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Policies to Achieve Spain's Climate Objectives

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IMF Selected Issues Papers are prepared by IMF staff as background documentation for periodic consultations with member countries. It is based on the information available at the time it was completed on May 16, 2025. This paper is also published separately as IMF Country Report No 25/122.

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Policies to Achieve Spain's Climate Objectives
Prepared by Damien Capelle, Divya Kirti, Ana Lariau, Nicola Pierri, Ippei Shibata, and Germán Villegas-Bauer*

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ABSTRACT: Spain aims to cut greenhouse gas emissions, which implies further 30 percent cut from 2023 levels by 2030, requiring new measures beyond current efforts. Emission intensity varies widely across Spanish firms, offering potential for reductions by incentivizing laggards to match less-polluting peers. Relying mainly on public spending, like subsidies or investments, would be costly and insufficient. Carbon pricing is the most effective, cost-efficient, and fiscally attractive option, especially given Spain's limited fiscal space. The ongoing EU-ETS expansion could be complemented with domestic actions to enhance carbon pricing's role.

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SELECTED ISSUES PAPERS

Policies to Achieve Spain’s Climate Objective

Spain

Prepared by Damien Capelle, Divya Kirti, Ana Lariau, Nicola Pierri, Ippei Shibata, and Germán Villegas-Bauer[1]

[1] “The author(s) would like to thank” footnote, as applicable.

POLICIES TO ACHIEVE SPAIN'S CLIMATE OBJECTIVES

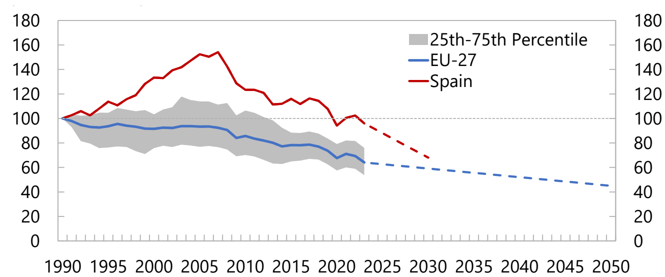
Spain has set up an ambitious goal of cutting its greenhouse gas emissions, which would imply a further cut of about 30 percent (vis-à-vis the 2023 level) by 2030. This will require new measures over and above the efforts already made. Wide heterogeneity in emission intensity across Spanish firms offers scope for further reductions in emissions through incentivizing convergence of laggards toward less-polluting peers. Doing so by relying predominantly on public spending—such as subsidies to upgrade capital or public investment—would be very costly and on its own insufficient to meet the new target. A predominant role of carbon pricing is the most effective, cost-effective and fiscally attractive option, even more so given Spain's limited fiscal space. The ongoing EU-ETS expansion could be supplemented with domestic actions to strengthen the role of carbon pricing.

A. Introduction

1. Spain significantly reduced its greenhouse gas (GhG) emissions in the past 15 years, but a further 30 percent cut will be needed to achieve the government's new, ambitious climate objectives. The government's updated 2023-2030 National Energy and Climate Plan (NECP) raised Spain's 2030 GhG-emission-reduction target from 49 to 55 percent vis-à-vis the 2005 level, and from 23 to 32 relative to the 1990 level. Despite Spain's pace of emission reduction being steady since the mid-2000s, its emissions were only slightly below 1990 levels in 2023, while those in EU-27 were already 36 percent below (Figure 1). Since 1990, the overall slower pace of emission reduction in Spain reflected improvements in both the energy intensity of economic activity (energy consumption per unit of GDP) and the emission intensity of energy (emissions per unit of energy), which have been broadly offset by the growth in population and income per capita (see details in 2022 Selected Issues). Electricity generation is the sector that has achieved the largest reduction in GhG emissions in Spain, fueled by a sharp rise in the share of renewables (reaching over 56 percent in 2024). This resulted in lower electricity costs in Spain relative to many other EU countries. By contrast, several other sectors such as agriculture and waste management have been lagging behind.

