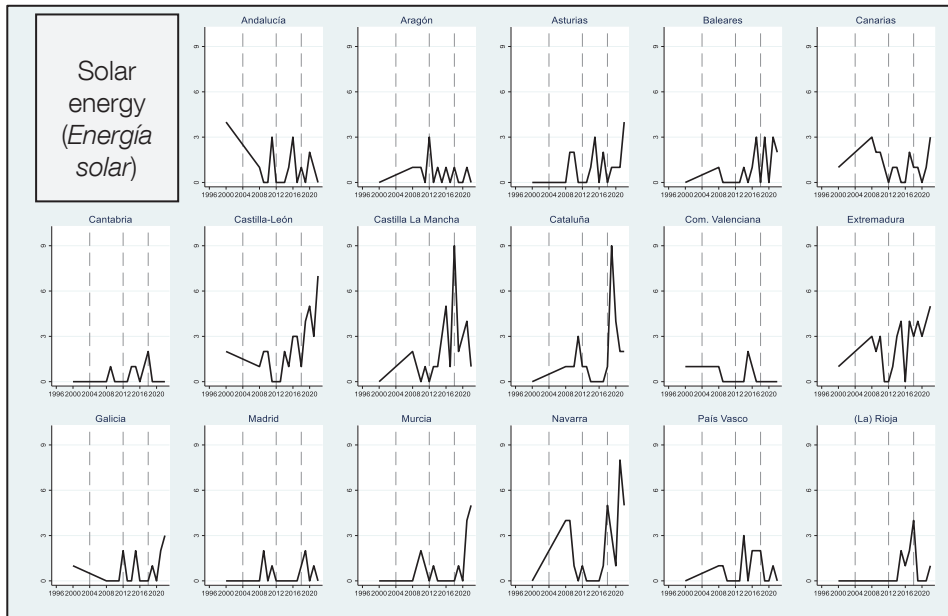
Source: own elaboration based on Aranzadi.

Figure A3. Frequency of regional hydrogen regulation (for each Autonomous Region)
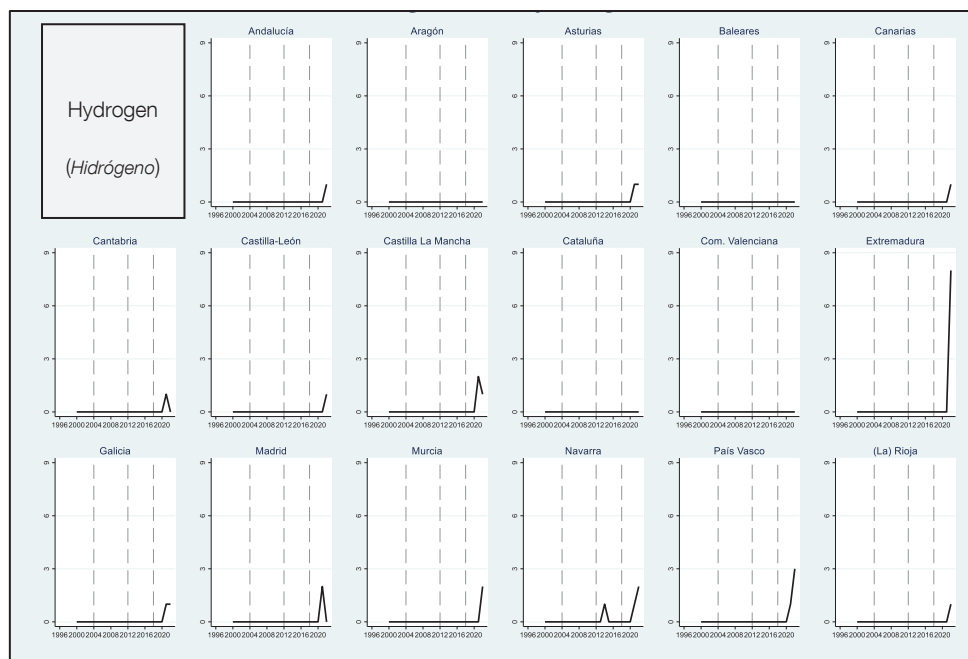
Source: own elaboration based on Aranzadi.

Annex B. Comparison of the volume of regulations with force of law adopted in Spain and France since 2000

Between 2000 and 2022, Spain published 6,739 regulations with force of law and France published 3,137 (see Figure B1). It is interesting to analyze, however, the breakdown by level of administration of these norms. In Spain, most of the regulations with force of law come from the regions, specifically 5502, with an average of 239 regulations adopted each year, compared to 136 in the French administration or 54 in the general state administration in Spain. Figure B2 shows more detail on the year-to-year evolution of regulatory adoption in both countries.

We conclude that the Spanish administration as a whole adopts more than twice as many regulations with force of law each year as the French administration. However, within Spain, this rate of adoption is dominated by the regions. Thus, the Spanish Autonomous Regions actually adopt more regulations each year than the French administration as a whole. The Spanish central administration in Spain is, on the contrary, less prolific than the French administration.

Figure B1. Summary table of Spanish and French regulatory output with force of law since 2000

	TOTAL NORMS ADOPTED (2000-2022)	AVERAGE (2000-2022)	TOTAL NORMS ADOPTED (2008-2022)	AVERAGE (2008-2022)
SPAIN (CENTRAL)	1237	53,8	764	50,9
SPAIN (REGIONAL)	5502	239,2	3650	243,3
FRANCE	3137	136,4	2105	140,3

Source: own elaboration based on Aranzadi-La Ley and Lamyline.

Figure B2. Spanish and French regulations with force of law in the long term
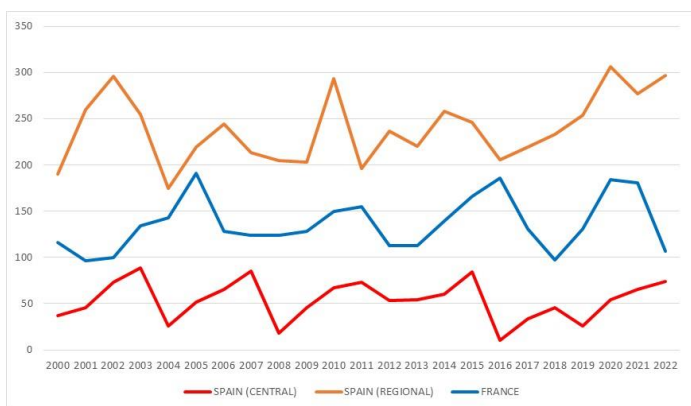
Source: own elaboration based on Aranzadi-La Ley and Lamyline.

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