4

THE SPANISH ECONOMY AND THE CLIMATE CHALLENGE

1 Introduction

The fight against climate change and the green transition is one of the biggest challenges facing our society. This chapter details how mitigating and adapting to global warming will involve a profound structural change in our economic growth model, with very relevant implications for practically every sphere of activity.

There is enormous uncertainty regarding the impact that these transformational challenges will have on the economy as a whole (see Section 2). Nonetheless, there is a broad consensus among researchers that, if greenhouse gas (GHG) emissions are not reduced significantly in the coming decades, the economic impact of the physical risks associated with global warming could be very large. Moreover, the shift to a low-emission economy also involves significant transition risks, which means that an orderly transition with a high degree of international coordination is desirable.

In recent years, Spain has made very significant commitments on the environment (see Section 3). Meeting the proposed targets – which are in line with those also set in the EU as a whole and in other advanced economies – will be an enormous challenge for the total Spanish economy in the coming years. However, beyond the possible aggregate economic impact of fighting climate change, this process will foreseeably have a very uneven impact across regions, sectors, businesses and households. In particular, there is evidence to suggest that the physical and transition risks linked to global warming may affect precisely some of the most vulnerable households and businesses more severely.

In view of the magnitude of the climate challenge, all economic policies and all agents need to contribute very actively to the green transition (see Figure 4.1). In particular, governments have a leading role to play. They have the necessary democratic legitimacy to establish the roadmap and also the broadest and most suitable set of instruments to achieve the proposed targets, especially in the fiscal sphere and to regulate economic activity (see Section 4). It is essential that these public policies provide economic agents with certainty – when present and future circumstances are so uncertain – and focus especially on temporarily mitigating the greater adverse short-term impact of climate change on the most vulnerable groups.

The financial system and central banks – within the scope of their competencies – must also contribute to the green transition. Without the active involvement of the financial system, it will be impossible to efficiently channel the large volume of

Figure 4.1
THE ROLE OF KEY ACTORS IN THE FACE OF THE CLIMATE CHALLENGE...

GOVERNMENTS

- Increasing green taxation and boosting public investment
- Deploying compensatory measures to mitigate adverse effects on the most vulnerable groups
- Setting environmental standards to enhance the regulation of economic activity
- Providing economic agents with certainty and a stable operational framework

FINANCIAL SECTOR

- Efficiently channelling the enormous volume of funds that needs to be invested in the green transition
- Properly assessing its own and other economic agents' exposure to climate risks
- Developing and harmonising new financial instruments

CENTRAL BANKS

- Incorporating climate considerations into their monetary policy operational frameworks
- Monitoring the risks to financial stability posed by climate change and the green transition
- Enhancing the regulation and prudential supervision of climate risks

... IN A CONTEXT IN WHICH...

- Extraordinary uncertainty surrounds the economic impact of climate risks
- Achieving a high degree of international coordination is necessary
- Increasing the quantity, quality and harmonisation of environmental information is essential
- Reviewing public policies continuously and rigorously is more important than ever

SOURCE: Banco de España.

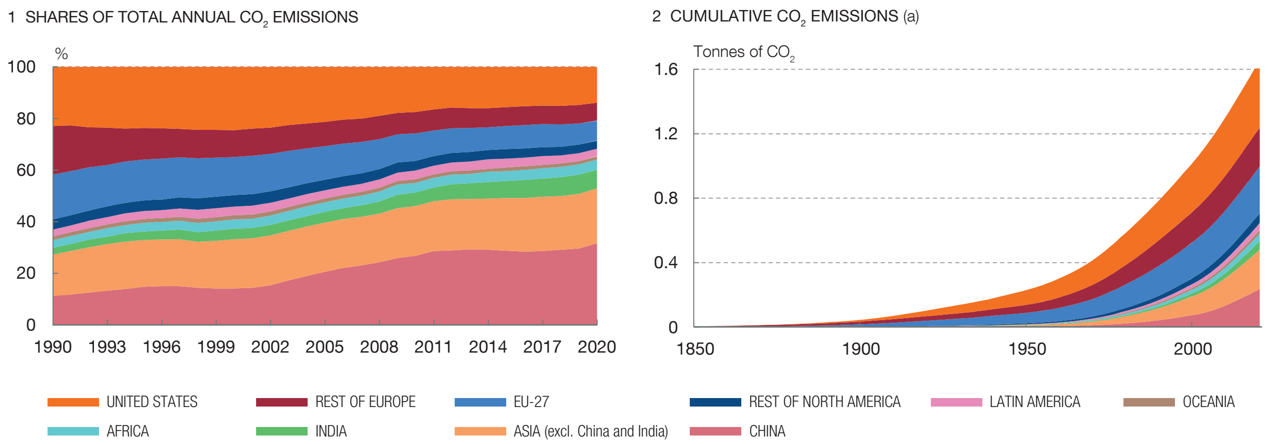
funds needed to develop new green technologies and to enable households and firms to adopt them across the board (see Section 5). Climate change and the transition to a low-emission economy are also a considerable challenge for central banks (see Section 6). In particular, these processes may have a very significant impact on the conduct of monetary policy and pose major risks to financial stability. As a result, decisive action by central banks is required to analyse the economic and financial implications of climate change and in the regulation of financial institutions and in the area of prudential supervision. An example of the initiatives in these areas are the stress tests for adverse weather events that have recently begun to be conducted in collaboration with credit institutions.

2 Global warming and initiatives to limit it

According to the Intergovernmental Panel on Climate Change (IPCC), the global temperature is increasing by some 0.2°C per decade and, in the last

Chart 4.1
CO_2 EMISSIONS

Extensive scientific evidence shows that global warming is caused by GHG emissions arising from human activity, notably CO_2 emissions. Currently, China is the main global CO_2 emitter (responsible for 32% of global emissions in 2020), followed by the United States (14%) and the EU-27 (7.7%). However, from a historical perspective, the United States has been responsible for more emissions of CO_2 of human origin since 1850 than any other country, followed by the EU-27 and China.



SOURCE: Our World in Data.

a Cumulative CO_2 emissions since 1850, excluding those from land use change (LUC).

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decade, has already reached 1.1°C above pre-industrial levels. This panel of experts – which has reflected the scientific consensus on climate change, its causes, its consequences and possible response strategies since 1988 – points out, moreover, that the warming of the planet that has been observed over recent decades has been caused almost entirely by GHG emissions stemming from human activity.[1] CO_2, which can remain in the atmosphere and contribute to global warming for centuries, stands out among the anthropogenic greenhouse gases.[2] As seen in Chart 4.1.1, China is currently the world's main emitter of CO_2 (being responsible for 32% of global emissions in 2020), followed by the United States (14%) and the EU-27 (7.7%). From a historical perspective, however, the United States has been responsible for most CO_2 emissions of human origin since 1850 (25% of the cumulative total), followed by the EU-27 (18%) and China (14%) (see Chart 4.1.2).

The IPCC warns that, without a very significant reduction in GHG emissions, global warming will continue and that this could have very serious consequences for the planet, some of which might be irreversible. In fact, a

1 See IPCC (2021) and IPCC (2022).

2 See Prentice et al. (2001). This chapter refers almost exclusively to CO_2 emissions. In 2019, such emissions accounted for 75% of global GHG emissions. Other important greenhouse gases are methane (18%), nitrous oxide (4%) and fluorinated gases (2%). As in the case of CO_2, there are also global agreements to reduce these other greenhouse gases. For example, agreements were reached at the Glasgow COP 26 to reduce methane emissions by 30% from their 2020 levels by 2030.

large number of studies show that global warming will cause, among other disruptive phenomena, a rise in sea levels, an increase in the frequency and intensity of extreme weather events – such as heat waves, droughts, floods, cyclones and hurricanes – and a very significant loss of biodiversity in the years ahead.[3] As seen in Chart 4.2, some of these physical risks vary considerably across regions.

In recent years, in the light of this evidence, many Governments have made very significant environmental commitments – essentially as regards the reduction of GHG emissions – both in coordination with others and individually.[4] Notable among these initiatives is the Paris Agreement of 2015, reached at the 21st United Nations Climate Change Conference (COP 21) and ratified by 191 countries. The aim of this agreement is to keep the increase in global temperature this century below 2°C (above pre-industrial levels), although it also aspires to limit this rise to 1.5°C. For this purpose, the various signatory countries have adopted commitments to reduce their emissions, known as nationally determined contributions (NDCs). The fulfilment and ambition of these commitments will be regularly reviewed.

In the case of the EU, the coordination of actions to mitigate the effects of climate change and to promote the green transition has mainly been based on the European Green Deal.[5] Notable among such actions is the European Climate Law,[6] enacted in June 2021, which sets a legally binding target of net zero GHG emissions by 2050 and requires both Member States and EU institutions to take the necessary measures to meet this target. This Law also sets an intermediate target for 2030 of reducing GHG emissions in the EU as a whole by 55% (from 1990 levels). To make these targets operational, the European Commission has proposed a broad package of legislation known as the "Fit for 55 Package",[7] most of which is currently in the legislative approval process.

In recent years, many Governments have been adopting various economic policy measures, within the framework of these environmental commitments (see Sections 3.1 and 4). The main initiatives include, on the one hand, various regulatory interventions aiming to limit energy consumption and promote the development and adoption of less polluting energy sources. On the other, action has also been taken in the area of fiscal policy, aiming to ensure that economic agents internalise the environmental costs of their actions. Notable within this category are

3 For the relationship between climate change and biodiversity, see Pörtner et al. (2021).

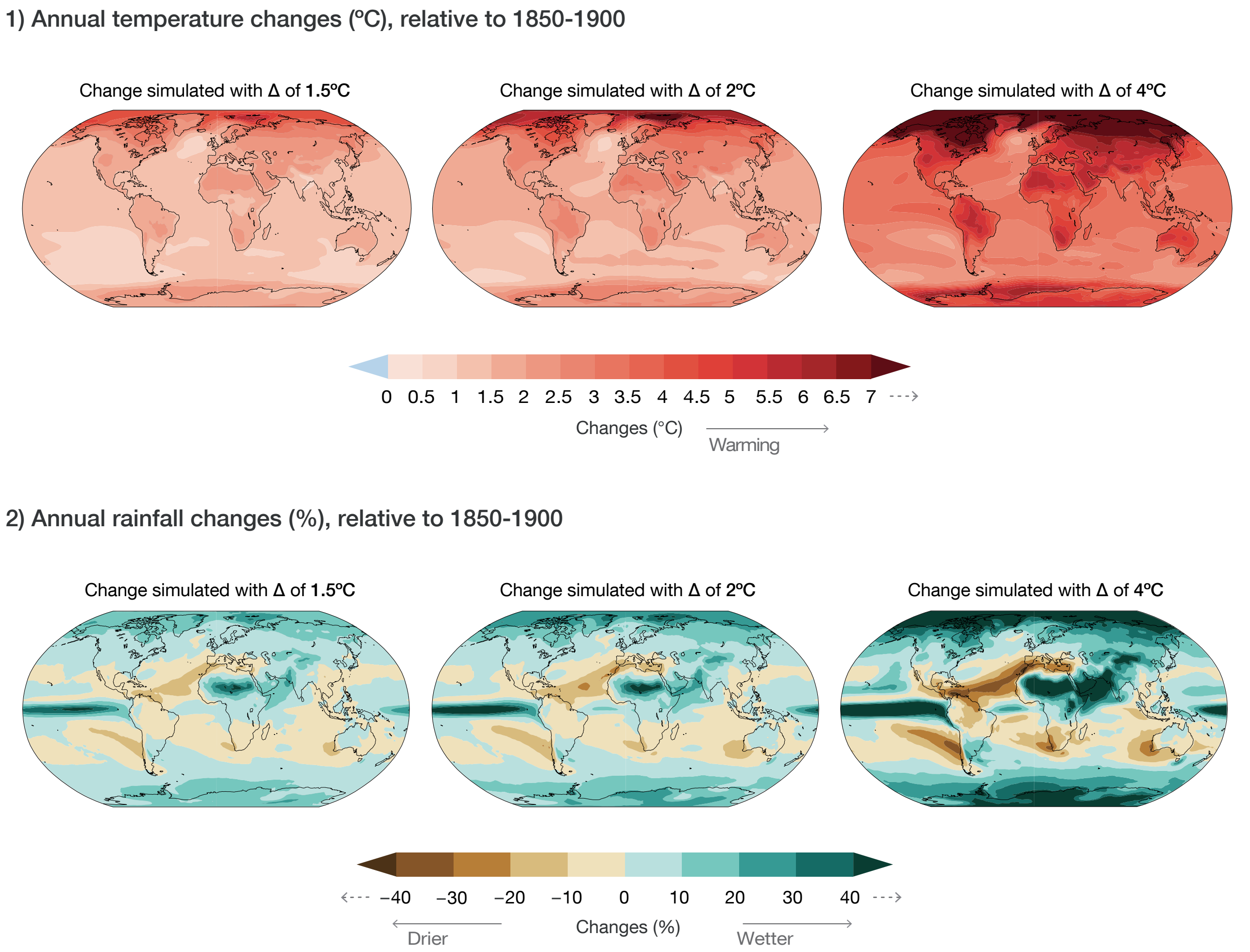
4 For an analysis of the various international and European initiatives adopted in this area, see Dormido et al. (2022), forthcoming.

5 See European Commission (2019). It is important to stress that the European Green Deal not only addresses climate change but also includes other initiatives such as the Biodiversity Strategy for 2030 (see European Commission (2020a)), the EU Action Plan "Towards Zero Pollution for Air, Water and Soil", and the EU's Circular Economy Action Plan (see European Commission (2021a)).

6 See Regulation (EU) 2021/1119 of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law').

7 See European Commission (2021c).

Chart 4.2
ESTIMATED CHANGES IN GLOBAL TEMPERATURE AND RAINFALL IN 2100



SOURCE: IPCC (2021).

the creation and subsequent expansion of markets for emission allowances (for example, in the EU, where the Emissions Trading System (ETS), the world's largest market for GHG emissions, is a basic pillar of EU climate policy)[8] and the imposition and tightening up of various green taxes. Fiscal policy initiatives to encourage public and private investment in new technologies to accelerate the green transition have also proliferated in recent years. Notable in Europe, for instance, is the Recovery and Resilience Facility (RRF), which aims to implement €724 billion of investment projects in the period 2020-2024, of which a very significant proportion (at least 37%) must contribute to the green transition.

8 This system places an upper limit (which is reduced over time) on the total amount of greenhouse gases that can be emitted by all the activities it covers. Some of the emission allowances associated with this limit are (temporarily) allocated free of charge, while the rest are auctioned. However, there is a secondary market for these allowances, which determines a market price for GHG emissions (see Dormido et al. (2022), forthcoming).

In any event, despite the initiatives deployed, the trend reduction in GHG emissions committed to in the current NDCs is not yet apparent. This trend would still entail a global temperature more than 2°C above pre-industrial levels by the end of the century (some 2.4ºC higher) (see Chart 4.3). In fact, the consensus of scientific experts suggests that limiting the increase in global temperature to 2ºC would require the volume of global GHG emissions to be reduced on average by 3.2% per annum over the next thirty years, which is significantly more than the reduction that has been committed to (under the NDCs of the Glasgow COP 26 held in November 2021).[9] It should be noted here that the 6.1% reduction in global GHG emissions observed in 2020 appears to have been entirely one-off and was essentially a result of the sharp contraction in activity caused by the COVID-19 pandemic and the measures taken to contain its spread.

Against this background, it is increasingly likely that the physical risks associated with climate change will materialise, but also that significant transition risks will arise if the transition has to be stepped up in the future. Apart from the physical risks associated with global warming highlighted above, the transformation into a low-carbon-emission economy may also be accompanied by considerable transition risks. These risks essentially stem from the mitigation initiatives taken by the authorities. For example, insofar as many of these actions may entail an increase in energy prices in the short term, this may pose a risk to the incomes and the creditworthiness of households and firms that use energy intensively. At the same time, the lack of certainty for economic agents regarding the public policies and the structural transformation process that will have to be implemented in the years ahead may adversely affect their consumption and investment decisions and, in this climate of heightened uncertainty, financial market disruption cannot be ruled out. The probability of these risks materialising in the future and how intensely they do so will doubtless depend on the speed and orderliness with which the transition to a low-carbon economy is proposed and implemented. In this respect, any delay in the transition could increase the need to implement it more abruptly in the near future: compare, for example, the emission reduction paths that would be consistent with a 2ºC increase in the global temperature assuming a transition beginning in 2021 and one that begins in 2030 (the orange and green lines in Chart 4.3.2, respectively). This would also significantly increase the transition risks.

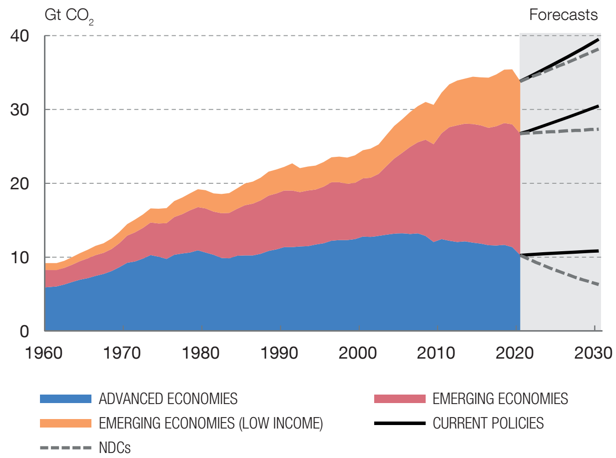
The assessment of the economic impact of the various physical and transition risks associated with climate change is subject to enormous uncertainty, although there seems to be a certain consensus as to the high costs of not adjusting the current path of GHG emissions and the advantages of an orderly

9 To achieve the more ambitious target of limiting the increase in temperature to 1.5°C, 151 countries, accounting for 90% of global GDP, have committed to reaching climate neutrality by 2050 (Climate Ambition Alliance: Net Zero 2050). In the case of the United States, China, the EU and Japan, achieving climate neutrality through an orderly transition will require more resolute action before 2030 than has currently been announced. See Nieto (2022).

