BANCO DE ESPAÑA
Eurosistema

16.02.2024

The economic and financial implications of climate change

Club Última Hora - Cercle D'Economia de Mallorca

Palma de Mallorca

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1 Introduction

Ladies and gentlemen, let me begin by thanking Carmen Serra, Chair of the Serra Group, and José María Vicens, Chair of the Cercle d'Economia de Mallorca, for their kind invitation to speak at this conference at the Club Última Hora. I also wish to thank professor and Council Member of the Banco de España Carles Manera for helping to make this meeting possible.

We are here today to discuss one of the greatest challenges facing our society: climate change and the transition to a low-carbon economy.

From an economic standpoint, the consensus among researchers is that if we fail to significantly reduce greenhouse gas (GHG) emissions in the coming decades, the impact of the *physical risks* associated with global warming will be very significant. At the same time, the transition to a low-carbon economy also poses *transition risks* arising from the need to adapt the productive model.

In this setting it is imperative that public policies actively contribute to the green transition.

Governments, in particular, have a key role to play in this process. They have the necessary democratic legitimacy to define a roadmap and the best toolbox to achieve the proposed targets, especially through fiscal and regulatory policies.

But climate change and the transition to a low-carbon economy also pose a major challenge for central banks, as they could significantly affect both economic activity and price and financial stability.

In my address today I will first focus on illustrating how the materialisation of some of the physical risks associated with climate change could affect the economic and financial situation. I will then show how ambitious, timely, orderly and predictable mitigation policies are our best option to tackle climate change, not only from an environmental standpoint, but also from an economic one.

2 The economic implications of physical risks

The regular reports of the Intergovernmental Panel on Climate Change (IPCC) warn that, unless GHG emissions are significantly reduced, global warming will continue.[1] Numerous studies show that in the coming years global warming will cause, among other disruptive phenomena, a rise in sea levels, progressive soil desertification, an increase in the frequency and intensity of extreme weather events and a very significant loss of biodiversity.

Despite the uncertainty in quantifying the physical risks associated with climate change and their economic impact, the consensus is that the Iberian Peninsula will be particularly affected.

[1] IPCC. (2023). *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva, Switzerland.

By way of illustration, the exercises carried out by the Network for Greening the Financial System (NGFS)[2] indicate that Spain would suffer a substantial economic decline if these risks were to materialise in the coming decades (both those associated with chronic phenomena – higher temperatures, desertification and rising sea levels – and those associated with severe or extreme weather events such as floods, storms or wildfires).

These risks can materialise through various channels. They can affect the supply side of the economy by disrupting production processes, damaging physical capital, reducing productivity and increasing mortality. Meanwhile, demand would also be affected by the negative effects of climate events on wealth and uncertainty, which would affect the consumption and investment decisions of households and companies. These processes would also have an impact on financial stability, as they would entail adjustments in the financial position of households and firms and affect their ability to meet their payment commitments.

I will now summarise the results of various Banco de España papers that have examined some of the economic implications of several of the physical risks mentioned.

First, we studied the physical risks associated with rising temperatures. In particular, the Banco de España has analysed the macroeconomic and financial impact of **droughts and severe heatwaves** in Spain, since our country is particularly prone to these events.[3]

This exercise[4] shows that, in the year following a drought or a severe heatwave, there is a marked slowdown in economic growth and a rise in inflation, accompanied by a fall in housing prices.[5] In particular, the one-year impact on real GDP growth of this scenario would be as large as -1.3 percentage points (pp), and it would be accompanied by a decrease of 4.2% in house prices and a 1.5 pp rise in inflation with respect to the baseline scenario, in which the drought and heatwave episode does not occur.

In any event, the economic impact is heterogeneous by sector and mainly depends on each sector's exposure to weather conditions. The most affected sectors in terms of gross value added would be construction, mining and quarrying, forestry and fishing, and transport-related sectors.