Figure 1. GhG Total Emissions

(Index 1990=100)



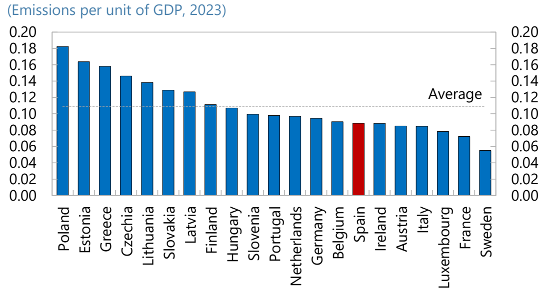
Sources: European Environment Agency (EEA) , Spain National Energy and Climate Plan, and IMF calculations.

Notes: The shaded area corresponds to the interquartile range of GhG emissions (index) within the 27 EU member countries. The last year of actual data is 2022. The numbers for 2023 are based on forecasts produced by the EEA. The numbers from 2024 onward are based on linear projections between the end-2023 values and the GhG emissions consistent with the commited emission-reduction targets set by Spain and EU-27, respectively.

2. While Spain's aggregate GhG emission intensity is broadly in line with its European peers, firms' emission intensities within industries are more heterogeneous in Spain than in France and Germany. Despite being the fifth largest GhG emitter in Europe, Spain's aggregate GhG emission intensity (measured as emissions per unit of output) is below the European average, and broadly in line with Germany, Italy and France (Figure 2, Panel A). Looking at the firm level, Spanish firms' emission intensity (measured as emissions over revenue) within industries is also broadly similar to that of their French, German and Italian counterparts on average, but it is more heterogeneous (Figure 2, Panel B). Spanish firms at the 90th percentile of the distribution of emission intensity within their industry emit 8 times more per unit of revenue than firms at the 10th percentile of the distribution, versus a multiple of 6 in France and 5 in Germany and Italy.

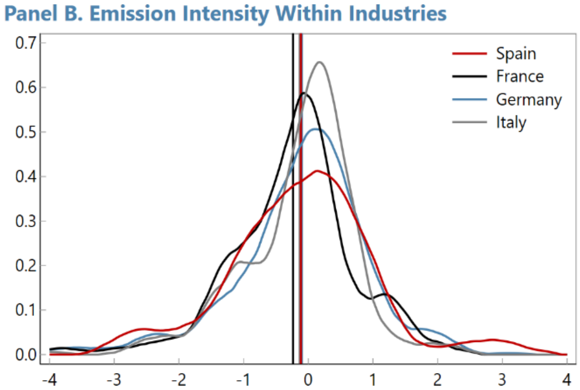
Figure 2. Emission Intensity

Panel A. Aggregate GhG Emission Intensity
(Emissions per unit of GDP, 2023)



Sources: OECD Air Emissions Accounts, IMF World Economic Outlook, and IMF staff calculations.
Note: Emissions are measured in kilograms of CO2 equivalent and output in PPP 2021 international dollars.

Panel B. Emission Intensity Within Industries



Sources: Capelle and others (2024) and IMF staff calculations.

Notes: Panel B plots the kernel densities of the log of emissions intensity (measured as emissions over revenues), separately for Spain, France, Germany, and Italy, after controlling for industry × year fixed effects. The 4-digit SIC industry classification is used. Vertical lines denote means. Firms in the following sectors are excluded: (1) finance, insurance, and real estate; (2) public administration; (3) railroad transportation and local and interurban passenger transit; (4) pipelines except natural gas; and (5) electric, gas, and sanitary services.