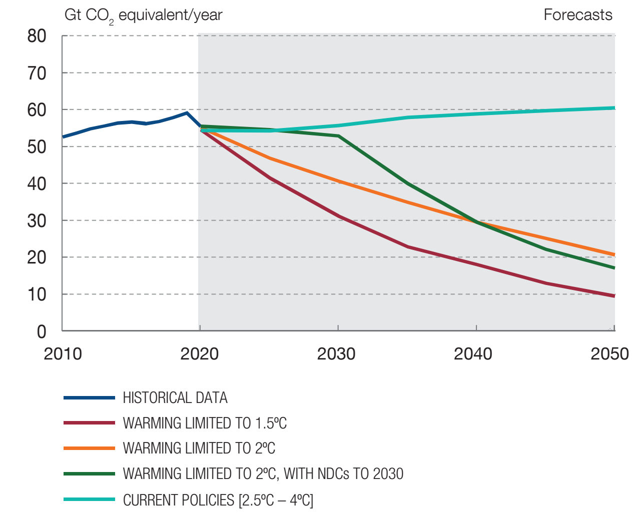
Chart 4.3
GLOBAL WARMING AND MITIGATING INITIATIVES

The consensus of scientific experts suggests that to limit the global temperature rise to 2ºC will require the volume of global GHG emissions be reduced on average by 3.2% per annum over the next 30 years, a significantly higher rate of reduction than committed to under the NDCs of the Glasgow COP 26 held in November 2021.

1 CO_2 EMISSIONS BY REGION (a)



2 ANNUAL GHG EMISSIONS AND GLOBAL WARMING SCENARIOS IN 2100 WITH RESPECT TO PRE-INDUSTRIAL LEVELS (b)



SOURCES: IMF, Global Carbon Project and IPCC.

a Shows the CO_2 emissions arising from fossil fuels. From 2020, the forecasts correspond to a scenario with current policies. "NDCs" includes, in addition, the national mitigation initiatives up to 2030.
b The scenarios correspond to the trajectories presented in the contribution of Working Group III of the IPCC (2022) and are expressed in terms of planet temperature increases in 2100 with respect to pre-industrial levels.

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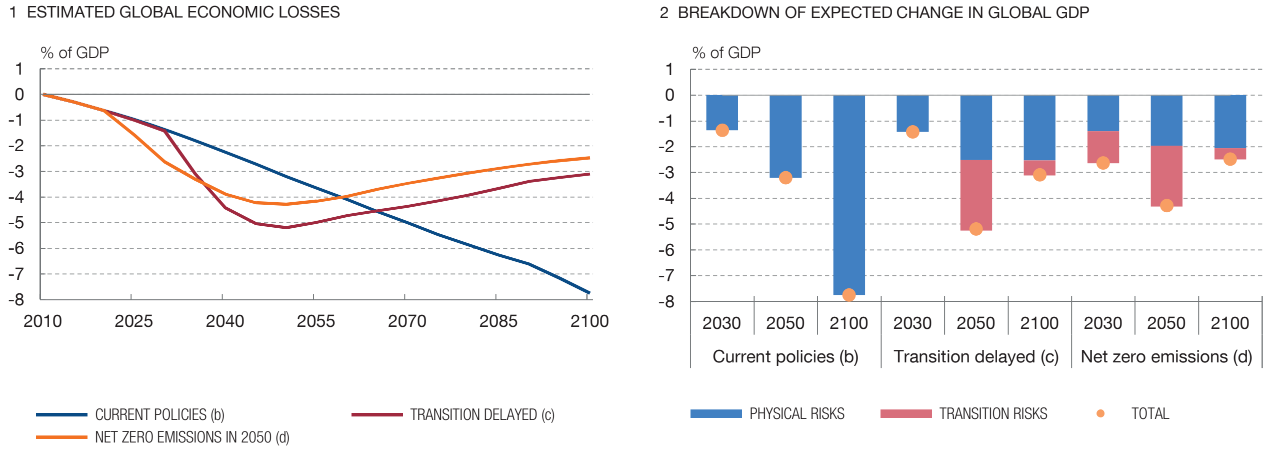
adjustment. In addition to the scientific uncertainty involved when discussing climate change and the green transition, sufficiently numerous or broad economic benchmarks to assess precisely how different agents will respond to climate shocks and the transition risks or how these elements will feed into each other do not exist. In this respect, great caution should be exercised when interpreting the quantitative results of the available models that seek to estimate the economic impact of climate change and the green transition. For example, in two of the benchmark studies in the literature (Nordhaus (2017) and Dietz and Stern (2015)) there is an enormous disparity in the estimated effects of global warming, owing to the different assumptions made.[10] That said, from a qualitative point of view, there seems to be some consensus that not adjusting the current path of GHG emissions may have considerable economic costs in the long term (under this scenario there would be no transition risks, but physical risks would materialise more markedly) and that a gradual adjustment of this path would be best to ensure an orderly transition (for example, without excessively delaying the adjustment of emissions). This can be inferred, for example, from the report of the Network for Greening the Financial System (NGFS) (see Chart 4.4).

10 In particular, these studies estimate long-term global GDP losses ranging from 0.7% under a moderate scenario to 62% under a severe scenario.

Chart 4.4

GLOBAL ECONOMIC COSTS OF THE MATERIALISATION OF PHYSICAL AND TRANSITION RISKS ASSOCIATED WITH CLIMATE CHANGE, UNDER VARIOUS SCENARIOS (a)

According to the NGFS, the possible scenarios differ according to the timing and intensity of mitigation measures. The costs of the materialisation of transition risks are higher earlier under the more ambitious scenarios. In the long term, the physical risks dominate in all scenarios and involve greater costs the later the necessary measures are implemented.



SOURCE: NGFS.

a Of the different options offered by the NGFS scenarios, the results of the IAM REMIND-MAgPIE 2.1-4.2. model are presented here.
b In this scenario no further measures are taken in addition to those already in force, leading to an increase in global temperatures of between 2.5ºC and 4ºC in 2100, with respect to pre-industrial levels.
c This scenario assumes that annual emissions do not decrease until 2030 and that, as a result, harsh policies have to be implemented to keep global warming below 2ºC in 2100, with respect to pre-industrial levels.
d This last scenario envisages measures to reduce net emissions to zero in 2050, while the increase in global temperature is kept below 1.5ºC in 2100, with respect to pre-industrial levels.

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Further progress in the fight against global warming will require greater international coordination, while taking into account the specific development conditions of each country. Since climate change and the green transition are a truly global challenge, an internationally coordinated response is needed. This response must, however, take into account the differing capacity of each economy to adjust its emissions profile. For example, the empirical evidence suggests that, for countries at an early stage of development, economic growth and an increase in GHG emissions are positively related, while this relationship is reversed once a high level of per capita income is attained.[11] Also, a recent study by the Banco de España,[12] which analyses CO_2 emissions in 230 countries over the period 1995-2018, indicates that the demographic composition of economies is another factor that affects their level of emissions. In particular, countries with a higher proportion of young people (aged 20-30) and over-60s have a lower level of emissions relative to output than those with a higher proportion of the population in the middle age groups.

11 This relationship is known as the Kuznets environmental hypothesis (see Dasgupta et al. (2002)). However, some studies find that this empirical relationship is not very robust (see, for example, Stern (2004)).

12 See Basso, Jaimes and Rachedi (2022).

In this context, it is essential that the advanced economies support the emerging economies in adapting to and mitigating climate change, but also that mechanisms are put in place to prevent "carbon leakage" if a sufficient degree of coordination is not achieved. Indeed, as required by some of the environmental agreements already achieved at global level, it is essential that the advanced economies provide the emerging economies with the funds and technology they need to be able to undertake the green transition at a pace that does not limit their necessary economic development. Nonetheless, if the international coordination of climate policies fails to prevent significant disparities across countries in the level of ambition of their mitigation initiatives, then it will be necessary to design instruments to prevent economic activity moving to those jurisdictions where climate policies are less restrictive, a process known as "carbon leakage". The carbon border adjustment mechanism recently proposed by the European Commission is a case in point.[13] As a recent Banco de España paper[14] indicates, such a mechanism may significantly help to prevent an increase in the EU's environmental ambition from leading to competitiveness losses for its economies and would thus reduce the negative impact on GDP of the green transition.

In any event, it should be noted that if a high degree of globally synchronised climate ambition materialises, it could cause very significant bottlenecks in certain key sectors for the energy transition. Some of these bottlenecks appear to be apparent already in certain commodities (such as copper, lithium, cobalt and nickel) that are key to the mitigation policies implemented worldwide. According to some studies,[15] these bottlenecks may intensify significantly in the coming years with the transition to a carbon-neutral economy, which a large number of countries have committed to achieving by the middle of this century. Should this happen, the transition process could slow down and its economic cost may increase considerably.

3 The asymmetric impact of climate change in Spain

3.1 Climate risks and the transformational challenge facing the Spanish economy

There is consensus among the scientific community that the Iberian Peninsula could be significantly affected by the physical risks associated with climate change and that this impact would be highly uneven across regions. The considerable intensity and asymmetry of the possible impact of global warming in

13 At its meeting of 15 March 2022, Ecofin approved the general approach of a carbon border adjustment mechanism to ensure the environmental integrity of the EU's policies and prevent carbon leakage, in line with World Trade Organization rules, as part of the "Fit for 55 Package" (see Council of the European Union (2022)).

14 See Delgado and Santabárbara (2022), forthcoming.

15 See, for example, Boer et al. (2021).

Spain is highlighted, for example, by the European Commission's PESETA IV report.[16] Among other things, this multidisciplinary and highly granular study illustrates how the temperature, annual rainfall and water stress will change in Spain and in its regions, in comparison with the rest of the EU, under different global temperature scenarios (see Chart 4.5). In particular, it suggests that the impact of global warming on rainfall will be highly uneven across the peninsula, with sharper declines in the south, and that the duration of water shortages and the proportion of people exposed to them will increase notably, especially in the south east.

Even though they are subject to a high degree of uncertainty, these projections point to the need to develop and implement an ambitious strategy to mitigate and adapt to climate change in Spain. In general terms, the basic pillars of such a strategy are the Climate Change and Energy Transition Law, the National Energy and Climate Plan (NECP) 20212030, the National Plan for Adapting to Climate Change (PNACC by its Spanish abbreviation) and the Just Transition Strategy.[17] Within the framework of this set of initiatives, and in keeping with the commitments at European level in the European Green Deal and the "Fit for 55 Package", Spain proposes, among other targets, to fully decarbonise the economy by 2050 and to have a system of electricity generation based exclusively on renewables. In the process of transition towards this new energy model, certain minimum targets have also been set for GHG emission reductions (a decrease of 23% from 1990 levels), for the use of renewables (42% of final energy consumption and 74% of electricity generation) and for energy efficiency improvement (a decrease of 39.5% in primary energy consumption).

As part of this strategy, and to be able to meet the environmental commitments made, a broad range of initiatives capable of bringing about a far-reaching transformation in the way in which economic and social activity is carried out in Spain will need to be implemented in the coming years. For example, within the framework of the Law on Climate Change and Energy Transition, proposals have been made for notable changes to patterns of mobility and the creation of low-emission zones in major cities. Also, the NECP envisages the need for higher taxes on heavily polluting activities (for further details, see Section 4). The Technical Building Code[18] lays down new building regulations, to ensure that buildings' energy consumption is low. A fundamental driving force behind many of these initiatives will be the Recovery, Transformation and Resilience Plan (RTRP),[19] presented by the Government in October 2020, which proposes assigning 39% of the funds that Spain receives under the Next Generation EU (NGEU) programme to the green transition.

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16 See Feyen et al. (2020).

17 Also notable, in other related initiatives, are the Renewable Hydrogen Roadmap, the Spanish Circular Economy Strategy and the National Strategy for Green Infrastructure and Ecological Connectivity and Restoration.

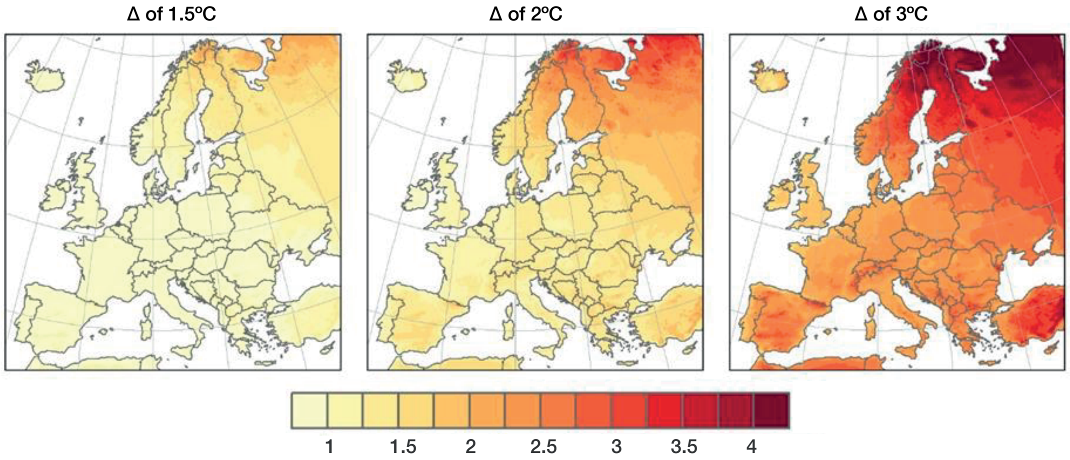
18 See Royal Decree 732/2019 of 20 December 2019.

19 The final text with detailed information was published in April 2021. See the Recovery, Transformation and Resilience Plan.

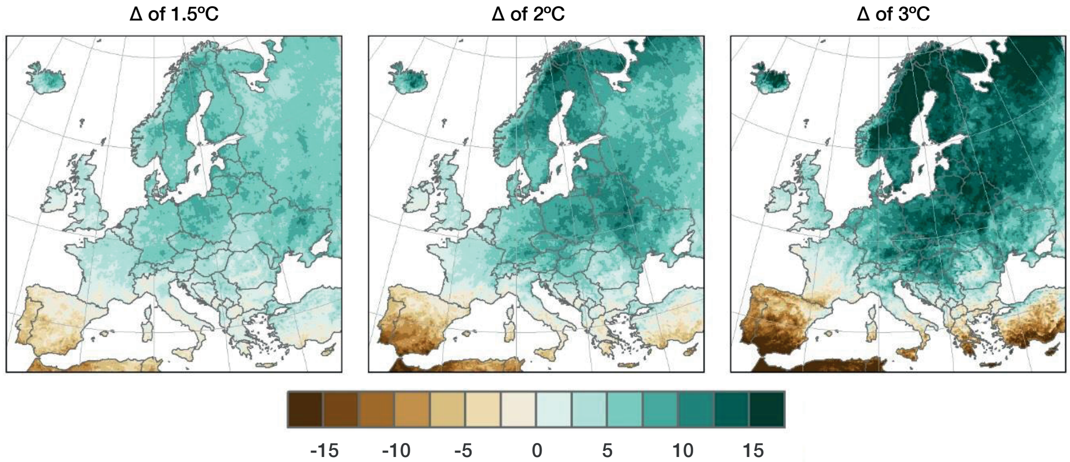
Chart 4.5

ESTIMATED CHANGES IN TEMPERATURE, RAINFALL AND EUROPEAN WATER RESOURCES IN 2100

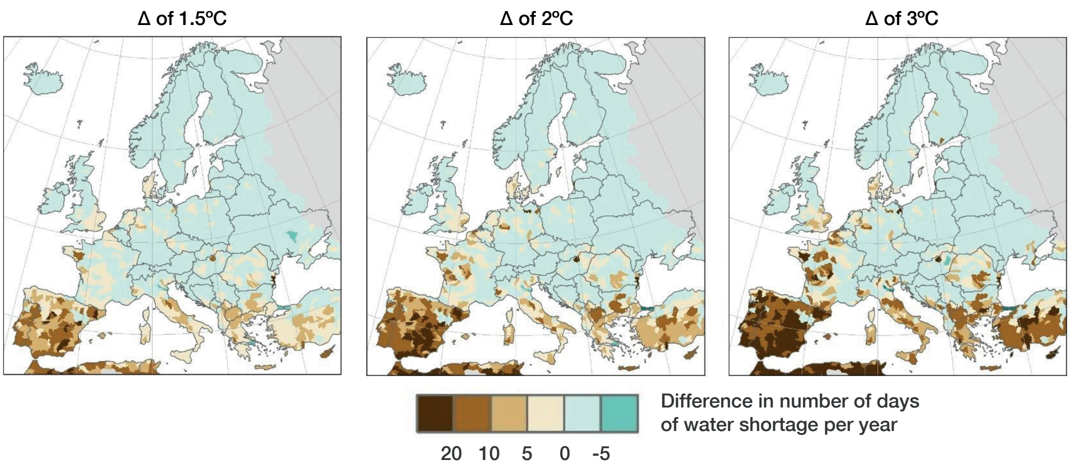
1) Changes in average annual temperature (in degrees centigrade) relative to 1981-2010 under three aggregate global warming scenarios: +1.5ºC, 2ºC and 3ºC.



2) Change in average annual rainfall (%) relative to 1981-2010 under the three global warming scenarios.



3) Impact on water resources.