The financial sector is highly exposed to climate change risks as it finances other sectors, including those exposed to extreme weather events or that are not necessarily

[2] Network for Greening the Financial System. (2023). "(Phase IV) Scenarios". https://www.ngfs.net/ngfs-scenarios-portal/

[3] AMCESFI. (2023). *Informe Bienal del Riesgo del Cambio Climático para el Sistema Financiero*. https://www.amcesfi.es/f/webwam/RCL/Publicaciones/archivos/AMCESFI_Informe_Cambio_Climatico_2023.pdf

[4] The drought and heatwave analysis is based on the corresponding scenario in the ECB 2022 Climate Stress Test. In turn, the ECB scenario was calibrated with the NGFS estimates of heat stress-related labour productivity shocks in the countries analysed up to 2050, assuming temperature paths consistent with a global temperature increase of 3 °C by the end of this century compared to pre-industrial levels.

[5] The drought considered in this scenario is associated with a 26.5% decrease in precipitation compared with the historical average, similar to that seen during the 2017 drought. However, its economic impact could be higher than in previous episodes, due to the possible non-linear effects of the 3 °C global warming at the end of this century considered in this scenario.

environmentally friendly. In fact, in the previous simulation, the negative impact on activity and house prices would also result in a slight reduction in banks' solvency ratios.

In particular, the materialisation of severe droughts and heatwaves would lead to a 0.2 pp reduction in the CET1 ratio of Spanish institutions. Most of this impact would persist over a three-year horizon. Bank capital consumption in this adverse scenario is mainly explained by higher impairment losses and lower net income generation, in line with lower economic activity.

The banking sector would probably react by deleveraging, which would mitigate part of the impact on solvency that I just mentioned, but exacerbate the macroeconomic impact. In any event, if droughts and heatwaves were to become recurrent, their negative impact on the solvency and profitability of the banking sector would be greater than the short-term effects identified in this analysis. Also, heatwaves and droughts can occur simultaneously in several countries, posing additional risks.

Second, we analysed the **risks of desertification**, defined as the process of land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Once again, Spain is one of the European countries most vulnerable to this phenomenon, as almost three quarters of its territory are drylands that are prone to desertification.[6]

Naturally, desertification can have substantial economic and financial consequences. Empirical evidence shows that its chronic nature can lead, for example, to out-migration from the affected areas, among other socio-economic changes. In turn, these effects could have an indirect impact on banks by affecting economic growth and, ultimately, borrowers' creditworthiness.[7]

For instance, in a forthcoming Banco de España working paper, Broto and Hubert (2024) analyse the extent to which the desertification process affects lending to Spanish non-financial corporations, in an initial attempt to gauge its impact on economic growth and employment.[8] The main explanatory variable in this research is an aridity index, which correlates positively with temperature and negatively with rainfall and which has deteriorated across almost the entire country in recent decades.

This deterioration nonetheless varies considerably from region to region. On the one hand, 20% of the Spanish territory classed as dry (sub-humid) in the 1970s is now considered semi-arid, i.e. it has become more arid. Meanwhile, the humid northern regions of the Iberian Peninsula have also become increasingly arid. On the other hand, certain areas in the vicinity of the Pyrenees or the Ebro Delta have lower aridity levels than was previously the case.

[6] See Ministerio para la Transición Ecológica y el Reto Demográfico. (2022). *Estrategia nacional de lucha contra la desertificación en España*.

[7] See Basel Committee on Banking Supervision (BCBS). (2021). *Climate-related risk drivers and their transmission channels*.

[8] To analyse this correlation, the authors draw on municipal-level granular data on aridity and from the Banco de España's Central Credit Register for the period between 1984 and 2019.

The key takeaways from this research into the correlation between lending to non-financial corporations and aridity are as follows.

First, greater aridity is associated with a lower volume of lending to non-financial corporations, particularly over longer time horizons. Specifically, a 1 pp increase in the aridity index is associated with a 20 basis point (bp) fall in the volume of long-term lending. Nonetheless, it takes between 10 and 15 years before this effect becomes statistically significant.