3. This paper analyzes the factors underlying the differences in emission intensity across firms in Spain and the impact of policies to encourage emission reduction. Section B explores the drivers of firm-level emission heterogeneity and the implications for economy-wide emissions of lagging firms catching up with top performers. Section C examines the fiscal and economic impact of different climate mitigation policies using counterfactual simulations based on a multi-sector heterogeneous-firm general equilibrium model. Section D discusses policy implications and concludes.[1]

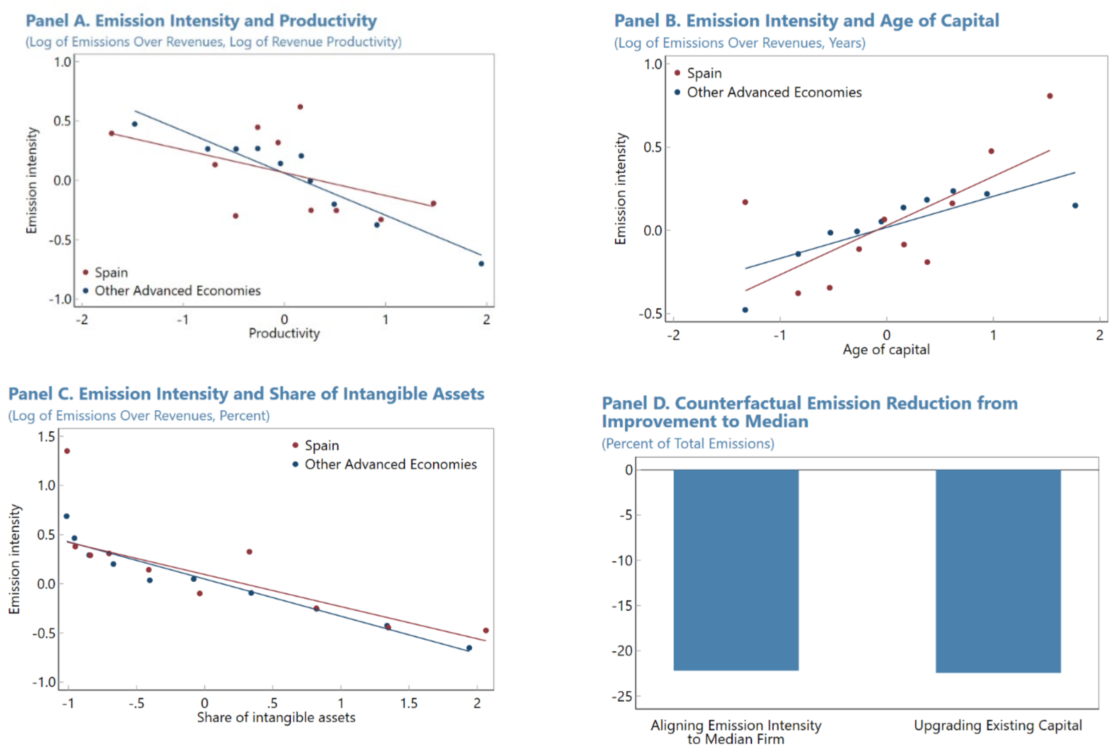
[1] Sections B and C build upon Capelle and others (2024).

B. Firm-Level Emission Heterogeneity

Data

4. **The paper combines firm-level data on emissions, balance sheets, and income statements for 3,209 listed firms in advanced economies, including 48 Spanish ones over 2010-2023.** Data on annual self-reported emissions at the firm level is from ICE Data Services. The focus is on CO2 equivalent (CO1eq) scope 1 (direct) and scope 2 (indirect emissions from purchased energy) emissions. Data on balance sheet and income statements is from S&P Compustat Global. As market incentives are central to the analysis of climate mitigation policies, we exclude sectors in which firms' investment decisions are primarily influenced by direct public interventions and ownership rather than market forces.[2]