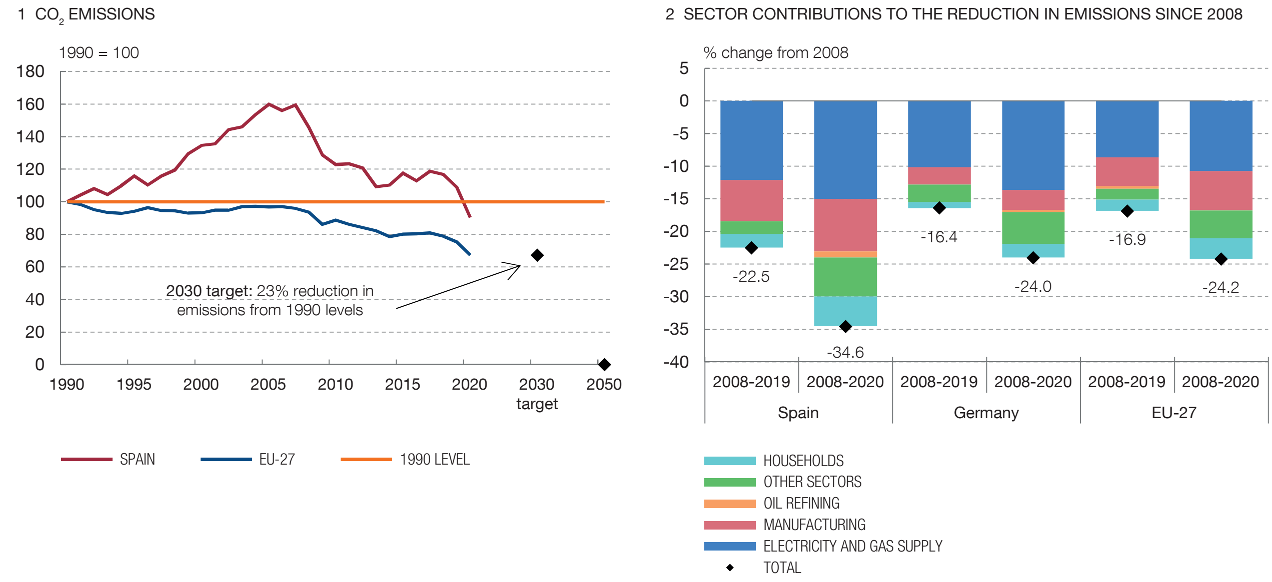


SOURCE: JRC PESETA IV report, European Commission, 2020.

Chart 4.6

GREENHOUSE GAS EMISSIONS: EVOLUTION AND CONTRIBUTIONS OF DIFFERENT SECTORS

In Spain, GHG emissions peaked in 2008, approximately 18 years after they did so in the EU as a whole. Since then, emissions in Spain have declined on average by 4.1% per annum, to stand 13% below their 1990 levels in 2020, still far from the targets set for 2030 and 2050. The factor that has contributed most to this fall in emissions has been the increase in the share of renewables in the production of electricity, although the change in the sectoral structure of the economy, the specialisation in less energy intensive products and the decline n household emissions have also contributed to the aggregate reduction.



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SOURCES: Our World in Data and EUROSTAT.

In any event, the transformational challenge facing the Spanish economy is enormous. In Spain, GHG emissions peaked in 2008, approximately 18 years after they did so in the EU as a whole (see Chart 4.6.1). Since then, emissions in Spain have decreased, on average, by 4.1% per annum, to stand 13% below their 1990 levels in 2020. As SerranoPuente (2021) has pointed out, the main factor behind this fall in emissions appears to have been the increase in the share of renewables in the production of electricity (to 43% in 2020), although the change in the sectoral structure of the economy, the specialisation in less energy intensive products and the decline in household emissions will also have contributed to the aggregate reduction (see Chart 4.6.2). Nonetheless, in 2020 the Spanish economy's direct GHG emissions still amounted to 274.6 million tonnes.[20] These emissions accounted for 7% of total EU emissions (0.7% of global emissions) and made Spain the fifth largest EU emitter (the 23rd EU emitter in terms of per capita emissions). To meet the targets set for 2030, the Spanish economy's GHG emissions must decline on average by 1.5% per annum in the coming years.

20 According to preliminary INE estimates, in terms of equivalent tonnes of CO_2. CO_2 emissions amounted to 213.3 million tonnes, 77.7% of the total. Methane and nitrous oxide (other greenhouse gases) represented 14% and 6.4%, respectively, of total GHG emissions in Spain in 2020.

Figure 4.2
THE ASYMMETRIC IMPACT IN SPAIN OF THE PHYSICAL AND TRANSITION RISKS ASSOCIATED WITH COMBATING GLOBAL WARMING

The Iberian Peninsula could be significantly affected by the physical risks linked to climate change:
— This impact would be highly uneven across regions.
— For example, lower rainfall in the southern part and greater water stress in the south east.

The impact of the green transition will be very uneven at sectoral level:
— Manufacturing, agriculture, transport and electricity and gas supply are the most GHG emitting productive activities in Spain.
— That said, the exposure of a particular sector to climate change does not only depend on its direct GHG emissions but also on its energy intensity and its links to other sectors.

Climate change and the green transition will affect different types of firms unevenly:
— Within each sector, smaller firms seem to be less prepared for climate challenges; many of them have still not assessed the impact these challenges may have on them.
— Among the main risks associated with the green transition identified by firms, higher inflationary pressures and greater administrative burdens (linked to new disclosure requirements) stand out.

The impact of the physical and transition risks may vary considerably from one person to another:
— The foreseeable increase in the prices of more polluting goods and services over the coming years will probably have a greater impact on lower-income households, those whose household reference person is aged 35-45, those residing in rural areas, those with a lower level of education and larger households.
— It would be desirable for public policies to have mechanisms to compensate, temporarily, the most vulnerable households in each of these groups.

SOURCE: Banco de España.

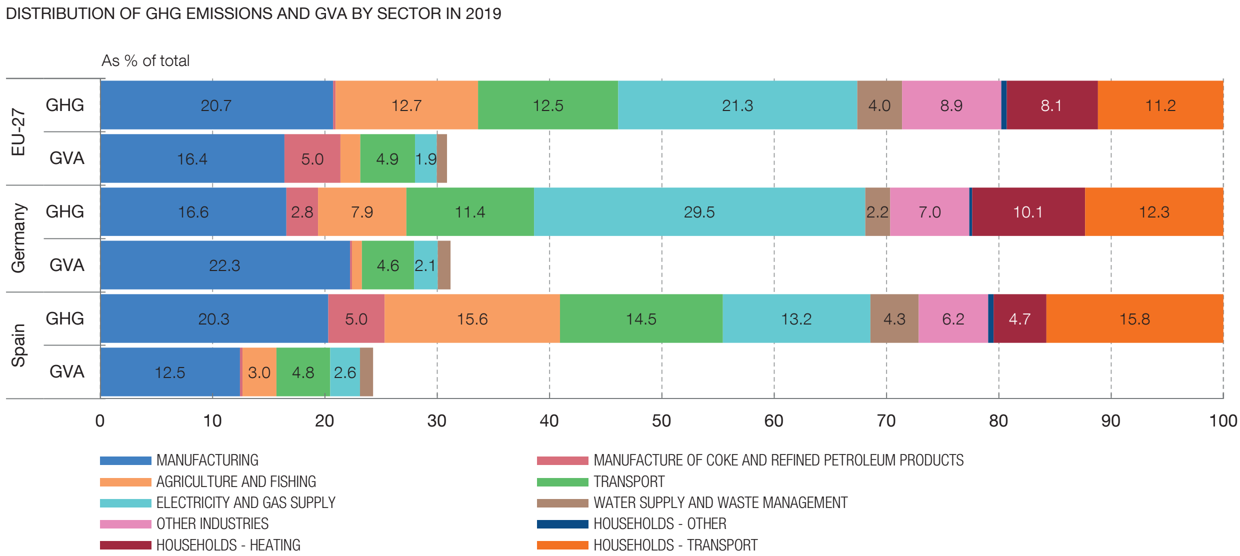
Although this rate of reduction is significantly lower than the average rate recorded since 2008, achieving it will involve an extra incremental effort that should not be underestimated. In particular, beyond the extraordinary challenge involved at aggregate level (for example, the proportion of electricity generated from renewable sources must increase from 43% in 2020 to 74% in 2030), the transition towards a more sustainable economy will entail a considerable challenge for certain types of sectors, firms and households (see Figure 4.2), as illustrated in the following sections.

3.2 The sectoral heterogeneity of the climate challenge

Manufacturing, agriculture, transport, and electricity and gas supply are the productive activities with most GHG emissions in Spain. According to Eurostat, in 2019 household activity – essentially connected with transport and heating – accounted for 20.9% of GHG emissions in Spain (see Chart 4.7). All other emissions came from the productive sector, where manufacturing, agriculture, transport, and

Chart 4.7
GREENHOUSE GAS (GHG) EMISSIONS BY SECTOR

Direct emissions are concentrated among a small number of industries: manufacturing, agriculture and fishing, transport, and electricity and gas supply account for almost 70% of GHG emissions both in Spain and Europe and generate less than 25% of Spanish GVA and around 30% of European GVA.



SOURCE: Eurostat.

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electricity and gas supply – industries that account for approximately 25% of the gross value added (GVA) of the economy – accounted for almost 70% of GHG emissions in 2019.

Cross-sector differences in emission volume and intensity suggest that the green transition will foreseeably pose a highly uneven challenge for the different industries. Thus, for example, partly as a result of the sectoral differences in GHG emissions, some of the public policies already rolled out to mitigate global warming have had a very asymmetrical impact across economic activities. The European Emissions Trading System (EU-ETS) is a case in point, as so far it has affected only a small number of industrial sectors and aviation. Going forward, the ETS is expected to be extended, to include emissions associated with shipping, road transport and buildings.

An individual sector's exposure to climate change depends not only on its direct GHG emissions but also on its energy intensity and its links with other sectors. Climate change mitigation measures have meant that a sector that uses a great deal of energy or has numerous inputs from high-emission sectors will foreseeably face a relatively higher increase in its production costs, while one that invoices a large share of its output to highly contaminating sectors will probably face a sharp fall in demand.

Input-output tables enable each sector's carbon footprint to be identified,[21] including both its direct and indirect GHG emissions (the latter, deriving from its energy intensity and participation in value chains). Chart 4.8 depicts this carbon footprint – direct and indirect GHG emissions per million euro of output – for the different economic sectors, distinguishing between those that are highly emission intensive (over 1,000 tonnes of CO_2 per million euro of output) and those that are not. Among the latter, construction, food and beverage preparation, hospitality and retail are noteworthy in that they have low direct emissions but a relatively high carbon footprint overall, owing to the indirect emissions stemming from their links to other contaminating sectors or to their higher relative share of the total GVA of the economy.

A general equilibrium sectoral model developed by the Banco de España makes it possible to assess the implications of Spanish industries' asymmetrical exposure to the green transition process. In particular, the Banco de España's CATS (CArbon Tax Sectoral) model[22] has a highly granular sectoral structure (51 non-energy industries and two energy industries (fuel and electricity)) which includes the cross-sectoral relationships contained in the input-output tables described above. Using this model, calibrated for the Spanish economy, the general equilibrium effects stemming from changes in the relative prices of the different economic sectors' products in response to any shock can be identified, together with the magnitude of the potential substitution processes between different intermediate inputs and consumer goods in the economy.

The model is primarily used to generate medium-term climate stress scenarios, to assess the different productive sectors' degree of exposure in the event of an increase in the price of emission allowances or an extension of EU-ETS coverage. In particular, in the event of an increase in the price of emission allowances similar to that observed in recent years (from approximately €25 per tonne of CO_2 in 2019 to almost €100 per tonne in early February 2022), the model predicts a cumulative decline after three years of 0.6% in Spanish GDP. If an extension of ETS coverage to include all productive sectors' emissions is added, the model predicts a fall of 1.3% in GDP after three years. In any event, as indicated earlier, the scale of these aggregate impacts must be interpreted with the utmost caution. In particular, the model does not include certain aspects that could be critical for a quantitative determination of the implications of the green transition for the economy overall; for instance, the possibility of a non-linear acceleration in technological change or in the implementation of short-term energy efficiency measures in response to large-scale shocks.[23] Also, as with other models, the results of the CATS model are highly

21 For more details on the methodology used to calculate each industry's carbon footprint, see Yamano and Guilhoto (2020).

22 See Aguilar, González and Hurtado (2022), forthcoming.

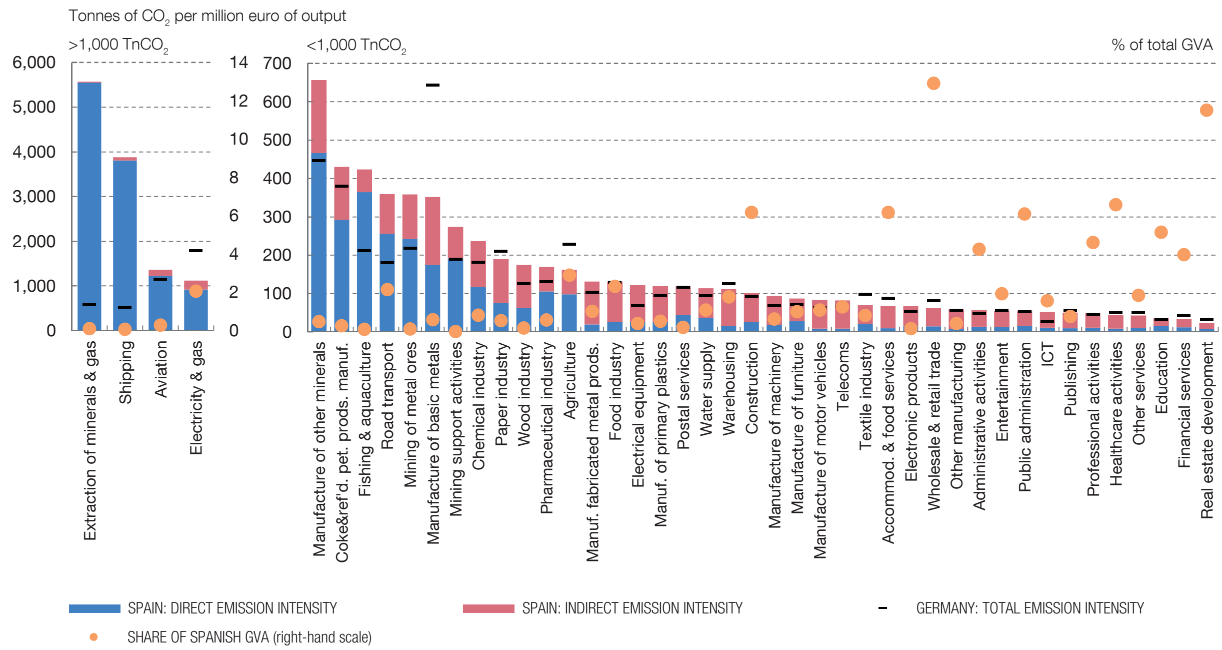
23 In this respect, the simplification hypotheses that the CATS model applies to the energy sectors are a constraint, since they assume that all electricity generated is consumed in the country, while all oil is imported.

Chart 4.8

DIRECT AND INDIRECT GHG EMISSION INTENSITY IN SPAIN

Emission intensity by sector in Spain is highly uneven, both in the case of direct and indirect emissions. The latter stem from the use of inputs from other sectors, especially energy inputs. Of the four most emission intensive sectors, only electricity and gas supply, whose emission intensity is lower than in Germany, accounts for a significant share of Spanish GVA overall. Meanwhile, construction, food and beverage preparation, hospitality and retail are all noteworthy in that they have low direct emissions but a relatively high carbon footprint overall, owing to the indirect emissions stemming from their links to other contaminating sectors or to their higher relative share of the total GVA of the economy.

EMISSION INTENSITY OF OUTPUT (a)



SOURCE: IMF Climate Dashboard.

a Direct and indirect emission intensity is calculated with data as at 2018 drawing on International Energy Agency (IEA) data on energy-related CO_2 emissions and the 2021 OECD Inter-Country Input-Output (ICIO) Tables.

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sensitive to certain elements that cannot be accurately assessed, such as the different economic sectors' capacity to substitute their inputs,[24] and how the tax revenue stemming from the ETS is used.[25] However, despite these limitations, the CATS model is particularly useful for a qualitative assessment of the potential sectoral asymmetries resulting from the green transition process. In this respect, as shown in Chart 4.9, under the first of the scenarios considered, i.e. an increase in the price of the ETS allowances, the sectors most affected, after the energy sectors, would be other non-metallic mineral products, aviation and paper. Under the second scenario, i.e. an increase in the price of the ETS allowances plus broader ETS coverage, the sectors most affected, in addition to the energy sectors, would be transport (shipping, aviation and road transport) and agriculture and fishing.

24 See Bachmann et al. (2022).

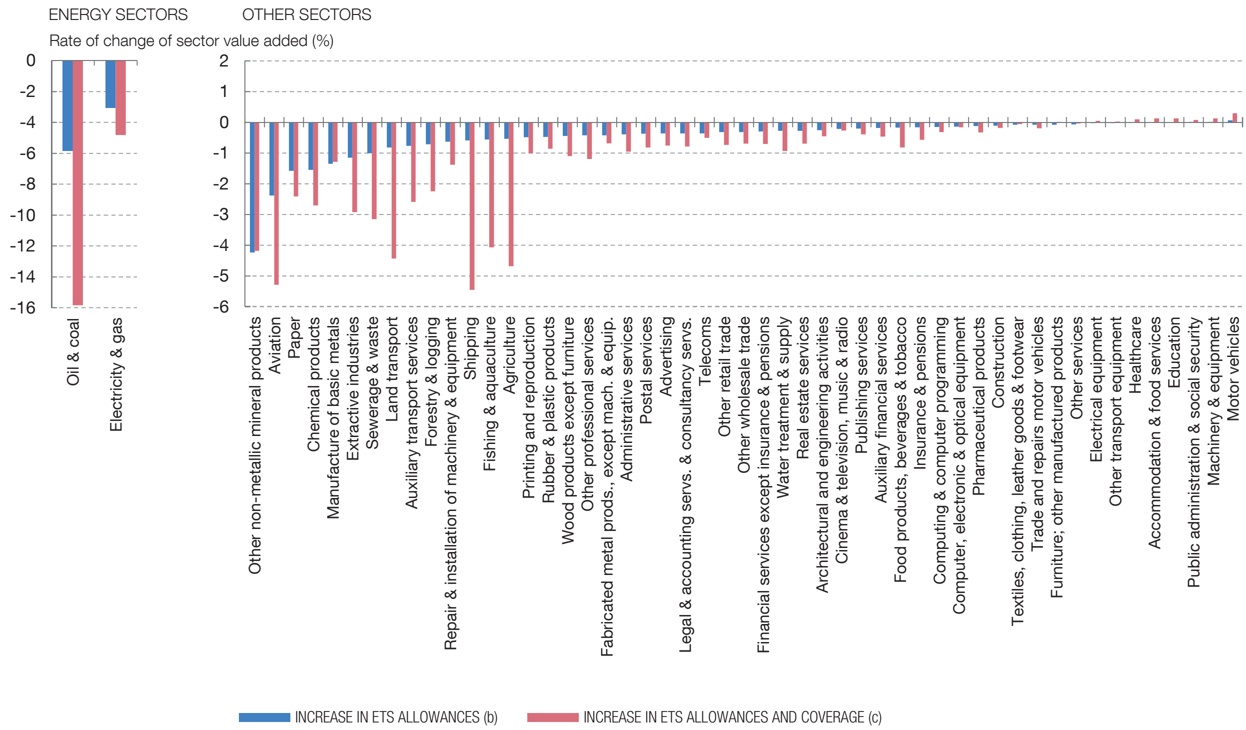
25 For instance, if this tax revenue is used to cut taxes on labour, the overall impact on GDP in the two scenarios analysed would be positive. Using a different model, Hinterlang et al. (2021) obtain a similar result for Germany. See the discussion in this respect in Section 4.1.