Second, the impact of aridity on lending varies by sector. Agriculture is without doubt the hardest hit, with lending to this sector falling by around 25 bp over a 20-year period after a 1 pp increase in the aridity index. Conversely, overall the Spanish tourism sector has proven relatively impervious to aridity, having managed to adapt to the effects of higher temperatures and less rainfall.

In any event, we should be wary of extrapolating these findings to the future, since adverse non-linear effects could emerge if the desertification process continues and certain aridity thresholds are breached.

Third, wildfires could also become increasingly commonplace as a result of climate change, triggering financial losses, for example via the cost of collateral and lending to the private sector. Indeed, recent years have seen an increase in both the frequency and the severity of wildfires,[9] with Spain among Europe's worst affected countries.[10] For instance, it accounted for around 40% of the EU land ravaged by forest fires in 2022.

A recent Banco de España paper[11] looks at how wildfires impact bank lending to affected firms. Specifically, such lending declines by around 6% compared with the credit extended to similar unaffected firms.

Moreover, the analysis reveals that, in a context of asymmetric information, local banks (i.e. those whose lending is concentrated in a particular province) play a pivotal role in mitigating the impact of fires on economic activity, using their superior qualitative data to lend to profitable firms affected by the fires.[12] As a result, it is found that, two years after a fire, employment falls by around 2% when there are no local banks operating in a fire-hit region, whereas it remains unchanged when local institutions take an active role in lending.

[9] See OECD (2023). "Taming Wildfires in the Context of Climate Change". OECD Publishing, Paris.

[10] See European Commission, Joint Research Centre, Hugo Costa, Daniele De Rigo, Giorgio Libertà, Tracy Houston Durrant and Jesús San-Miguel-Ayanz (2020). "European wildfire danger and vulnerability in a changing climate: towards integrating risk dimensions: JRC Peseta IV project: Task 9 - forest fires". Publications Office of the European Union.

[11] Álvarez-Román, Laura, Sergio Mayordomo, Carles Vergara-Alert and Xavier Vives (2024). "Climate Risk, Soft Information, and Credit Supply". Banco de España, Working Paper.

[12] Also, because local banks have better access to qualitative data, they can reduce their lending to firms to a lesser extent without incurring greater risk.

Fourth, flooding is another type of extreme weather event that can pose physical risks.

According to a granular analysis[13] conducted by the Banco de España, 1.3% of the residential properties used as mortgage collateral in Spain are located in areas at risk of flooding within the next 10 years. Over longer time horizons (50 and 500 years), this proportion rises to 2.7% and 7.7%, respectively.[14] Overall, this analysis therefore suggests that the banking sector's mortgage portfolio currently has limited exposure to flood risks.

However, the frequency of such events and the size of flood-prone areas could increase in the future if nothing is done to prevent climate change. In any event, further work is needed to improve the available databases and to continue researching, inter alia, the extent to which property appraisals already capture flood risks or if, alternatively, there is a risk that appraisal values might suddenly change were such events to occur, and the role of insurers.

Fifth, severe environmental degradation can also have adverse economic and financial impacts through various channels, including, again, the value of real estate collateral.

We already have evidence of these kinds of effects in Spain. A case in point is the Mar Menor, the largest salt-water lagoon in Europe, on the South-Eastern coast of Spain, in the region of Murcia. The Mar Menor is also a major tourist hotspot, with 7,500 beds in the surrounding area and annual visitor numbers historically exceeding the 200,000-mark.

However, since the 1960s the Mar Menor ecosystem has come under increasing strain with the growth of agriculture and tourism. This ecological degradation is primarily the result of the expansion of the agricultural sector and agri-food industry in the vicinity of the lagoon, particularly since the shift from dry-farming to irrigated crops (now accounting for more than 80% of the total area).

This deteriorated environment, combined with frequent climate change-related flooding and extreme temperatures in the region (as high as 47°C in August 2021), has been a key factor behind the changes in the nitrogen and phosphorus nutrient cycles, leading to eutrophication (i.e. an increase in biomass in a body of water), and the widespread growth of algal blooms in particular. This massive expansion of algae (dubbed the "green soup") meant that light can no longer reach the bottom of the lagoon. The plants on the lake bed die off, leading to an increase in decomposition caused by bacteria, which use up the available oxygen, thus killing the fish.