Figure 3. Emission Intensity and Firms' Characteristics



Sources: Capelle and others (2024) and IMF staff calculations.
Notes: Variables in Panels A-C are standardized to have a zero mean and a standard deviation of one. The figure in Panel D illustrates counterfactual reductions in total emissions of Spanish firms in the sample if: (i) every firm with emission intensity above the 50th percentile of the emission intensity distribution within the same industry × year group saw its emission intensity reduced to that value ("Aligning emission intensity on median firm"); and (ii) every firm had at most the same age of capital as the firm in the 50th percentile age of old capital ("Upgrading Existing Capital"), where the 50th percentile is defined for the sample of firms in France, Italy, Germany, and Spain combined. Only industry × year groups with at least 2 firms are included. The 4-digit SIC industry classification is used. Firms in the following sectors are excluded: (1) finance, insurance, and real estate; (2) public administration; (3) railroad transportation and local and interurban passenger transit; (4) pipelines except natural gas; and (5) electric, gas, and sanitary services.

[2] Specifically, the excluded sectors are finance, insurance, real state, public administration, utilities, railroad transportation, and local and interurban passenger transit sectors. If these sectors were not excluded, the number of Spanish and advance economy firms would be 74 and 4,300, respectively. Results based on the entire sample, without excluding any sectors, are summarized in Annex I.

Findings

5. Achieving emission intensity convergence of lagging Spanish firms toward best practice within their industry, including by upgrading their capital, could have a major impact on economy-wide emissions. Emission-intensive firms tend to be less productive, operate with outdated physical capital, have limited intangible capital, and exhibit weaker management practices (Figure 3, Panels A-C).[3] If lagging Spanish firms were able to lower their emission intensity to the 50th percentile of the distribution across Spanish, French, German, and Italian firms within their industry, economy-wide emissions could be reduced by approximately 22 percent—i.e., nearly 75 percent of the needed 30-percent reduction to achieve the 2030 target (Figure 3, Panel D). In practice, a sizeable fraction of this potential improvement in environmental performance could be achieved by upgrading existing capital to new less energy- or emission-intensive alternatives—a process that also tends to be accompanied by output and productivity gains. For instance, Spain's economy-wide emissions could also fall by about 22 percent if Spanish firms in the bottom 50 percent of the distribution of physical capital age (across Spanish, French, German, and Italian firms) upgraded it to the 50th percentile.[4] Thus, incentivizing lagging firms to catch up with top performers could substantially reduce emissions. However, these counterfactual exercises exogenously assign emission intensities or the age of capital from greener to browner firms, holding firms' output constant. They do not consider whether such outcomes are feasible, which policies can achieve such gains, and at what cost. These considerations are explored in Section C through the lens of a quantitative model.

C. Economic and Fiscal Impact of Climate Mitigation Policies

Model Specification and Calibration

6. To evaluate the economic effects of alternative emission reduction policies, a general equilibrium multi-sector model with heterogenous firms is developed and calibrated to match Spanish firm-level data. Full details on the model are provided in Capelle and others (2024). A key feature is that firms make input purchase and investment decisions that determine their carbon emissions. In the short run, firms can adjust their variable inputs to reduce energy consumption. In the medium term, they can invest in research to improve their overall energy efficiency and increase capital intensity to further optimize energy usage. Importantly, firms can upgrade to newer capital equipment, which cuts energy use and emissions. By matching firm-level data for a range of sectors

[3] Capelle and others (2024) show that these associations are robust to comparing firms within the same industry, country and year, and to additional robustness checks. Moreover, instrumental variable results suggest a causal relationship from the age of capital and technological investments on emission intensity.

[4] Specifically, this counterfactual exercise assumes that firms whose average physical capital age exceeds the median age (7.4 years) reduce it to the median age. The estimate of the age of capital parallels the perpetual inventory method for estimating the size of capital stocks. All past investments (after accounting for depreciation) are weighted by the number of years since the investment took place, and divided by the sum of past investments (after accounting for depreciation).