Chart 4.9

SECTORAL IMPACT OF ENVIRONMENTAL EMISSION POLICIES (USING THE CATS MODEL) (a)

An increase in the price of ETS emissions reduces activity in non-energy sectors such as building materials and other non-metal mineral products, aviation, paper and chemical products. If ETS coverage is extended, the greatest impact among the non-energy sectors would be in the various transport sectors (shipping, aviation and land transport), and agriculture and fishing. In both scenarios there would be a significant reduction in energy use (owing to their emission intensity), which would be most acute in the case of oil. Accordingly, higher emission prices accelerate the electrification of the economy.

INCREASE IN PRICE OF CO_2 EMISSIONS FROM €25 TO €100 PER TONNE, AND INCREASE IN PRICE AND COVERAGE



SOURCE: Banco de España.

a See Aguilar et al. (2022).
b Increase in price of CO_2 emissions, from €25 to €100 per tonne.
c Increase in price of CO_2 emissions, from €25 to €100 per tonne, and extension of coverage of EU-ETS to include all the emissions of all the productive sectors.

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The CATS model also enables assessment of the extent to which the Spanish economy's sectoral structure and its productive sectors' emission intensity could affect green transition costs in Spain compared with those in other European countries. As Charts 4.7 and 4.8 show, there are some highly significant differences between the sectoral composition and emission intensity of Spain's industries and those of other European economies, such as the EU-27 average or Germany. Thus, for example, Spain's manufacturing industries tend to be more emission intensive than their German counterparts. However, the reverse is also true, for example, in electricity and gas supply, manufacture of basic metals or agriculture, where emission intensity in Spain is considerably lower than in the same industries in Germany. In turn, emission intensity in the services sector is more closely aligned between the two economies. According to alternative CATS model calibrations, overall these differences would not mean that green transition risks would be significantly more or less costly for the Spanish economy than for other European economies. In other words, if Spain's sectoral structure and Spanish industries' emission intensity overall were the same as those of Germany or the EU-27 average, the aggregate economic impact of the simulated transition risks would continue to be very similar.

3.3 An unequal challenge for different types of firm

In late 2021 the Banco de España surveyed Spanish firms on their view of how climate change and the transition towards a more sustainable economy might affect them. The survey, in which some 5,000 firms took part, was conducted through an additional module to the Banco de España Business Activity Survey (EBAE). In this module, firms were asked about the expected impact associated with climate change and the green transition, the time horizon of that impact, the level of awareness and initiatives launched in this field, the main risks detected, and their view of the role that public policy should play in this process.

The survey showed that Spanish firms had a relatively optimistic perception of the direct impact of climate change on their activity, albeit with notable differences by economic sector.[26] Specifically, around 35% of the firms surveyed expected climate change to have a very negative impact (slightly less than 10% of the total) or a moderately negative impact (approximately 25% of the total) on their activity.[27] In any event, as was to be expected in light of the findings presented in Section 3.2, the response was very uneven across industries. Thus, in general, firms operating in higher GHG emission intensity sectors – such as transport, agriculture and manufacturing – tend to expect climate change to have a more negative impact on their activity (see Chart 4.10).[28]

In any event, within each sector, the smaller firms were less well prepared for these climate challenges. A large majority of smaller firms have still not assessed the impact that climate change and the green transition may have on their activity. In addition, of those that had carried out this assessment, the percentage of small firms that expected a negative impact was almost 8 percentage points (pp) higher than among the larger firms.

26 For more details on the survey results, see Izquierdo and Montero (2022), forthcoming.

27 The percentage of all the firms surveyed that reported having carried out an assessment of these effects (approximately 65% of the total). Of this group of firms, 20% expected the impact to be positive, while the other 45% expected it to be neutral.

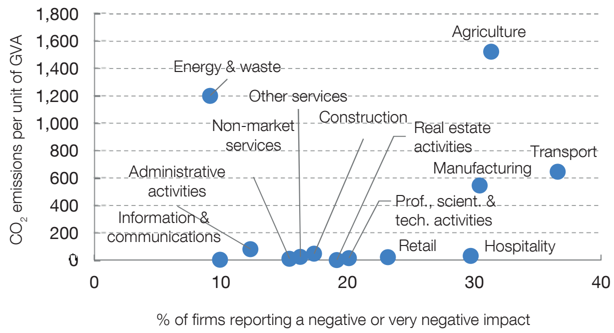
28 Energy sector firms reported that they were particularly well prepared for climate challenges; indeed, only 12% expected these challenges to have a negative impact on their activity.

Chart 4.10

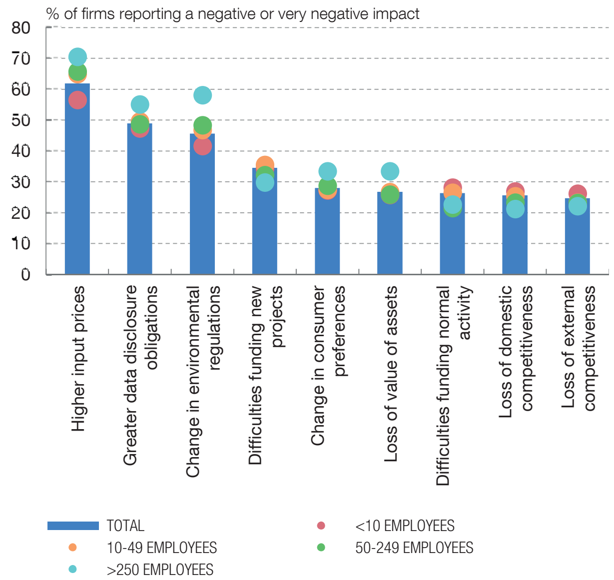
IMPACT OF CLIMATE CHANGE BY INDUSTRY AND RISKS DETECTED BY FIRMS

According to a survey conducted in 2021 by the Banco de España, asking for firms' views on how climate change and the transition towards a more sustainable economy might affect them, firms operating in higher GHG emission intensity sectors – such as transport, agriculture and manufacturing – tend to expect a more negative impact on their activity. The main risks detected by the firms were a potential increase in the price of energy inputs, greater reporting obligations and changes in environmental regulations.

1 IMPACT OF CLIMATE CHANGE AND EMISSIONS BY INDUSTRY



2 MAIN RISKS PERCEIVED BY FIRMS AND DIFFERENCES BY FIRM SIZE (a)



SOURCES: Banco de España (Climate module of 2021 Q4 EBAE) and Eurostat (2019).

a Size differences estimated after taking into account the impact of the industry in which the firms operate.

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Once the results were controlled for industry differences, the smaller firms were more vulnerable to the problems that climate change and the green transition could pose in terms of funding and loss of competitiveness (see Chart 4.10.2). Beyond the size differences, newly created firms were especially concerned about the potential loss of value of their assets, while more highly indebted firms expressed greater concern regarding potential difficulties in funding their normal activity or new projects to address the climate change challenge. For their part, less productive firms expressed more concern for the potential future funding and competitiveness problems, and for the possible increase in the price of their inputs.

Concern for the possible inflationary pressures that the green transition process could create was, in absolute terms, the risk considered most relevant for their activity by the highest percentage of firms (see Chart 4.10.2). This could reflect the sharp surge in prices observed worldwide in recent quarters (for more details on this inflationary episode, see Chapter 3 of this report). Indeed, part of the recent inflationary episode could stem from the ongoing climate transition, for instance, insofar as it has been partially associated with the supply shortage owing to the closure of certain highly contaminating plants in China, the higher demand for gas as the resolve to drive coal out of the energy mix has quickened, and very sharp price rises in certain commodities (such as lithium) used in the manufacture of electric batteries.

Another of the main risks associated with the green transition identified by firms was the possibility of having to bear a heavier administrative burden linked to new data disclosure obligations. In order to achieve efficient green transition progress, the volume, quality and standardisation of the data available on firms' granular exposure to the different climate challenges – both in Spain and the rest of Europe – must be enhanced. This is crucial, not only for the firms themselves, for example when it comes to making investment decisions, but also for the public authorities, for instance to design possible offset policies (see Section 4.2), and for the financial system, to ensure that funding flows can be efficiently assigned between sectors and firms (see Sections 5 and 6 below).

In this respect, the annual "non-financial statement" (NFS) required of Spanish firms, whose content and scope was extended significantly following the entry into force of Law 11/2018,[29] has substantial scope for improvement. In its supervision of the non-financial statements of entities whose shares are admitted to trading on regulated markets, the National Securities Market Commission (CNMV) identifies each year the areas in which more detailed breakdowns are required and sets out the aspects where enhanced data quality and comparability are needed.[30] Nevertheless, under the current regulations, three essential problems persist: there are no harmonised standards and reporting is not in digital format, which hinders large-scale data processing and cross-firm comparison; firms that belong to a group can be exempted from submitting individual data if the consolidated European group to which they belong provides such data, which means that the (essential) national breakdown is lost; and reporting is not obligatory for small and medium firms (fewer than 250 employees), which poses a challenge as it means their main indicators must be estimated. To remedy the current data shortcomings, strategies need to be designed to enable the necessary data to be compiled without imposing an excessive cost on firms, especially small ones.

At the domestic level, Article 32 of the Spanish Climate Change Law will also entail climate change risk disclosure requirements for entities whose shares are admitted to trading on regulated markets and for credit institutions, insurers and reinsurers, and firms according to size. Every two years, the Banco

29 Law 11/2018 transposes Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups. Since 2021, some 3,800 non-financial firms (those that have more than 250 employees, which is a more demanding requirement than the 500 employees envisaged in the Directive) are required to report this information in Spain, although they may be exempted if they belong to a European group.

30 The results of the CNMV's supervision of the non-financial statements of entities issuing shares are summarised in the *"Informe sobre la supervisión de la información no financiera del ejercicio 2020 y principales áreas de revisión del ejercicio siguiente"* (Spanish version only).

de España, the CNMV and the Directorate General of Insurance and Pension Funds (DGSFP), each within their respective competences, will together draft a report on the degree of alignment with the climate change goals set out in the Paris Agreement and in EU regulations, based on future scenarios, and on the risk assessment for the Spanish financial system associated with climate change and the policies to fight it. This report will be coordinated by AMCESFI, the Spanish macroprudential authority.

As part of the European Green Deal, the European Commission has launched a process for reform of the Non-Financial Reporting Directive (NFRD). The proposal for a Corporate Sustainability Reporting Directive (CSRD) was presented in April 2021. It has now passed through several stages and is to be submitted for debate in the European Parliament in spring 2022 for final approval. The main new features in the CSRD are the adoption of reporting standards and the requirement that reporting (compulsory for large European firms) be in digital format. The proposal includes the mandate given to the European Financial Reporting Advisory Group (EFRAG) to draft the European sustainability standards. The first set of standards will be common to all economic sectors, will be approved by means of a Delegated Regulation and will foreseeably come into force from 2024. It is essential that these sustainability standards are compatible with the international standards being drafted by the International Sustainability Standards Board (ISSB).

3.4 The asymmetric impact of the green transition for households

The physical and transition risks associated with climate change could have a highly uneven impact on individuals, according not only to where they live[31] but also, among other aspects, to their health, age, educational level and income. Thus, for example, many studies indicate that both global warming and high air pollution levels (closely linked to GHG emissions) could have a considerable negative impact on health, especially among children, the elderly and persons suffering from chronic diseases.[32] In the same vein, it seems likely that higher income and higher educational level households could find it easier to adopt measures that would enable them to better adapt to the different climate change risks. In particular, more highly educated individuals would be better prepared to face episodes of large-scale reallocation of economic activity between firms and sectors[33] which, as described in Sections 3.2 and 3.3 above, will foreseeably arise in the coming years in the framework of the transition towards a more sustainable growth model.

31 According to the White House (2021), between 2008 and 2016 an average of 21.5 million people worldwide were forcibly displaced each year by extreme weather events. Rigaud et al. (2018) foresee that, in Latin America, southern Asia and Sub-Saharan Africa, 2.8% of the population will be displaced as a result of extreme weather events by 2050. Also, according to Desmet et al. (2021), solely because of rising sea levels, 1.4% of the world population will be displaced by the year 2200.

32 See, for example, Holub, Hospido and Wagner (2020), Chay and Greenstone (2003) and Schlenker and Reed-Walker (2016).

33 See, for example, Notowidigo (2020), Charles et al. (2018) and Lamo et al. (2011).

Between 2006 and 2020, the consumption pattern of the average Spanish household generated 271 kg of CO_2 per €1,000 of expenditure. This takes into account all the pollution generated throughout the production process and is obtained by combining the Household Budget Survey, information from the input-output tables, and the air emission accounts for each industry. At an itemised level it is observed that 20% of this carbon footprint stems from the consumption of goods produced by the electricity, gas, steam and air conditioning supply sector, while a further 18% is associated with expenditure on goods produced by the food, beverages and tobacco industry. Between 2012 and 2020 the average amount of CO_2 per euro spent fell by 6% in Spain, from 281 kg to 264 kg of CO_2 per €1,000 spent. An international comparison shows that the carbon footprint of average expenditure in Spain is significantly lower than in the United States. In particular, between 2006 and 2018, the consumption pattern of the average US household generated 832 kg of CO_2 per $1000 spent, three times more than in Spain, essentially because the production process of the US electricity, gas and water sector is much more emission intensive.

Nevertheless, the consumption pattern of lower income households in Spain has a higher carbon content. In particular, compared with households that receive no income, which are those with the most intensive consumption of high CO_2 emission goods, the consumption spend of Spanish households in the bottom decile of the income distribution entails slightly fewer emissions: some 1.15 kg of CO_2 less per €1,000 spent. By contrast, households in the top income decile are much less emission intensive: 5.63 kg of CO_2 less per €1,000 spent compared with non-income households (see Chart 4.11.1). The reason for this negative correlation between consumption emission intensity and income is essentially that the percentage of expenditure on high-emission industries[34] declines with income, from 8.7% for households with income between the 10th and 50th percentiles of the distribution, to 8.2% for households in the top income decile (see Chart 4.11.2).

CO_2 emission intensity per euro spent also varies sharply with age. Thus, between 2006 and 2020, Spanish households whose reference person was around 20 years old had a larger expenditure carbon footprint – 19 kg of CO_2 more per €1,000 spent – than those whose reference person was 75 years old. The most emission intensive age group is around 40 years old: their expenditure carbon footprint amounts to 24 kg of CO_2 more per €1,000 spent than that of 75-year olds (see Chart 4.11.3). Once again, the differences in consumption emission intensity between age groups are mainly linked to the different share of expenditure that each type of household devotes to high emission sectors (see Chart 4.11.4).

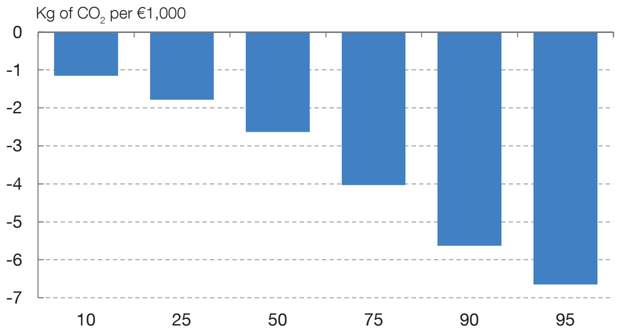
34 These are the industries whose emission intensity (measured as kg of CO_2 per €1,000 of output) is higher than the average for all industries (see Chart 4.8). They include, in particular, fishing and aquaculture, manufacture of coke and refined petroleum products, manufacture of other non-metallic mineral products, electricity, gas, steam and air conditioning supply, shipping and river transport and aviation.

Chart 4.11

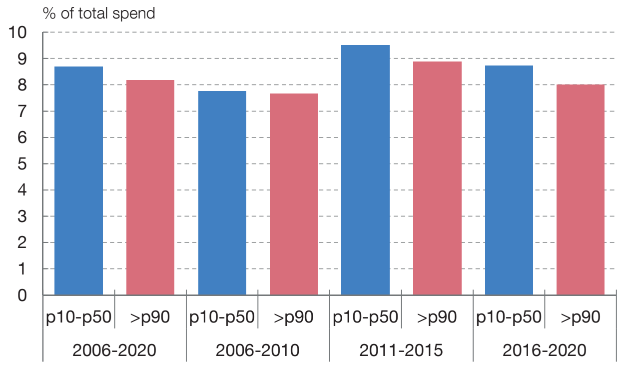
EMISSION INTENSITY AND PROPORTION OF SPANISH HOUSEHOLDS' EXPENDITURE ON HIGH EMISSION INDUSTRIES

Between 2006 and 2020, the consumption pattern of lower income Spanish households had a higher carbon content. Emission intensity peaks around 40 years of age and falls off swiftly thereafter. The proportion of expenditure on high emission industries is largest among households with a lower level of education, those that are not home-owners, larger households and those that live in smaller municipalities.