A Banco de España paper by Lamas et al. (2023)[15] shows that property prices in the surrounding areas took a sizeable hit once the locals realised the scale of the environmental damage in the Mar Menor. This realisation, which dawned some time after the actual

[13] See the 2023 Report on Climate Change Risks of the Spanish macroprudential authority (AMCESFI). This analysis is carried out by pooling data from the National Floodplain Mapping System, developed by the Ministry for Ecological Transition and Demographic Challenge (MITECO), the Land Registry and the Banco de España's Central Credit Register.

[14] There is no evidence to show that the loan-to-value (LTV) ratio is higher in areas at greater risk of flooding.

[15] "Impact of climate risk materialization and ecological deterioration on house prices in Mar Menor, Spain" (Matías Lamas, Mari Luz Lorenzo, Manuel Medina and Gabriel Pérez-Quirós). Scientific Reports 13, 11772 (2023).

damage had been done, was borne out by an increase in the number of negative tweets since 2015, as well as in the number of negative news reports on the Mar Menor.

The return on housing investment was 43 % lower in the surroundings of Mar Menor than in comparable neighbouring zones in the period 2015-2021, a period comprising six years after the moment in which the lagoon began to reflect the impact of the degradation of the ecosystem. This negative return differential represents a total loss in housing wealth of more than 4 billion euros, around ten times the gains from the very change from dry-farming to irrigated crops which made this ecosystem fragile in the first place.

As a result, the return on housing investment was 43% lower in the surroundings of the Mar Menor than in comparable neighbouring areas between 2015 and 2021, a six-year period after the moment in which the lagoon began to reflect the impact of the ecosystem's degradation. This negative return differential represents a total loss in housing wealth of more than €4 billion, around ten times the gains from the very change from dry-farming to irrigated crops which made this ecosystem fragile in the first place.

The authors also show that the median mortgage principal in the control area has risen by more than 40%, while remaining unchanged in the Mar Menor area, suggesting that banks have incorporated lower housing values into their lending decisions.

Also, the number of house purchases, which was similar in both areas prior to 2015, has almost doubled since in the control area relative to the area around the Mar Menor, reflecting the weaker performance of the latter's economy.

The analysis suggests that house buyers and property investors did not account for climate-related risks and their impact on the lagoon. It is only when these risks materialise and the public becomes aware of them that climate-sensitive assets, such as real estate, undergo a shift in prices

3 The economic implications of transition risks

According to the NGFS simulations that I mentioned at the beginning of my speech, **the implementation of policies to achieve an energy transition that would cut net CO_2 emissions to zero by 2050** – not only by means of strict climate policy, but also by boosting innovation – **would significantly reduce the economic costs associated with the extreme and chronic physical risks that we face if we do nothing.**

However, the transformation towards a low-carbon economy **may cause attendant transition risks to arise** as a result of mitigation initiatives that the authorities have already implemented and the need to adapt economic activity.

Ultimately, the world must reduce the use of fossil fuels and adopt cleaner technologies to cut GHG emissions. To do this, governments are taking measures to increase the implicit cost of GHG emissions by raising carbon prices – whether via carbon taxes or auctions of emissions allowances – and imposing regulatory standards that penalise the use of polluting (brown) technologies and/or bolstering public and private investment in green technologies.

In some cases, these actions can have adverse effects on households' purchasing power, firms' profitability, the stability of financial markets and government deficits. Furthermore, the uncertainty surrounding the scale and the speed of implementation of these public policies can negatively affect the decisions of economic agents.

The Banco de España has developed several macroeconomic models[16] to analyse these impacts. They are general equilibrium models with a highly granular sectoral structure that capture, in considerable detail, the use of different types of energy in production and consumption and in which GHG emissions occur as a result of energy use. These models have been used to simulate rising carbon prices, for example, and reveal the costs of the transition in terms of lower GDP, consumption and employment.