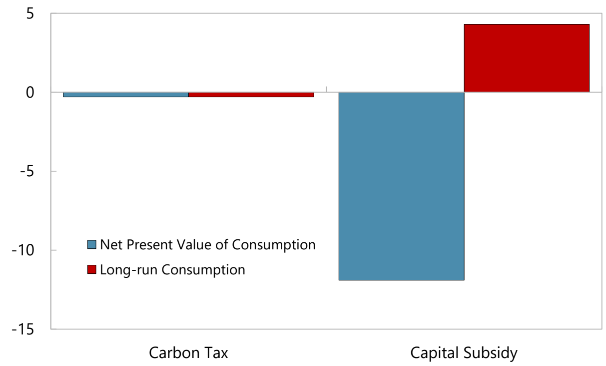
in Spain and allowing for scenario analysis, the model provides a deep analysis of the potential impact of emission reduction policies on macroeconomic outcomes and firm performance.

Figure 4. Economic Impact of Environmental Policy Changes

Panel A. Summary of Model Simulations

	Net Present Value of Consumption	Long-run Consumption	Fiscal Cost	Policy Instrument
	All values in % change of actual economy			
Carbon Tax	-0.3	-0.3	-0.4	$63.9
Capital Subsidy	-11.9	4.3	23.9	56.3%

Panel B. Impact of Environmental Policies on Consumption
(Percent relative to baseline in consumption)



Sources: Capelle and others (2024) and IMF staff calculations.
Notes: The model is calibrated to Spain and shows the economic impact of environmental policy changes through carbon taxes and capital susidies respectively to achieve a 15-percent reduction in GhG emissions. A 4-percent time discount factor is used to compute the net present value of consumption. Consumption values refer to the steady-state and are weighted averages across sectors, where the weights are the country-specific sector shares. The fiscal cost is the sum of the steady-state and transition net subsidies, annualized, and is in percent of steady-state GDP in the counterfactual economy.
The carbon tax is expressed in US dollars.

Counterfactual Simulation Results

7. **While subsidies for capital upgrades could help reduce GhG emissions, continued expansions in the scope and level of carbon pricing would achieve more ambitious targets at a lower economic and fiscal cost.** The model described above is used to simulate the impact of two alternative policy tools, namely higher carbon prices and larger subsidies to newer capital vintages, each calibrated to achieve a 15 percent emission reduction compared to baseline, which is approximately half of the needed emission reduction to meet Spain's 2030 target in its latest NECP. To achieve a 15 percent reduction in GhG emissions, the carbon price in this model would need to increase by about US$ 64 per ton of CO2eq above its baseline level, while capital subsidies would need to cover over 50 cents for every dollar a firm spends on upgrading capital, which would come at a large cost to the budget and current Spanish households' living standards (Figure 4, Panel A). Using a discount rate of 4 percent, the model-based analysis implies a net present value loss in consumption of over 10 percent from relying solely on capital subsidies, while the net present value cost from higher carbon pricing would be negligible (Figure 4). More broadly, for values of the discount rate greater than 1.5 percent, the short-term fiscal cost of capital subsidies outweighs their long-term benefits in terms of increased output and productivity.[5] Furthermore, achieving large emission cuts, such as Spain's NECP target for 2030 (a reduction of over 30 percent relative to the

[5] Because capital subsidies entail large upfront economic costs and long-term gains, their adverse impact on the net present value of consumption rises with the discount rate, i.e. it is larger the less value is placed on future consumption by households.

2023 level) through capital subsidies alone is found to be unfeasible altogether, making it even more critical to rely on carbon pricing.

Caveats

8. **The above analysis comes with several important caveats.** First, it assumes that the current energy mix of the electricity grid is fixed and does not account for the impact of policies aimed at greening it (Domínguez-Díaz and Hurtado, 2024). Instead, it focuses solely on firms' technological and input choices given the existing grid. The analysis does not incorporate intermediate inputs and input-output linkages across sectors, which have been shown to significantly influence the effectiveness and cost of mitigation policies (Veiga Duarte and others, 2025), nor does it explore the implications of different mitigation policies on firms' competitiveness—a concern that has motivated the use of multiple mitigation instruments beyond carbon pricing. At the same time, by ignoring carbon price revenue recycling the analysis likely underestimates the economic benefits of carbon pricing compared to subsidies. Carbon pricing revenues can be recycled in ways that reduce economic distortions (e.g., through labor tax cuts), thereby lowering overall economic costs. In contrast, subsidies often require financing mechanisms that increase economic distortions, raising their overall economic cost.