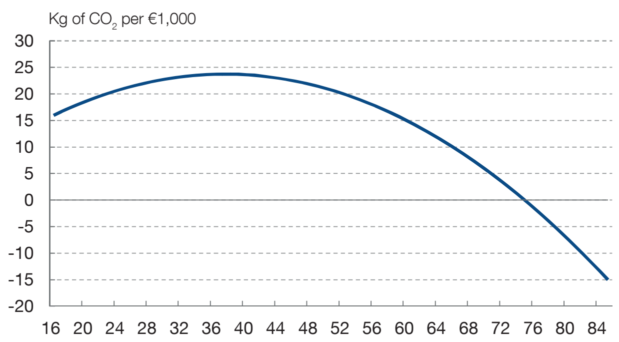
1 CHANGE IN EMISSION INTENSITY BY INCOME DECILE (a) (b)



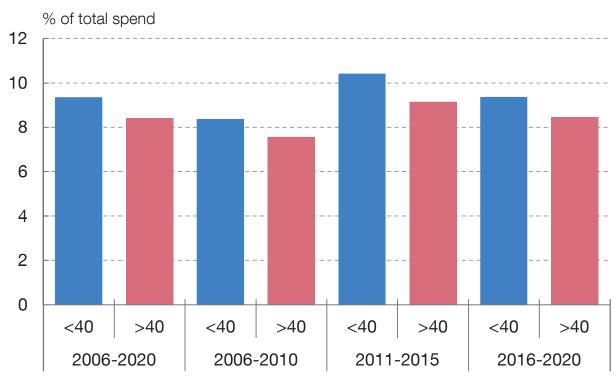
2 PROPORTION OF EXPENDITURE ON HIGH EMISSION INDUSTRIES BY INCOME DECILE (a)



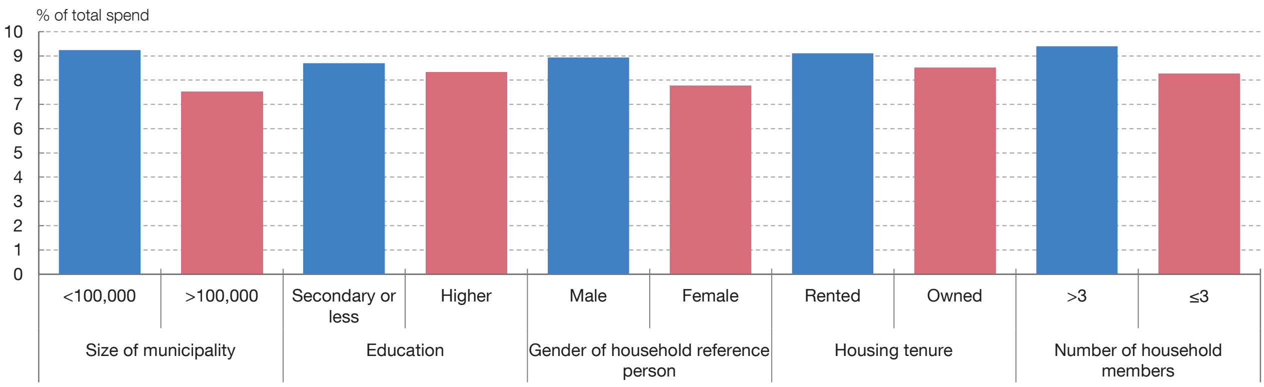
3 CHANGE IN EMISSION INTENSITY BY AGE GROUP (c) (d)



4 PROPORTION OF EXPENDITURE ON HIGH EMISSION INDUSTRIES BY AGE GROUP (c)



5 PROPORTION OF EXPENDITURE ON HIGH EMISSION INDUSTRIES BY OTHER SOCIOECONOMIC FACTORS



SOURCES: INE and Banco de España.

a Household income.
b Difference in emission intensity compared with non-income households.
c Age of household reference person.
d Difference in emission intensity compared with households whose reference person was around 75 years old.

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The amount of emissions per euro spent is also higher among Spanish households with a lower level of education, those that are not home-owners, larger households and those that live in smaller municipalities.[35] In particular, as Chart 4.11.5 shows, between 2006 and 2020 households living in municipalities with under 100,000 inhabitants devoted 9.2% of their spending to high emission sectors, compared with 7.5% for households living in larger municipalities. Moreover, the proportion of expenditure devoted to high emission sectors among households with lower secondary education or less was 8.6% in the same period, 0.3 pp more than among households with a higher educational level. In turn, households whose reference person was male devoted 9% of their expenditure to high emission goods, compared with 7.8% for households whose reference person was female.

To sum up, there are clear signs that the green transition process may affect different types of households very differently. In particular, the foreseeable increase in the coming years in the price of the most contaminating goods and services will likely have a more pronounced impact on low income households, those whose reference person is in the 35 to 45 age group, those that live in rural areas, households with a lower educational level and larger households.

In view of all the above, it would be advisable for public policies to shape mechanisms to temporarily compensate the more vulnerable households within each of these groups for the higher costs that the green transition could entail for them (see Section 4 below). Aside from equity considerations, the need to roll out compensatory measures of this kind would also be justified, to achieve the sufficient and necessary social consensus required to undertake the deep structural transformation that the economy and society need to address in the coming years to face the important climate challenges ahead.

4 The role of public policy in Spain

Public policy, particularly in terms of fiscal matters and the regulation of economic activity, has a pivotal role to play in the green transition. First, as it is governments and parliaments that have the legitimacy required to determine when and how the economy and society must undertake the far-reaching structural transformation needed to mitigate and adapt to climate change. Second, because the public authorities, when compared with other agents, have at their disposal the most comprehensive and granular set of instruments best suited to meeting the targets set as efficiently as possible, while also taking into account equity considerations. In any event, in the midst of an extraordinarily uncertain structural transformation process, it is essential that public policy provide certainty to the

35 See Basso and Pidkuyko (2022), and Basso, Jaimes and Rachedi (2022).

different economic agents, while facilitating a stable operational framework within which they can make their consumption, investment and production-related decisions with every assurance.

4.1 Green taxation

There is widespread consensus that green taxation is the most efficient means of ensuring that economic agents internalise the climate-related consequences of their decisions. Indeed, a wealth of academic literature attests to the fact that environmental or green taxes are the instrument best able to ensure that the prices the different economic agents face in their production and consumption-related decisions factor in not only the private cost, but also the social cost deriving from the environmental impact of such decisions.[36] With this in mind, in recent years carbon taxes have taken centre stage among the various initiatives launched by authorities across the globe to drive the green transition. Particularly noteworthy is the creation and subsequent expansion of various emissions trading systems (ETS), as well as the adjustments made to a series of green taxes, for instance, those levied on energy, hydrocarbons and transport.

Spain consistently features among the EU-27 economies in which green taxation raises the least revenue in relative terms (see Chart 4.12). Over the past two decades, when compared with the arithmetic mean of the EU-27, Spain's revenue gap in this regard has remained stable at around 1 pp. Specifically, in 2019 Spain posted a negative differential of 0.8 pp. Lower taxes on energy (and hydrocarbons in particular) accounted for 67% of this lower revenue.

Although hydrocarbon taxes are lower in Spain than elsewhere, tax rates have not risen in real terms in recent years (see Chart 4.13). The nominal rates of the excise duties on the consumption of standard petrol and diesel in Spain (a fixed amount in euro cents per litre) have been adjusted periodically since 1995. However, this has not led to any increase in the tax rate on such consumption in real terms, which would explain why this rate lies below that of the EU economies as a whole.[37]

Green taxes in Spain must be strengthened and their design improved if the country's economy is to forge ahead efficiently with the green transition. Published in March 2022 and prepared by a committee of independent experts at the request of the Ministry of Finance, with the assistance of the Spanish Institute of Fiscal Studies, the White Paper on the Reform of the Tax System[38] represents an essential starting point from which to assess a possible wholesale overhaul of

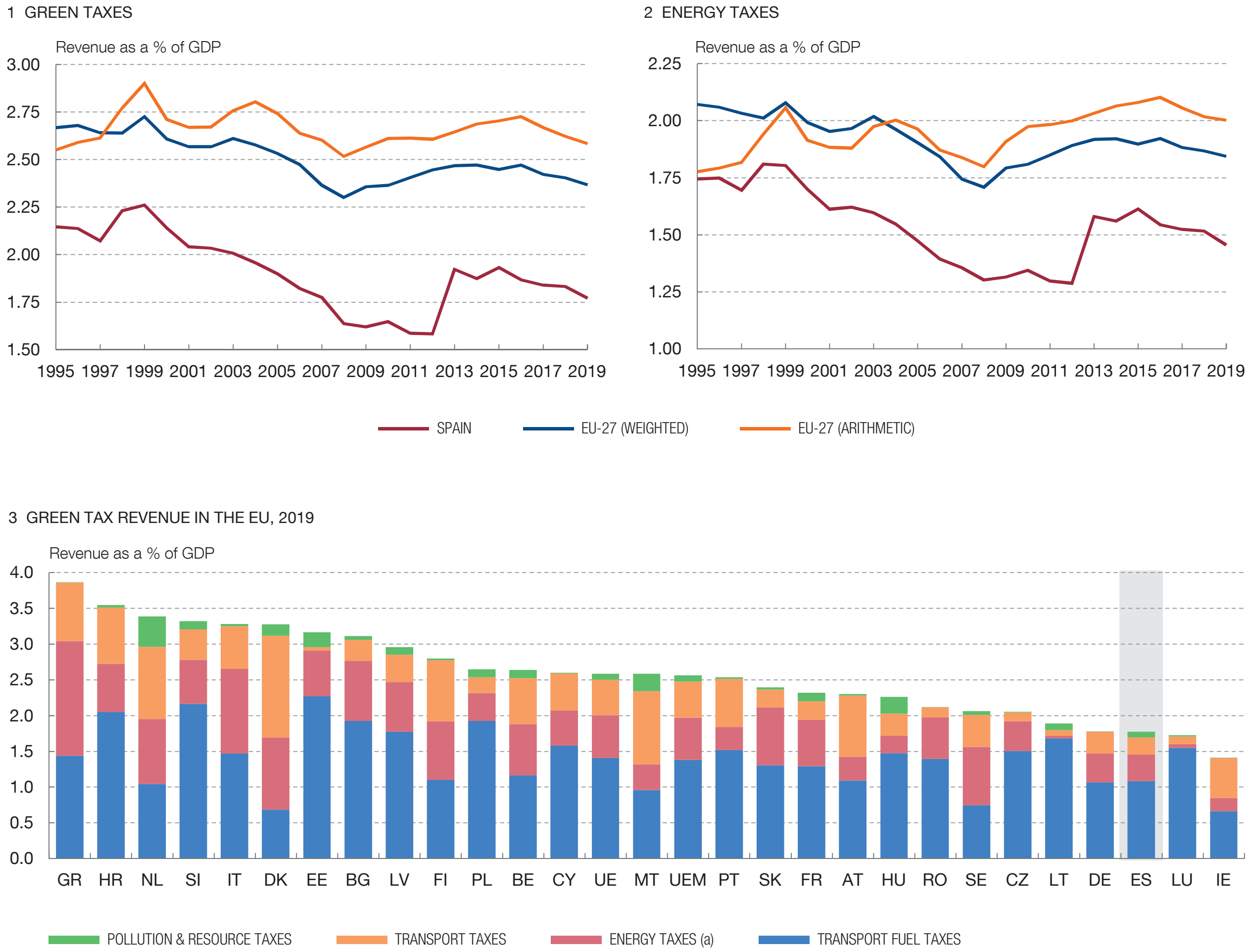
36 See, for example, Pigou (1932), Fullerton et al. (2010) and Stiglitz et al. (2017).

37 The rates on such taxes are a fixed amount of euro cents per litre of fuel, and any international comparison should therefore be adjusted for purchasing power parity (PPP).

38 See the White Paper on the Reform of the Tax System (only available in Spanish).

Chart 4.12
GREEN TAXATION IN SPAIN IN THE CONTEXT OF THE EU-27

Over the past two decades, Spain has consistently featured among the EU 27 economies in which environmental taxation raises the least revenue in relative terms. Spain's revenue gap with respect to the EU-27 average can largely be explained by the lower taxes on energy and, in particular, on hydrocarbons. A third of Spain's revenue gap is due to lower transport taxes.



SOURCE: Eurostat.

a Not including transport fuel.

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Spain's green taxes. Specifically, the report sets out a broad array of specific environmental proposals and recommendations that, taken as a whole, seek to encourage changes in household equipment and consumption and mobility patterns, as well as the development and adoption of technologies, capital goods and operational changes by firms, enabling the country to more efficiently reduce its pollutant emissions.

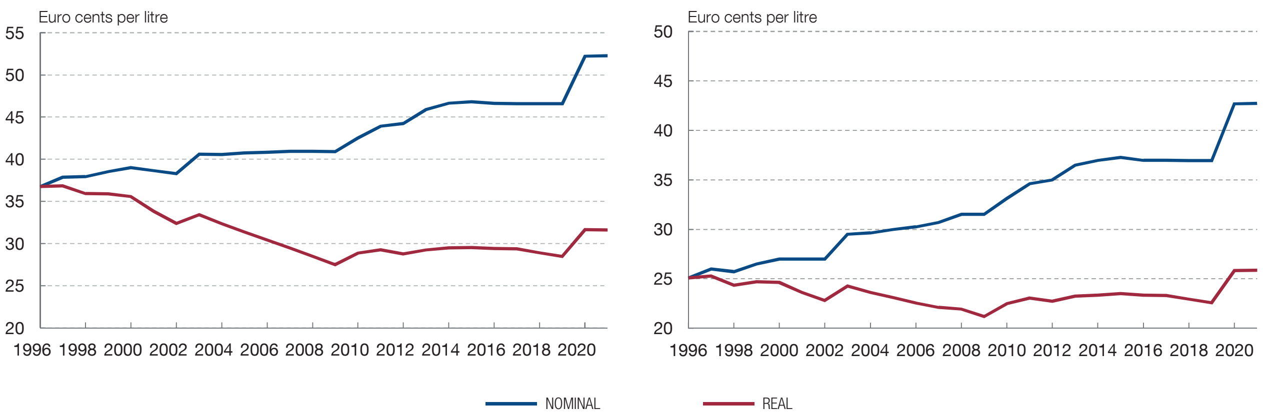
If used efficiently, the revenue raised by higher environmental taxes could significantly reduce the transition costs for the economy overall. Both the proposals detailed in the White Paper and Spain's sizeable shortfall in terms of green

Chart 4.13
CHANGES IN THE RATES OF EXCISE DUTIES ON HYDROCARBONS (1995-2020)

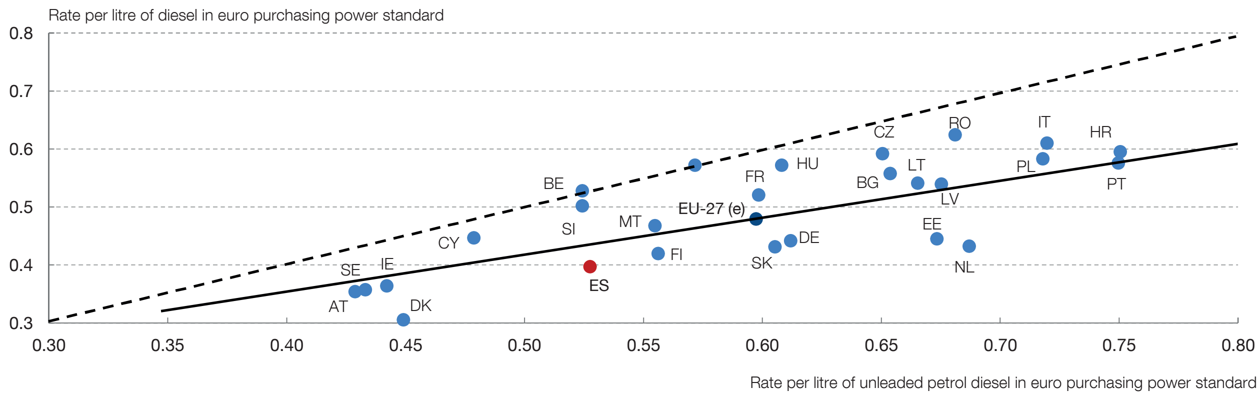
Excise duties on hydrocarbons did not rise in Spain in real terms between 1995 and 2020. When compared with the EU-27 economies, the Spanish tax rates on petrol and diesel, adjusted for purchasing power parity (PPP), are below the EU-27 average.

1 PETROL EXCISE DUTY RATES IN SPAIN (a) (b)

2 STANDARD DIESEL EXCISE DUTY RATES IN SPAIN (a) (b)



3 HYDROCARBON TAX RATES ADJUSTED FOR PPP IN THE EU-27 ECONOMIES, 2020 (c) (d)



SOURCES: Informe Anual de Recaudación Tributaria del año 2020 (AEAT), Excise Duties Tables - Part II Energy products and Electricity (European Commission 2020) and Eurostat (2021).

a The rates include both the general and special tax rates. The special rate includes the regional tranche, which has been homogeneous for all Spanish regions since 2019.
b The real rates are obtained by deflating the nominal rate by the household and NPISH final consumption expenditure deflator (1995 Index = 100).
c Average rates on consumption subject to excise duties. The nominal rates are adjusted by the price level indicator (PLI) for final household expenditure (EU 27 = 100 in 2020) that results from dividing the Purchasing Power Parity (PPP) indicators by the nominal exchange rate.
d Regressions with average values of the rates, adjusted for PPP, in force at 1 July 2020 in the EU-27 economies.
e EU-27 refers to the arithmetic mean of the rates, adjusted for PPP, in the EU-27 economies at 1 July 2020. In the case of Spain, the regional tranche of the special rate, amounting to 0.048 euro cents per litre, is not included.

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tax receipts when compared with its neighbouring economies point to ample room for increasing environmental tax revenue in the country's economy. It is worth stressing here that the revenue-raising potential of some of the tax initiatives that could be rolled out in this regard could significantly offset the short-term costs of the green transition for the Spanish economy. First, the higher environmental tax revenue could be used to reduce other taxes that significantly distort overall economic activity. For instance, some studies[39] have noted that using part of the additional green tax revenue raised to cut taxes on labour could have a considerable expansionary impact on activity. Meanwhile, the extra receipts from higher environmental taxes could be used to deploy policies to offset the short-term transition costs for the most vulnerable firms and households[40] (see Section 4.2). It should be borne in mind, however, that if the green transition is successful, a significant portion of the higher green tax revenue raised in the short term would be essentially temporary, declining gradually as households and firms adapted to a more sustainable growth model.