Nevertheless, it was also found that **properly designing measures to combat climate change can significantly reduce the scale of these transition risks and, in consequence, their macroeconomic impact.** For example, the adverse effect on households' purchasing power can be lessened if the revenue obtained via a carbon tax or auctions of emissions allowances is used to reduce other distortionary taxes.[17]

In any event, there is also evidence of potential harm to some sectors even with the use of policies aimed at avoiding substantial aggregate transition costs, such as in the case of the agriculture, fishing, transportation and energy sectors. It is worth noting that the sectors most affected are not only those directly affected by mitigation policies (such as those that currently fall under the EU's Emissions Trading System, e.g. paper production, or those that will do so under future expansions, e.g. shipping), but also those with strong ties to such sectors, e.g. the forestry, logging and publishing industries.

These findings show that 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 particularly vulnerable, among other reasons because such groups will be relatively harder hit by any increase in green taxes owing to their consumption and production patterns.

Using some of the tax revenue gained from policies to combat climate change to compensate those most harmed by that process and helping them to adapt will be key to minimising the transition costs and guaranteeing public support.

The probability of these transition risks materialising in the future and to what degree they do so will depend on the swiftness with which the transition to a low-carbon economy is implemented. Specifically, an orderly (as opposed to disorderly) transition will limit transition risks.

In effect, any delay in the transition could increase the need to implement it more abruptly in the future. This could trigger sharp relative price adjustments and a marked deterioration

[16] The first was the carbon tax sectoral (CATS) model, and we recently concluded development on an extension to that one called the carbon tax labour investment sectoral trade (CATALIST) model.

[17] See IMF (2015) and Metcalf and Stock (2023).

in the financial position of households and firms, adversely affecting financial stability, which would magnify the negative impacts on the real economy.

Indeed, stress test analysis shows that the banking system's solvency can be significantly eroded under such disorderly transition scenarios. For example, the Banco de España's estimates[18] show that, under those circumstances, the aggregate CET1 ratio of Spanish banks would fall by 1.2 pp in three years relative to the baseline scenario. In this scenario, accelerated transition measures are only applied after 2030 to compensate for the previous period of inaction, leading to abrupt and marked increases in the prices of fossil fuels in an environment in which economic agents have limited access to low emission technologies and their incomes and activity are negatively affected.

By contrast, **a scenario in which measures to combat climate change are implemented in a timely and gradual fashion limits their adverse economic and financial impact.** For example, the estimated impact on the aggregate CET1 ratio under such an orderly transition scenario would be just -0.15 pp over a three-year horizon.[19]

It should be noted that incentivising investment in renewable energies is one of the most important channels by which early mitigation policies can significantly lessen transition risks. This is the case because many of the investments needed for adaptation (investment in renewables, improvements in energy efficiency and electrification, for example) have long maturity periods.

These findings help to highlight **the importance of the credibility and certainty of environmental policies in minimising the short-term economic costs of transition policies.**

4 Final remarks

Allow me to close with three main points.

First, the economic analysis available reveals **the high economic costs that would be entailed by failing to correct the current path of GHG emissions.**

Second, it underlines the fact that delaying actions means an increase in both environmental and transition costs. Therefore, we must adopt **a mitigation strategy that is ambitious, timely, orderly and predictable to address climate change. This strategy should also be global to be effective**

Third, **climate change and the transition to a more sustainable economy will have highly heterogeneous effects** across regions, sectors, firms and households and may have a particularly adverse impact on the most vulnerable. In consequence, particular care must be taken to temper distributional effects. Otherwise, the economic costs of the green

[18] AMCESFI. (2023). *Informe Bienal del Riesgo del Cambio Climático para el Sistema Financiero.* https://www.amcesfi.es/f/webwam/RCL/Publicaciones/archivos/AMCESFI_Informe_Cambio_Climatico_2023.pdf

[19] A similar outcome is found in Delgado, Quintana and Santabárbara (2024), "Carbon Pricing, Border Adjustment and Renewable Energy Investment: a Network approach", forthcoming.

transition may not only be higher, but incidents of social unrest may hinder the speed and ambition of the process.