D. Conclusion

9. **In recent years, Spain has been moving toward achieving its 2030 climate targets through a mix of policy instruments that comprised investments, subsidies, and regulatory measures.** These efforts were fueled by the implementation of Spain's Recovery, Transformation and Resilience Plan, which had about 40 percent of the Next Generation EU (NGEU) funds devoted to green investments, including renovating the building stock to increase energy efficiency, making mobility and the transport sector more sustainable, increasing the share of renewables in the energy mix, addressing biodiversity challenges, and enhancing water and waste management.[6] To provide further incentives for decarbonization in sectors not included in the European Union Emissions Trading System (EU-ETS), in 2023 Spain introduced the so-called "white certificates", which are instruments issued to companies and organizations that implement projects leading to verifiable energy savings. These certificates can then be traded on the market, allowing companies that are required to meet certain energy-saving targets (e.g., gas and electricity marketing companies, wholesale petroleum product operators, and wholesale liquefied petroleum gas operators) to purchase the certificates from those who have achieved the required energy savings.

10. **Meeting Spain's new 2030 climate targets will require additional efforts, which should be centered around emission pricing mechanisms.** Expanding the scope and level of carbon pricing is the most cost-effective option to reduce GhG emissions, as it would allow to reach more

[6] The Recovery Transformation and Resilience Plan is a roadmap of structural reforms and investments, established as a requirement to access funds—in the form of grants and loans—from the Recovery and Resilience Facility. This is a temporary financing instrument that lies at the core of Next Generation EU, a plan put in place in 2021 to support Europe's recovery from the pandemic, making its economy greener, more digital and more resilient.

ambitious abatement targets at a lower economic and fiscal cost than other options, which would be critical in light of Spain's limited fiscal space and the end of NGEU funding in 2026. The ongoing expansion of the EU-ETS will play a critical role but, given that the impact of carbon pricing in EU-ETS2 sectors might take time to fully materialize and free allowances under EU-ETS1 will be phased out only gradually over 2027-34, complementary domestic actions are needed to meet Spain's 2030 emission goal.[7] Domestic policy options could include raising carbon taxation in the residential and road transport sectors, encouraging the adoption of a landfill tax by more autonomous communities to further discourage waste disposal, and providing price-based incentives to optimize the use of fertilizers in agriculture. Another option could be introducing feebates in the agriculture and livestock sector, which has been done recently in Denmark and could leverage on the advanced emissions monitoring system in livestock farms currently in place in Spain. Importantly, staff analysis in this paper also suggests that, by inducing firms to upgrade their capital stock, mitigation actions could help increase productivity over time, contributing to keep the economic cost of carbon pricing low.

11. Putting in place measures that mitigate the social impact of carbon pricing would improve its political acceptability. Despite its low overall economic cost, carbon pricing can entail significant distributive impacts across industries and households that can hamper its political and social acceptability. Such concerns can be mitigated by using some of the revenues to compensate the most vulnerable and cut distortionary taxes on households and firms, with the remainder to contribute to reduce Spain's fiscal deficits. The Social Climate Plan—financially supported by the EU Social Climate Fund—is a helpful EU-level step in this direction as it will fund compensatory measures that mitigate the impact of carbon pricing on vulnerable households, micro-enterprises and transport users. Such approach could be emulated when expanding the scope and level of green taxation in Spain more specifically.

[7] The expansion of EU-ETS primarily involves broadening its scope to cover emissions from the maritime transport sector under EU-ETS1 and introducing a new ETS2 that will apply a carbon price to emissions from fuel combustion in buildings and road transport starting from 2027.

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