4.2 The need to address distributional aspects

It seems unlikely that the green transition will advance at a good pace if the markedly asymmetric impact this process will have on different types of sector, firm and household is not factored in and mitigated. Indeed, as noted in Section 3, climate change and the transition to a more sustainable economy will have highly heterogeneous effects across regions, sectors, firms and households. In fact, such processes are likely to have a notably adverse impact on certain groups of firms and households that are already particularly vulnerable (see Sections 3.3 and 3.4, respectively), among other reasons because such groups will be relatively harder hit by any increase in green taxes, owing to their consumption and production patterns (see Section 4.1). With this in mind, it is important to note that while society as a whole may be willing to act decisively to address the challenges posed by the green transition (as borne out by various surveys[41]), particular attention must be paid, for reasons of both efficiency and equity, to mitigating the distributional effects this process will entail. Otherwise, not only may the economic costs of the green transition be higher, but the speed and ambition of the process could also be conditioned by potentially disruptive episodes of social unrest.

Aware of the need to take the distributional aspects associated with the fight against climate change into account, the authorities have come up with various mechanisms to ensure a more equitable transition. For instance, the European Union has created a Just Transition Fund to adopt potential measures to compensate the regions hardest hit by the green transition.[42] Meanwhile, Spain has approved a Just Transition Strategy, which envisages a raft of initiatives for softening the adverse impact of the shift towards a more sustainable economic model on certain groups.[43]

39 See, for example, Hinterlang et al. (2021), Aguilar et al. (2022) and Delgado and Santabárbara (2022).

40 See, for example, Benkhodja et al. (2022).

41 See, for example, Centro de Investigaciones Sociológicas (2021) (only available in Spanish).

42 See European Commission (2020b).

43 See the Just Transition Strategy.

In any event, any necessary offsetting measures to be rolled out in future must be carefully designed to ensure a targeted approach, without undermining the incentives to reduce pollutant emissions. In particular, any offsetting measures targeting households should preferably be framed via personal income tax and should be dependent on household income, so as not to alter the relative price signs deriving from taxes in the overall economy. Moreover, these transfers could be made conditional on the need to make consumption and investment decisions in keeping with the transition towards a more sustainable economic and social model. These would take the form of "green cheques", to be used, for instance, for investment in equipment that helps reduce GHG emissions.

4.3 Public investment and subsidies

Aside from using green taxes to discourage the most environmentally harmful activities, fiscal policy also has a key role to play in stimulating the massive investment required to facilitate the green transition. In order to meet the climate targets set out in the European Green Deal (including a 55% reduction in GHG emissions by 2030), the European Commission estimates that additional investment of €520 billion a year will be required up to 2030.[44] Along similar lines, Spain's Climate Change Law seeks to mobilise €200 billion between 2021 and 2030 to boost, inter alia, investment in the electricity, transport and residential sectors.

Public investment, particularly in core research, must be a cornerstone of the green transition. In a context of tremendous uncertainty as to which technologies might drive the future green transition, and of investment from which there may be little direct benefit for investors, public investment has a pivotal role to play in driving the necessary structural transformation of the economy. Moreover, the academic literature notes that it is precisely in a climate such as the current one that public investment exerts the strongest pull on private investment.[45]

In any event, given the sheer scale of the investment needed, alongside environmental taxes and public investment, subsidies should also be made available to encourage private investment in green technologies. In this regard, Acemoglu et al. (2016) suggest that, given the relative advantage (in general terms) currently enjoyed by dirty technologies over their greener counterparts, taxes on the most environmentally harmful activities should be combined with subsidies for investment in new, cleaner technologies. This would prevent any delay in the adoption of such new technologies, while at the same time avoiding an excessive hike in green taxes that could cause very significant economic distortions.

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44 See European Commission (2022).

45 See, for example, Alloza, Leiva-León and Urtasun (2022), forthcoming.

The Recovery, Transformation and Resilience Plan (RTRP) should act as a key lever for driving public and private investment in Spain in the coming years. Of the €69.5 billion earmarked under the Spanish RTRP over the next six years (within the framework of the NGEU programme), more than €27 billion is expected to be set aside to support the green transition. In particular, there are plans to invest over €6.8 billion to improve the energy efficiency of public and private buildings, alongside €13.2 billion earmarked for sustainable urban and long-distance mobility, for example in the form of programmes including incentives for the purchase of electric vehicles and the installation of recharging points, for upgrading railway infrastructure and for developing urban public transport. Also contemplated is a drive towards the decarbonisation of the energy sector, with a €6.4 billion-plus investment in clean technologies and infrastructure.

Fully harnessing the transformational capacity of the NGEU programme will call for decisive action both in Spain and at EU level. Indeed, as noted in Chapter 2 of this report, a rigorous selection of the investment projects to be funded will be required if Spain is to make the most of this programme, while supplementing such investments with the roll-out of an ambitious package of structural reforms. Moreover, from an EU standpoint, it may be advisable to extend the time frame envisaged for loan applications under the NGEU programme, to limit the risk that any of the investments required to press ahead with the fight against climate change, as well as with the digitalisation and the strategic autonomy of the EU, might fall by the wayside. Elsewhere, outside this programme, new tools should also be developed at EU level to enable certain structural investment needs that are shared by the different EU economies (such as those associated with climate change) to be funded on a permanent basis.

4.4 Other government measures and the need for ongoing assessment of policies

Aside from fiscal policy, the public authorities can also turn to other regulatory measures to further the green transition. Notable examples of such actions include, for example, initiatives establishing air quality targets, such as the European Air Quality Directive (currently under review), the energy performance standards for the development and renovation of buildings, the rules laying down certain vehicle manufacturing standards[46] and the penetration targets for the use of renewable energy sources to generate electricity.

In any event, meeting the environmental targets set without wasting resources and avoiding any unwanted effects on activity calls for the ongoing assessment

46 For example, Regulation (EU) 2019/631 establishes CO_2 emission standards for new passenger cars and for new light commercial vehicles registered in the Union.

of public policies. While all economic policies should, in general, undergo thorough evaluation, this is all the more relevant in the area of climate change and the green transition, since many of the instruments proposed are relatively new and the direction and scale of their possible impact are still highly uncertain. In this regard, as noted in Section 3.3 above, the proper evaluation of public policies requires an increase in the amount of granular information available on environmental matters and access to that information for researchers. By way of example, detailed below are some recent Banco de España research papers that allow the implications of certain economic policy initiatives to be assessed.

As part of the fight against climate change, the fight against air pollution could have a very significant impact on the health and labour market participation of the Spanish population. In particular, Holub et al. (2020) show that, for the period running from 2005 to 2014, there is a positive correlation between the levels of air pollution in the main Spanish cities and the amount of sick leave taken by employees. Moreover, this positive correlation is significantly more pronounced in the largest cities in the sample (over 500,000 inhabitants). According to the estimates in this study, a reduction in air pollution in Spain during the period analysed led to an increase in the labour supply equivalent to an extra 5.58 million days' work and a saving of at least €505 million over the entire period.[47]

In Spain, the impact of subsidies to purchase electric vehicles has been highly uneven across municipalities. Notable among the initiatives rolled out in recent years to drive the green transition (both in Spain and in many other advanced economies) has been support for the purchase of low-emission vehicles. For instance, since February 2009 the Spanish Government has budgeted close to €1 billion in various rounds of the MOVES programme. Nonetheless, Anghel and Muñoz (2022) note that, up until the implementation of the most recent programme (MOVES III), these incentives for the purchase of low-emission vehicles did not lead to a significant increase in the number of these vehicles registered in Spain, once adjusted for the secular trend towards the greater presence of such vehicles on the market. This finding tallies with those of Diamond (2009), who finds little correlation between the purchase of electric vehicles in the United States and the subsidies offered by various US states, and of Münzel et al. (2019) who, after analysing programmes to encourage purchases of electric vehicles in various European countries, find a positive, albeit very limited impact on registration numbers. Nevertheless, such programmes do appear to have had a positive impact on the probability of electric vehicle sales in Spanish municipalities with a greater number of recharging points and higher income per capita.

47 This calculation does not factor in the possible additional benefits in terms of a reduction in mortality and in other medical treatment-related costs. Given that the impact of air quality on the labour supply is greater among workers in worse health or with chronic illnesses, these additional effects could be substantial.

While investment in renewable energy sources could have a positive impact on overall employment, this need not necessarily be apparent at local level. In particular, Fabra et al. (2022) find evidence that Spanish municipalities that have received investments in solar or wind farms in recent years have not generally seen any significant decline in local unemployment.

5 The role of the financial system

In order to mobilise the huge amount of funds required both to combat climate change and for the green transition, it is essential that the financial system play an active role. Regardless of any initiatives that may be developed by the public authorities (in the areas of economic regulation and fiscal policy) to deter conduct that may increase negative environmental externalities and to encourage sustainable investment, the fact remains that it is the financial system as a whole (from banks to institutional investors and other financial intermediaries) that plays a key role in channelling the funds that such actions require across activities, sectors, firms and households. To do so efficiently, it is essential that all participants in the financial system and the capital markets are able to accurately identify the extent to which they and the other economic agents are exposed to the various physical and transition risks associated with climate change, and that they actively factor such information into their risk management.

To enable the financial system to act as a lever for the transition to a more sustainable economy, recent years have seen the roll-out of a wide range of initiatives in a variety of spheres.[48] Many of these initiatives essentially seek to increase the total amount of information available on economic agents' exposure to climate change-related physical and transition risks. Noteworthy examples of these initiatives include the voluntary recommendations prepared by the Task Force on Climate-Related Financial Disclosures, which seek to help businesses disclose information on climate-related risks and opportunities,[49] and the work performed by the European Commission since 2018 under the action plan for financing sustainable growth, in particular, the implementation of the Sustainable Finance Disclosure Regulation (SFDR)[50] and the proposal for a Corporate Sustainability Reporting Directive (CSRD), which will change the current requirements under the Non-Financial Reporting Directive.

Some of these initiatives are geared towards establishing and harmonising the way the financial system needs to assess and process the risks posed by climate change and the green transition. At a global level, particularly noteworthy examples of such initiatives include those developed under the United Nations

48 See González (2021a).

49 See Task Force on Climate-related Financial Disclosures (2017).

50 See Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector.

Environment Programme Finance Initiative (UNEP Fi), such as the Principles for Responsible Investment, the Principles for Responsible Banking and the Principles for Sustainable Insurance. At the European level, the initiatives notably include the development of a European taxonomy of environmentally sustainable economic activities. Also worth noting is the proposal for a Directive on corporate sustainability due diligence.[51] Moreover, from a supervisory and financial stability standpoint, various supervisory guidelines have been drafted and work has begun on stress-testing of banks, as a learning exercise, in the face of a potential worsening of climate risks (see Sections 6.2 and 6.3 for more details).

In the wake of these institutional initiatives, but also, above all, as a result of a growing, genuine interest on the part of investors, recent years have seen an extraordinary boom in sustainable finance. This has led to the emergence and development of new financial instruments, such as green bonds, social bonds, sustainability bonds and sustainability-linked bonds.[52] As Chart 4.14.1 shows, between 2013 and 2021 (the latest information available), the volume of funds channelled through these green and sustainable instruments on international bond markets increased very significantly, particularly since 2019. This growth was equally notable in the case of Spanish issuers (see Chart 4.14.2). Specifically, green bond issuances rose by 83% in 2021 and in September 2021 the Spanish Treasury made its first ever green bond issue.

On the capital markets, a key current question is whether the various financial assets fully price in all of the climate risks to which they are exposed. Otherwise, the problem would be twofold. First, any assets for which the climate risks are underestimated, or the benefits of the green transition are overestimated, could suffer a sharp price correction at any time. Second, this would distort the allocation of resources across activities, sectors and firms, thereby hindering the speed and efficiency of the green transition. In any event, Marqués and Romo (2018) note that, to date, the academic literature has not reached a definitive conclusion on whether or not the climate risks priced into the different financial assets are currently being accurately assessed.[53]

This notwithstanding, recent bond market developments point to the existence of something of a "green premium". For example, Gimeno and Sols (2020) find that, in the case of the European Investment Bank (EIB) and the

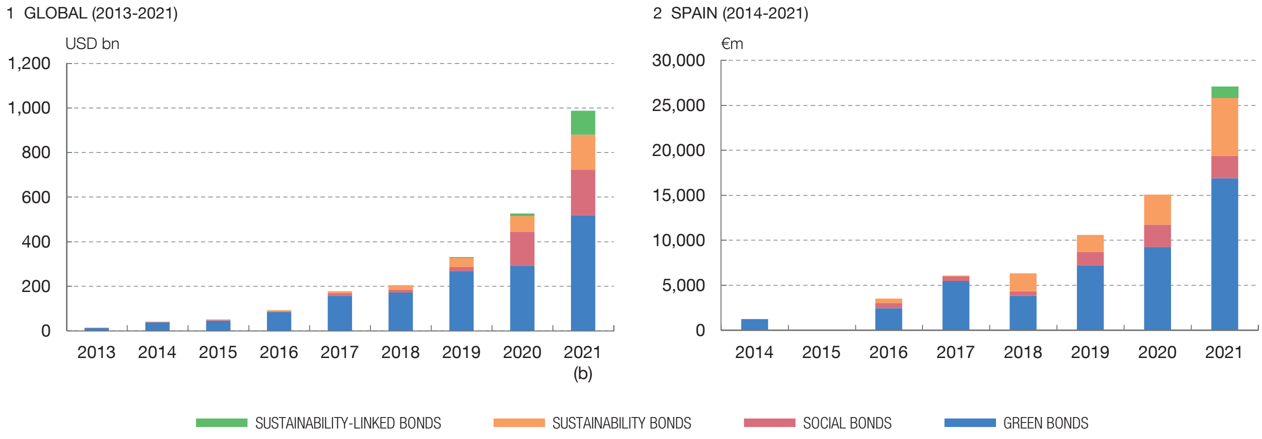
51 This proposal seeks to foster sustainable and responsible business conduct throughout global supply chains.

52 See González and Núñez (2021). A green bond is one whose funds are earmarked for financing projects that are directly related to sustainability, the preservation of natural resources and the transition to a low-carbon economy. In the case of social bonds, the proceeds are allocated to a range of social projects that, for example, seek to promote health or education and to positively impact communities. A sustainability bond is a bond whose proceeds are used for environmentally sustainable purposes, combining green and social projects. Lastly, a sustainability-linked bond is one whose financial and/or structural characteristics can vary depending on whether the issuer meets a pre-defined (environmental, social or governance-related) sustainability target.

53 For instance, Monnin (2018), Hong, Li and Xu (2019) and Kumar, Xin and Zhang (2019) present evidence of inaccurate climate risk assessments in carbon intensive assets. However, Griffin et al. (2015) and Gimeno and González (2022) suggest that financial markets are alert to climate-related news.

Chart 4.14
GREEN AND SUSTAINABLE BONDS (a)

Recent years have seen a considerable increase in the volume of funds in the international bond markets channelled through a range of green and sustainable instruments, both globally and in Spain.



SOURCES: González and Núñez (2021) with figures from IFF, Sustainable Debt Monitor & CBI and Dealogic.

a A green bond is one whose funds are earmarked for financing projects that are directly related to sustainability, the preservation of natural resources and the transition to a low-carbon economy. In the case of social bonds, the proceeds are allocated to a range of social projects that, for example, seek to promote health or education and to positively impact communities. A sustainability bond is a bond whose proceeds are used for environmentally sustainable purposes, combining green and social projects. Lastly, a sustainability-linked bond is one whose financial and/or structural characteristics can vary depending on whether the issuer meets a pre-defined (environmental, social or governance-related) sustainability target.
b Provisional figures.

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Kreditanstalt für Wiederaufbau (KfW), green bonds have in recent years posted a negative yield spread over conventional bonds from the same issuer (see Chart 4.15.1).

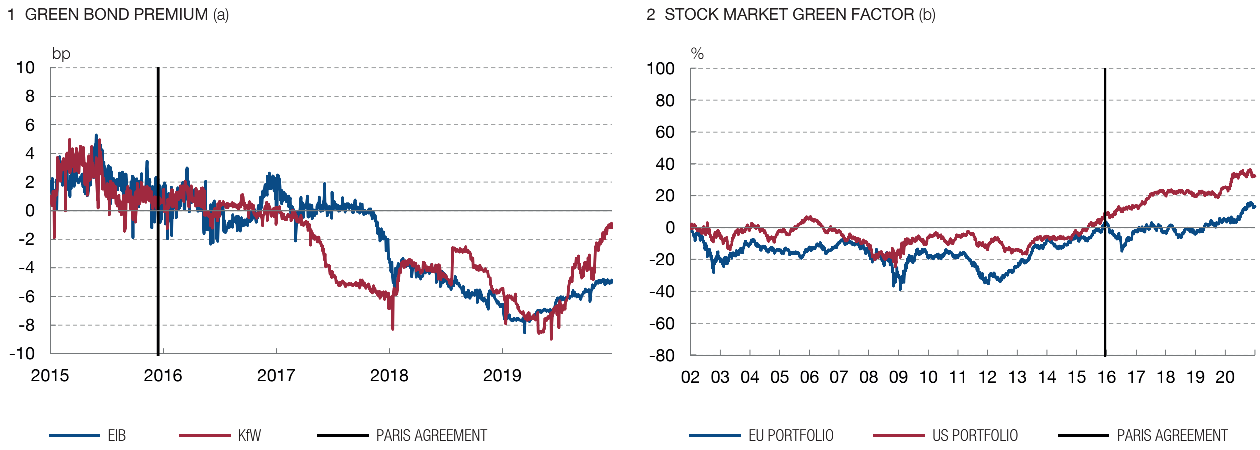
In the case of equities, some studies have identified a "green" factor that explains the excess stock market returns to an extent similar to or even greater than that explained by other factors commonly used in the literature. Specifically, Gimeno and González (2022) calculate a green factor as the return on a portfolio that maintains a long position in green assets and a short position in browner assets (see Chart 4.15.2),[54] and demonstrate that this factor (which has grown in importance since the Paris Agreement) offers relevant information for stock market investors.

Looking ahead, the progress of sustainable finance will critically depend on improvements to the information available, on the headway made in defining international standards and on the ex post verification of the commitments undertaken by the issuers of sustainable instruments. The availability of information is key in this area, while the lack of standards that are uniform, as well as mandatory at global level, makes it very hard to assess the extent to which a firm is

54 The two subportfolios are created by giving equal weighting to 50 (60) firms on the S&P 500 (the broad EURO STOXX index), with small and large carbon footprints, and with equal weightings by sector and size.

Chart 4.15
YIELD SPREAD BETWEEN GREEN AND CONVENTIONAL ASSETS

The most recent bond market developments point to the existence of something of a “green" premium in favour of green bonds and a green factor in equities that explains much of the excess returns.



SOURCES: Gimeno and Sols (2020) and Gimeno and González (2022).

a The premium is calculated as the average of the spreads between the yield of the green bonds and the yield they should have based on the estimated yield curve for conventional bonds.
b The green factor is calculated as the yield on a portfolio with a long position in green assets and a short position in browner assets. The two sub-portfolios are created by giving equal weighting to 50 (60) firms on the S&P 500 and the broad EURO STOXX index with small and large carbon footprints, and controlling to ensure both are weighted equally by sector and size.

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environmentally sustainable. The existence of standards is of particular importance in financial markets and, above all, in the case of green bonds, given the challenges associated with compliance and verification of the commitments taken on by the issuers, so as to avoid any “greenwashing”. In this regard, as noted in certain studies,[55] the fact that green bond issuers are not reducing their emissions underscores the need for a shift towards emissions models that take into account all of an issuer’s productive activity and not just individual investment projects.[56] Moreover, verification also has a very important role to play throughout this entire process. The European Commission understands this, and is currently developing a European green bond standard with four key requirements: taxonomy-alignment, transparency, external review and supervision of reviewers by ESMA.

6 The role of central banks

Climate change and the transition to a more sustainable economy also present a considerable challenge for central banks. Specifically, such processes of structural change may have a most significant impact on monetary policy conduct

55 See, for example, Ehlers, Mojon and Packer (2020).
56 See Delgado (2021).

(see Section 6.1) and pose considerable risks to financial stability (see Section 6.2), calling for a resolute response in terms of both banking regulation and prudential supervision (see Section 6.3). Insofar as central banks are capable, within their mandates, of adapting to these challenges, they will be able to actively contribute to the green transition. In addition, as with other institutional investors on the international capital markets, central banks could also bolster the transformational process required for the fight against global warming through their investment policy in respect of their own asset portfolios (see Section 6.4).

6.1 Monetary policy

There is already a broad consensus that climate change and the green transition may affect monetary policy conduct through various channels. Such structural processes may, for instance, induce changes in the level and volatility of inflation, affect the level of the equilibrium real interest rate or cause disruptions in the financial system (particularly in credit institutions) that hamper monetary policy transmission.

As has been evidenced in recent quarters, the green transition can have a most significant impact on the level of inflation and, therefore, on the monetary policy stance. Indeed, part of the sharp upturn in global inflation since early 2021 has been associated with the policies recently adopted by various governments across the world to reduce their economies' GHG emissions more swiftly. For example, after the European Commission announced the "Fit for 55" legislative package on 14 July 2021, the price of EU emission allowances rose by 56%, resulting in an increase of 142% over 2021 as a whole. This exerted further upward pressure on electricity prices in both the wholesale and retail markets. As indicated in Chapter 3 of this report, which also analyses the other factors behind the current inflationary episode, faced with such price dynamics, the world's main central banks have had to make considerable adjustments to their monetary policy stance in recent quarters.

The mitigation of and economies' adaptation to climate change will affect not only the level of inflation, but also its volatility. A broad range of studies suggest that, insofar as global warming is associated with adverse weather events becoming ever more extreme and frequent, the prices of certain goods, such as food, may show greater volatility in the future.[57] However, the various economic policies rolled out to pave the way for the green transition may also make inflation more volatile. A recent study by the Banco de España points in this direction: Santabárbara and Suárez-Varela (2022) empirically document that the emissions trading schemes introduced in many advanced economies have generated greater inflation volatility in recent years, chiefly in the energy component.

57 See European Environment Agency (2021).

These structural processes will also shape conventional monetary policy space, insofar as they have an impact on the equilibrium real interest rate (r*).[58] From a conceptual perspective, such an impact may in principle be both upwards and downwards. On the one hand, the materialisation of physical risks linked to climate change and the greater uncertainty associated with the green transition would exert downward pressure on the level of r*, owing to declining labour productivity, higher mortality and greater precautionary saving. On the other, the equilibrium real interest rate may rise on account of the sharp increase in the demand for funds to finance the numerous investment projects needed for a structural change in current production and consumption patterns. These investments may in turn also trigger a notable increase in aggregate productivity and in r*. For the time being, there continues to be considerable uncertainty surrounding which of these channels will be the most relevant in quantitative terms.[59] At any rate, should the final net effect mean a reduction in r*, interest rates would reach the effective lower bound more frequently in the future, limiting the space for conventional monetary policy tools.

Monetary policy transmission may also be affected. Should the increasing materialisation of physical risks associated with climate change trigger losses that cause a noticeable deterioration in credit institutions' balance sheets (see Section 6.2), the transmission of monetary policy decisions through the banking system would be impaired.[60] Such adverse effects would be greater still if a sharp rise in credit risk premia (attributable to a sudden reappraisal of climate-related financial risks, for example) were to have, inter alia, a negative impact on the collateral provided by institutions in monetary policy operations.[61]

Accordingly, although they are at an admittedly incipient stage, the world's main central banks have begun to factor in climate change and green transition-related considerations when determining and implementing their monetary policy.[62] By way of example, the Bank of England published its first climate-related financial disclosure in 2020, setting out its approach to managing the risks from climate change in its operations.[63] For its part, the US Federal Reserve is currently developing various scenarios to incorporate the financial risks posed by climate change in its economic models.[64]

58 The natural or equilibrium interest rates are those which prevail when the economy remains at its potential level and inflation is stable at its target level. For more details of the concept, determinants and monetary policy implications of the natural interest rate, see Galesi, Nuño and Thomas (2017).

59 See, for example, Cantelmo (2020) and Brand et al. (2018).

60 See Álvarez et al. (2022) and Alogoskoufis et al. (2021a).

61 See, for example, Isabel Schnabel's speech, "Climate change and monetary policy", of 17 December 2020.

62 See NGFS (2020b) and González and Núñez (2021).

63 See "The Bank of England's climate-related financial disclosure 2020", Bank of England, 18 June 2020.

64 See Lael Brainard's speech, "Building Climate Scenario Analysis on the Foundations of Economic Research", Federal Reserve, of 7 October 2021.

The European Central Bank (ECB) has committed to an ambitious action plan to 2024 to incorporate climate considerations into six key areas of its monetary policy framework.[65] First, in its monetary policy assessments and macroeconomic modelling, by accelerating the development of new models and conducting theoretical and empirical analyses to monitor the implications of climate change for the economy, the financial system and the transmission of monetary policy. Second, in the statistical setting, through the development of new experimental indicators, covering green financial instruments and the carbon footprint of financial institutions, as well as their exposures to climate-related physical risks. Third, in relation to the introduction of disclosure requirements for private sector assets as a new eligibility criterion or as a basis for a differentiated treatment for collateral and asset purchases.[66] Fourth, in risk assessment capabilities, by conducting climate stress tests of the Eurosystem balance sheet. Fifth, in the valuation and risk control frameworks for assets mobilised as collateral by counterparties for Eurosystem credit operations. And lastly, in the corporate sector purchase programme, by incorporating climate change criteria, in line with its mandate, in the framework guiding the allocation of corporate bond purchases and by disclosing climate-related information from 2023 Q1.

6.2 Financial stability

The banking sector is chiefly exposed to the risks posed by climate change and the green transition through lending to productive activities.[67] For example, the physical risks linked to extreme weather events could adversely impact the quality of a portion of bank loans, as such events would foreseeably undermine real estate collateral values and business productivity in the geographical areas affected.[68] In addition, the taxes and subsidies introduced by public authorities to provide for the energy transition may also influence borrowers' profitability and liquidity and, as a result, their capacity to meet their financial commitments with credit institutions.

One possible way to estimate the extent of the banking sector's exposure to transition risks is to analyse the distribution of lending to firms according to their emission intensity. According to this approach, firms belonging to sectors with higher emission levels accounted for close to 17% of credit exposures

65 See ECB press release, "ECB presents action plan to include climate change considerations in its monetary policy strategy", of 8 July 2021.

66 See ECB press release, "ECB to accept sustainability-linked bonds as collateral", of 22 September 2020.

67 The institutional and academic literature analysing this exposure is broad. See, for example, BCBS (2021a), Financial Stability Board (2021), Hansen (2022) and Roncoroni et al. (2021).

68 In principle, the insurance sector and, where appropriate, the public frameworks for tackling natural catastrophes would make it possible to mitigate the impact of these physical risks, preventing their concentration in sectors and specific geographical areas. However, the global scope and scale of these risks will likely entail mutualisation costs that are too high to be fully covered through such insurance mechanisms.

to productive activities in Spain in 2018. This proportion was slightly lower than the euro area average (see Chart 4.16.1). Furthermore, an experimental indicator developed by the Banco de España that seeks to quantify the carbon footprint intensity[69] of Spanish credit institutions' portfolio of loans to resident firms suggests that this footprint has shrunk significantly in recent years (see Chart 4.16.2). This is consistent with the declining emission intensity of the total Spanish economy during this period (see Section 3.1), but also with a slight restructuring of Spanish credit institutions' loan portfolio towards less polluting industries (see Chart 4.16.3).

There are also different approaches for assessing the banking sector's exposure to the physical risks posed by climate change, although such evaluations are as yet very preliminary. One such approach has been proposed by the ECB as part of the climate stress test[70] developed in 2021, in which it assessed, inter alia, the impact of physical risks on European banks on the basis of their geographical location and portfolio composition. However, the estimation of the banking sector's sensitivity to physical risks in this exercise should be regarded as an initial tentative approach. Specifically, there are doubts as to the relative impact assigned to the different types of physical risks associated with climate change. Examples include that assigned to the risk of wildfires and growing desertification, which would affect southern European countries more, compared with the risk of greater floods, which would have a larger impact on some central and northern European countries.

In any event, the empirical evidence available for Spain confirms the adverse impact of physical risks on business activities. Specifically, a recent Banco de España study[71] suggests that firms affected by a wildfire in Spain suffer reductions in their credit balance and employment (see Chart 4.17). However, the real effects of this adverse shock are lower for those firms domiciled in locations where local banks operate as, on account of their exposure or the greater data available, they can help limit the negative effects of the materialisation of such physical risk. In addition, local banks' greater exposure to the areas affected would not be accompanied by an increase in the default rate of new loans, as this would be similar to that observed in non-local banks.

The physical and transition risks faced by credit institutions may pose a threat to financial stability, requiring a resolute response from central banks. Besides the various supervision and regulation initiatives that can be deployed by central banks (see Section 6.3), the climate stress tests these institutions are developing are a key tool for the early detection of the possible adverse effects of climate change

69 The carbon footprint of a given sector reflects the volume of GHG emissions generated both through its own direct activity and through the production of the inputs it uses, including energy. It may be expressed as an absolute value or by unit of output.

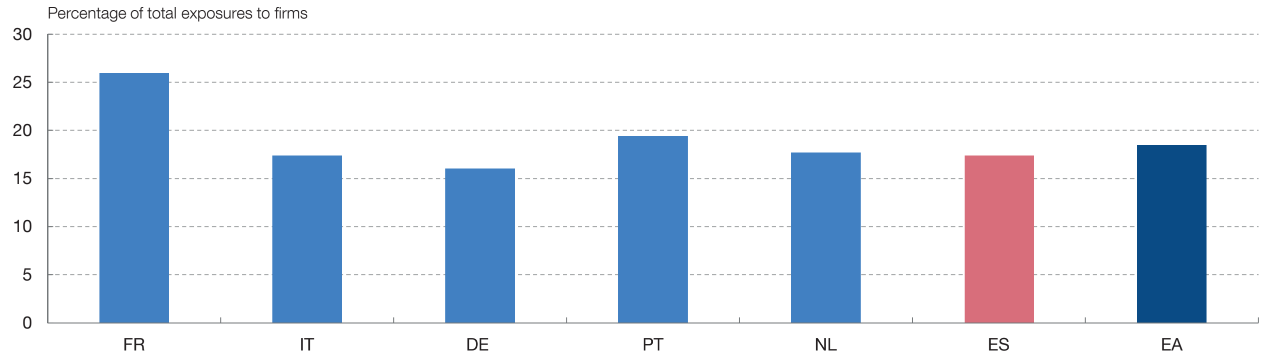
70 See Alogoskoufis et al. (2021b).

71 See Álvarez et al. (2022).

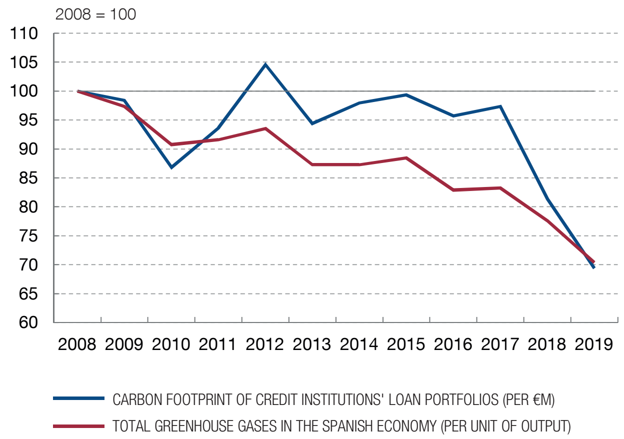
Chart 4.16
THE SPANISH BANKING SECTOR'S EXPOSURE TO CLIMATE-RELATED TRANSITION RISKS

Firms belonging to sectors with higher emission levels accounted for close to 17% of credit exposures to productive activities in Spain in 2018. This proportion was slightly lower than the euro area average. The carbon footprint intensity of Spanish credit institutions' loan portfolio has shrunk significantly in recent years, consistent with the declining GHG emission intensity in the total Spanish economy, but also with a slight restructuring of Spanish credit institutions' loan portfolio towards less polluting industries.

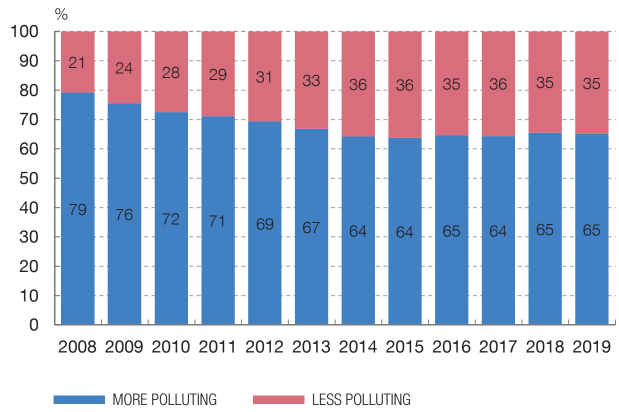
1 BANKS' EXPOSURES TO VERY HIGH EMITTERS BY COUNTRY IN 2018 (a)



2 CARBON FOOTPRINT OF SPANISH CREDIT INSTITUTIONS' LOAN PORTFOLIO (b)



3 STRUCTURE OF SPANISH CREDIT INSTITUTIONS' PORTFOLIO OF LOANS TO PRODUCTIVE ACTIVITIES ACCORDING TO EMISSION INTENSITY (c)



SOURCES: ECB, INE and Banco de España.

a Share of exposures to very high emitters published in the ECB economy-wide climate stress test (September 2021). Exposures to very high emitters are those linked to firms whose emissions are above the 90th percentile of the distribution of emitting firms to which the banks are exposed. They include direct emissions (Scope 1), indirect emissions related to energy consumption (Scope 2) and other indirect emissions broadly related to transportation (Scope 3).
b This indicator represents the weighted average of (direct and indirect) emission ratios per unit of output of the productive activities according to the relative weight of each industry in the stock of loans extended by Spanish credit institutions.
c Industries are classified as more or less polluting on the basis of their emission intensity (2008-2019 average), such that those whose emission ratios exceed the median of the 64 industries analysed are classified as more polluting.

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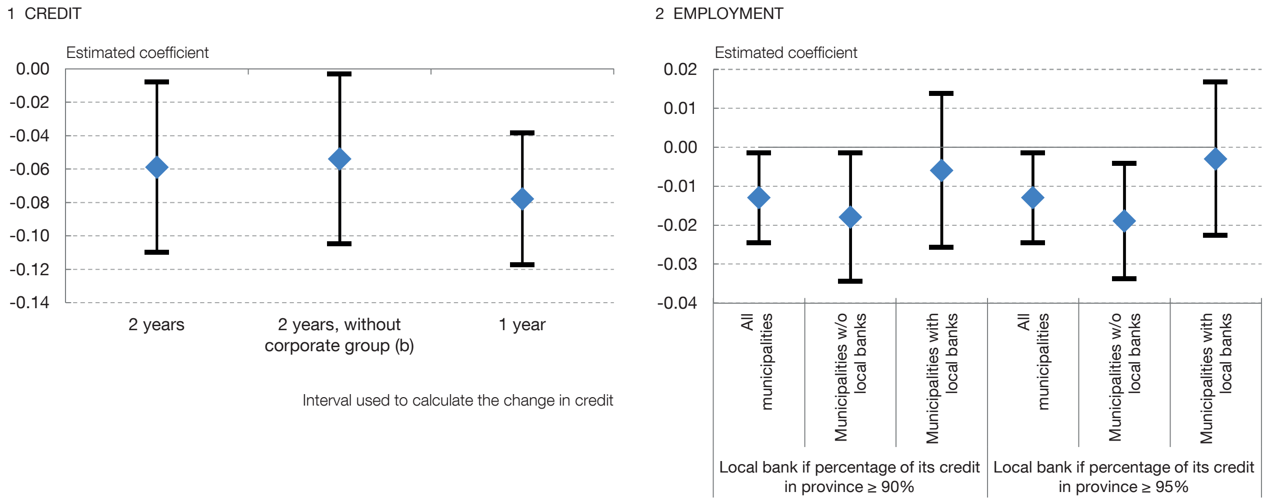
and the green transition on banking sector profitability and solvency. These tools are especially useful given their forward-looking nature, flexibility and ability to incorporate multiple scenarios, enabling them to capture much of the uncertainty associated with the ongoing structural change. In any event, numerous aspects of these instruments still need to be enhanced over the coming quarters. For example, a more detailed microsectoral breakdown should be introduced, as their structure is

Chart 4.17

EFFECT OF WILDFIRES ON CHANGE IN CREDIT AND EMPLOYMENT OF SPANISH FIRMS (a)

Firms affected by a wildfire suffer reductions in their credit balance and employment. The real effects are mitigated for those firms domiciled in municipalities where local banks operate as, on account of their exposure or information, they could limit the effects of the materialisation of physical risks.



SOURCE: Álvarez et al. (2022).

a Including wildfires with a burned area of 500 hectares or more in Spain between 2004 and 2017. Firms include those located less than 10 km and those between 20 km and 40 km from a wildfire. A firm is considered to be affected if it is less than 10 km from a wildfire. The bands represent the 90% confidence interval.

b The sample excludes firms belonging to a corporate group.

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still very much centred on assessing aggregate macro-financial scenarios. The projection period of the exercises should also be adapted to the long-term horizons associated with the green transition, which will also require incorporating dynamic responses from economic agents to technological progress, changes in consumer preferences and the restructuring of the productive system, among other factors.

The Banco de España’s top-down analysis shows that climate risks will have a moderate impact on the Spanish banking sector in the short term. This exercise,[72] which draws on the Forward Looking Exercise on Spanish Banks (FLESB) in-house stress-testing framework, analyses the impact on Spanish credit institutions of different policies to raise CO_2 emission allowance prices. Specifically, it quantifies their impact on the GVA of the main sectors of activity of the Spanish economy and estimates their pass-through to probabilities of default, differentiated by sector. The results of this exercise suggest that, on average, the impact of these policies on the quality of loans to firms would be moderate, although it would be greater in the case of the sectors of activity with higher emissions. The preliminary analysis also indicates that, if the physical risks associated with climate change were to materialise

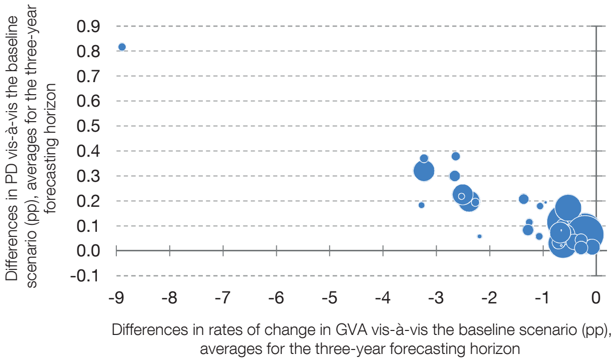
72 See Ferrer et al. (2021).

Chart 4.18

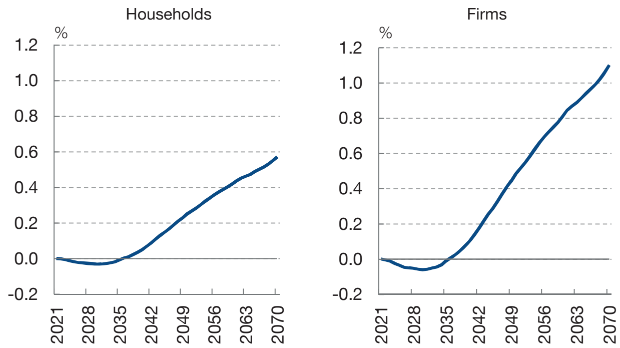
THE IMPACT OF CLIMATE RISKS ON THE QUALITY OF LOANS TO FIRMS IS UNEVEN ACROSS SECTORS, AND THE LONG-TERM DETERIORATION OWING TO THE MATERIALISATION OF PHYSICAL RISKS IS EXPECTED TO BE GREATER THAN THAT DUE TO TRANSITION RISKS

Raising CO_2 emission allowance prices would have a highly heterogeneous impact on the level of activity and probability of default (PD) of Spanish firms, depending on the level of their emissions and the type of policy implemented. The severest impacts would be concentrated in a small group of sectors, which would limit the final effect on bank profitability and solvency. The preliminary analysis also indicates that, if the physical risks associated with climate change were to materialise forcefully, there would be substantial long-term increases in households' and firms' probabilities of default. In the case of firms, the increases would be much sharper than those estimated at the outset of an orderly transition towards a more sustainable production model.

1 SHORT-TERM IMPACT ON PD AND GVA OF TRANSITION RISKS. FIRMS IN SPAIN (a) (b)



2 DIFFERENCES IN PD (c)



SOURCE: Banco de España.

a The severest scenario considers the combined effect of an increase in emission prices and the extension of ETS coverage to all business sectors and also to households.

b Each dot on the chart represents a sector. PD represents the probability that firms do not meet their financial commitments with banks. PDs are estimated over the projection horizon for each bank, but the difference in each sector's weighted average is depicted. Weighting is by number of borrowers. The size of the bubbles indicates the share of the sector's exposure in total credit exposures in Spain.

c The chart depicts, for each portfolio (households and firms) and each year, the difference in expected PD under two different scenarios: one in which physical risks materialise forcefully (hot house scenario) and another which envisages an orderly transition towards a sustainable energy model. The projections to 2070 are obtained by sequentially applying an autoregressive model that relates PDs and GDP growth. The GDP growth trajectories derive from scenarios drawn up by the NGFS.

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forcefully, there would be substantial long-term increases in households' and firms' probabilities of default. In the case of firms, the increases would be much sharper than those estimated at the outset of an orderly transition towards a more sustainable production model (see Chart 4.18).

6.3 Regulation and prudential supervision

In the area of regulation and prudential supervision, work is under way so that credit institutions are ready to identify, measure, manage and properly report on the financial risks posed by climate change and thus contribute to the green transition. This work notably includes the preparation of guidelines and supervisory expectations on how credit institutions should consider the risks posed by climate change and environmental degradation in their daily operations, business strategies, risk management, accounting and market communications. In Europe, the relevant recommendations have been issued by both the European Banking Authority (EBA) and by the Banco de España and the ECB.[73]

As regards disclosures, the initiatives being carried out at both the global and the European level notably include the EBA's publication of the standards on disclosures on environmental, social and governance (ESG) risks in January 2022.[74] These standards provide the basis for publication by the European banking sector of comparable quantitative information on how climate change risks affect their balance sheets. This information will include the so-called green asset ratio, which identifies the share of institutions' green assets – as defined in the European taxonomy – in their total assets. Furthermore, at the global level, in November 2021 the Basel Committee on Banking Supervision (BCBS) welcomed the establishment of the International Sustainability Standards Board (ISSB)[75] to develop global standards for sustainability reporting and announced that it was exploring the use of the Pillar 3 framework[76] to establish a common disclosure baseline for climate-related financial risks.

Owing to their novelty and the existing data gaps, ESG risk disclosures will pose a challenge and call for a great effort from the banking sector. But they will also be a key tool for making headway in the green transition. Considering the adaptation costs involved, the EBA has introduced certain transitional features in the standards. In any event, disclosing this information to the market will encourage institutions to move towards a sustainable economy and improve the measurement and management of the associated risks. According to a recent Banco de España paper,[77] which applies text mining techniques to the Pillar 3 reports for 2019 and 2020 of most of the significant banks directly supervised by the ECB, the level of detail on ESG risks included in these reports remains relatively low (see Chart 4.19). Nevertheless, the paper revealed that the degree of such disclosures increased between 2019 and 2020, particularly so among the smallest institutions (i.e. those with assets of less than €30 billion).

From a prudential standpoint, it is essential that higher capital requirements be maintained for the riskiest assets. This principle should also govern the adaptation of the regulatory framework to incorporate climate risks; that is to say, assets should be treated on the basis of their risk, with other economic policy considerations left to another type of public intervention.

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73 See EBA (2021), Banco de España (2020) and ECB (2020). At the global level, see the consultation in BCBS (2021c) on the principles for the effective management and supervision of climate-related financial risks and the previous report in BCBS (2021b) on the measurement of such risks.

74 See EBA (2022).

75 See International Financial Reporting Standards Foundation (2021).

76 The Basel regulations are based on three pillars: Pillar 1 (minimum capital requirements), Pillar 2 (supervisory review process) and Pillar 3 (market discipline through prudential disclosures).

77 See Moreno and Caminero (2022).

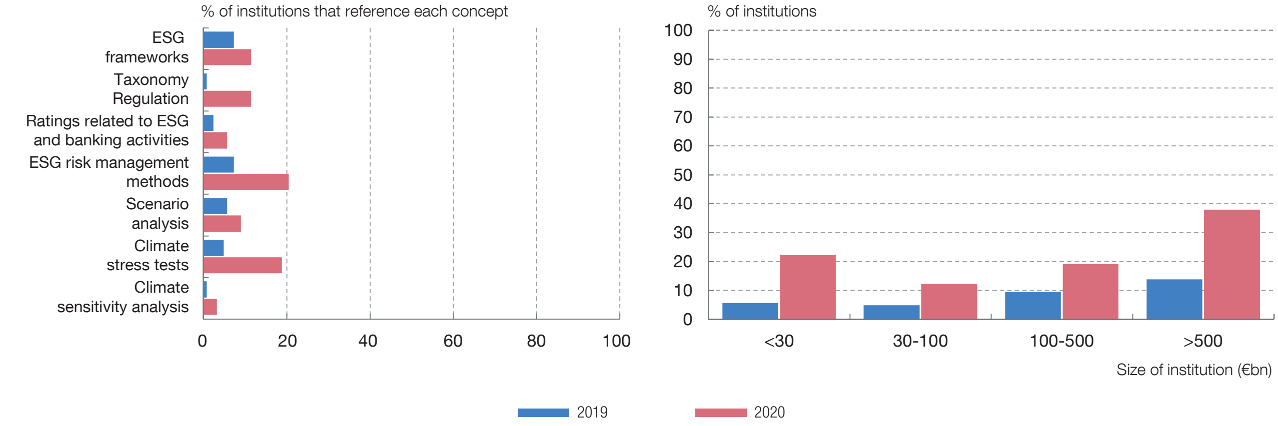
Chart 4.19

REFERENCES TO ESG RISKS IN EUROPEAN BANKS' REPORTS

The level of detail on environmental, social and governance (ESG) risks included in the Pillar 3 reports for 2019 and 2020 of most of the significant banks directly supervised by the ECB remains relatively low. Nevertheless, the degree of such disclosures increased between 2019 and 2020, particularly so among the smallest institutions (i.e. those with assets of less than €30 billion).

1 INSTITUTIONS REFERENCING CONCEPTS RELATED TO ESG FRAMEWORKS AND ESG RISK MANAGEMENT METHODS

2 INSTITUTIONS REFERENCING CONCEPTS RELATED TO ESG FRAMEWORKS AND ESG RISK MANAGEMENT METHODS BY SIZE



SOURCE: Moreno and Caminero (2022).

In terms of the microprudential regulation on capital requirements, there are numerous European and global initiatives for properly taking into account climate and environmental risks. In the banking reform package published in late 2021,[78] the European Commission has explicitly incorporated sustainability into Pillar 2 of the prudential regulations. By 2023, the EBA will also assess whether a dedicated prudential treatment of exposures associated with environmental and/or social objectives (as a component of Pillar 1 capital requirements) is needed. In this respect, it should be noted that the way in which Pillar 1 could potentially be adapted to incorporate these considerations is not clear because, among other reasons, an adequate historical calibration is not available for an event such as climate change, as it represents a profound structural break. For its part, the BCBS, whose work is still in an incipient stage, is also assessing whether the capital requirements framework for institutions correctly captures climate-related physical and transition risks.

Turning to macroprudential regulation, since climate change has a global scope, consideration must be given to its impact on systemic risk and the possibility of activating macroprudential tools to prevent and mitigate it. For instance, taking into account the extraordinary uncertainty surrounding the economic impact of climate change, a progressive increase in macroprudential capital buffer requirements might be considered. More restrictive measures, such as limits on concentration in certain

78 See European Commission (2021d).

sectors, could also be considered at a later date, depending on how public policies, the climate change process itself and the banking sector's exposures evolve. In any event, it should be borne in mind that any measures that are implemented should not hinder the financing of the large and sustained investments that will be needed for the transition towards a low-emission economy. Against this backdrop, in July 2021 the European Commission requested technical advice from the EBA, the ECB and the European Systemic Risk Board on the review of the macroprudential toolkit.[79] Among the questions raised by the European Commission was whether the macroprudential tools are appropriate to prevent and mitigate financial stability risks due to climate change.

Against this overall background, the ECB has considered a gradual approach to supervising the climate risks for the banking sector, centring its initial assessment on compliance with the supervisory expectations relating to organisational and methodological matters, where it has already detected some shortcomings. In 2021 the ECB indicated that credit institutions had made some progress in adapting their banking practices, with greater steps being taken in respect of transition risks.[80] In 2022 Q1 however, the ECB found that none of the Single Supervisory Mechanism (SSM) banks fully met its expectations. Further, it found that the institutions had made moderate progress in the disclosure of information since the preliminary assessment in 2020 and that there were significant gaps in how they measure the risks and the related impact on their business.[81] This new assessment will be complemented by the results obtained in the bottom-up climate risk stress test to be executed at the European level in 2022 H1.[82]

The Banco de España has also begun to assess the degree to which the institutions under its direct supervision are aligned with the supervisory expectations issued in October 2020. The approach used to inspect their climate and environment risk management is similar to that defined by the ECB, but applying the principle of proportionality to smaller and less complex institutions. The progress they have made and any potential obstacles identified will be gauged in 2022, which may prompt an update to the supervisory expectations.

6.4 Own portfolios

Central banks can also contribute to the green transition by incorporating sustainability criteria in their own investment portfolios.[83] At the global level,

79 See European Commission (2021b).

80 See ECB (2021).

81 See ECB press release, "Banks must get better at disclosing climate risks, ECB assessment shows", of 14 March 2022.

82 This exercise is geared towards assessing how prepared credit institutions are for dealing with the economic and financial shocks stemming from physical and transition risks. See ECB (2022). Unlike the top-down stress tests analysed in Section 6.2, a bottom-up stress test is conducted by the banks themselves, using their internal models and databases, albeit under the methodological guidelines provided by the supervisor.

83 See González (2021b).

the NGFS is channelling much of the work being carried out to this end by the world's central banks.[84] Further, in February 2021 the 19 euro area countries and the ECB agreed on a common stance for applying climate change-related sustainable and responsible investment principles in euro-denominated non-monetary policy portfolios.[85] In parallel, they undertook to start making climate-related disclosures for these portfolios within the following two years.

The Banco de España has also adopted the Eurosystem's recent common stance, having already applied sustainability and responsibility criteria in its investment policy for its own portfolios since 2019.[86] As part of this strategy, the Banco de España has direct green bond investments in different currencies and participates in two US dollar and euro-denominated investment funds launched by the Bank for International Settlements (BIS) for this type of asset.

7 Conclusions

From a scientific perspective, there is a broad consensus that global warming poses an extraordinary risk to our planet and that GHG emissions must be significantly reduced over the coming years. In addition, from the European and Spanish standpoint, Russia's recent invasion of Ukraine and the associated present and future geopolitical tensions also appear to advise accelerating the reduction in Europe's high reliance on fossil fuels.

From an economic perspective, there is still considerable uncertainty as to the scale of the potential impacts stemming from the various physical and transition risks associated with the fight against global warming. In any event, it seems evident that, in such an uncertain environment, the economic policies rolled out to facilitate and accelerate the green transition should be clear and internationally coordinated and provide certainty and a stable operational framework for economic agents.

The key levers for driving the green transition, both in Spain and internationally, should be green taxation, government investment and the regulation of economic activity. Bearing in mind that the physical and transition risks linked to global warming may have a stronger impact on precisely some of the most vulnerable households and firms, it is essential that these public policies focus particularly on temporarily mitigating the greater short-term adverse impact of climate change on such groups. The advisability of deploying this type of compensatory measures

84 See NGFS (2019 and 2020a).

85 See ECB press release, "Eurosystem agrees on common stance for climate change-related sustainable investments in non-monetary policy portfolios", of 4 February 2021.

86 See Banco de España press release, "The Banco de España adopts the Eurosystem's common stance for sustainable investment", of 4 February 2021, and Banco de España (2021).

is warranted not only by questions of equity, but also by the need to ensure a sufficient social consensus in order to efficiently undertake the necessary green transition.

In the current setting, a continuous and rigorous assessment of public policies is now needed more than ever. While all economic policy should generally be submitted to a rigorous assessment, it is even more relevant in the realm of climate change. Specifically, extraordinary uncertainty surrounds not only the climate risks to be faced, as well as their economic impact, but also the effectiveness and implications of many of the relatively new economic policy measures that are being rolled out to address them. It is only through a continuous and rigorous assessment of these initiatives that an efficient green transition, with no undesired effects or wastage of public and private funds, can be guaranteed.

If the public policies and climate risks are to be properly evaluated, the volume and quality of the data available must be increased. Having more high-quality environmental information that is harmonised across countries, sectors and firms is vital if the public policies that will pave the way for the green transition are to be designed correctly. Yet it is also essential for the financial system, to enable investors, credit institutions and central banks to adequately assess both their exposure and that of other economic agents to the different climate-related physical and transition risks. In this respect, despite the numerous initiatives deployed in recent years to increase the quantity and quality of the climate exposure information that is compiled and disseminated, much work remains to be done. From the standpoint of central banks in general and of the ECB and the Banco de España in particular, one priority at present and in the more immediate future is to make headway, within the financial system, in incorporating climate considerations into the operating frameworks of monetary policy, financial stability, supervision and regulation.

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GLOSSARY OF CLIMATE ACRONYMS

CATS CArbon Tax Sectorial model

CBPS Greening our Corporate Bond Purchase Scheme

COP 21 21st United Nations Climate Change Conference

COP 26 26th United Nations Climate Change Conference

CSRD Corporate Sustainability Reporting Directive

EBAE *Encuesta del Banco de España sobre la Actividad Empresarial* (Banco de España Business Activity Survey)

EFRAG European Financial Reporting Advisory Group

ESG Environmental, Social and Governance

ETS Emissions Trading System

EU-ETS EU Emissions Trading System

FLESB Forward Looking Exercise on Spanish Banks

GHG Greenhouse gases

IPCC Intergovernmental Panel on Climate Change

ISSB International Sustainability Standards Board

NDC Nationally Determined Contributions

NECP National Energy and Climate Plan

NGFS Network for Greening the Financial System

PNACC National Plan for Adapting to Climate Change

RTRP Recovery, Transformation and Resilience Plan

SFDR Sustainable Finance Disclosure Regulation

UNEPFI United Nations Environment Programme Finance Initiative