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*"The Tides of Change: The European Central Bank's
Strategies Against Climate-Driven Economic Risks"*

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"The Tides of Change: The European Central Bank's Strategies Against Climate-Driven Economic Risks"

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ABSTRACT

This thesis analyzes the way in which the European Central Bank (ECB) is dealing with climate change, with a special focus on global warming and its economic consequences. It looks into the ECB's approaches to incorporating climate risk assessments into its monetary policy and supervisory functions, emphasizing adjustments of corporate bond holdings, collateral frameworks, and risk management practices. In examining the economic consequences of climate change on Europe, the thesis highlights how the ECB tries to support a transition towards green economy while maintaining price stability. The research illustrates that such proactive steps by ECB are aimed at controlling financial risks and sustaining economic development against climate crisis.

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I. INTRODUCTION

Climate change is an urgent global challenge that significantly influences every sector, including the financial systems overseen by central banks. This thesis explores the changing role of central banks with particular regards to the European Central Bank in addressing various aspects of threats posed by climate change. The importance is how central banks use their distinct positions to promote economic resilience and sustainable economic transformation.

The first chapter attempts to establish a foundational understanding of climate change, discussing its natural variability as well as human influence. It explores how these changes have historically affected and will continue to influence global and national economies. The implications are extensive, affecting everything from agricultural productivity to global supply chains and insurance markets. The chapter discusses various theories and models that attempt to predict and quantify these impacts, providing a basis for understanding the potential roles that financial institutions, including central banks, might play in mitigating these effects.

Moving into the second chapter, the focus shifts to the specific actions and responsibilities of central banks in the context of climate change, with particular emphasis on the ECB. This chapter delves into how central banks are incorporating climate risk assessments into their monetary policy frameworks and supervisory roles into their decision making processes over time. It discusses the ECB's mandate and how it is adapting its traditional functions to include environmental considerations, reflecting a broader recognition of the links between financial stability and environmental sustainability. This part shows practical adjustments made by central banks for aligning their operations with environmental goals; highlighting it as a balancing act between fostering economic stability while still maintaining support for green growth policies.

Chapter three identifies innovative measures and forward-looking strategies that enable more effective management of climate-related risks by central banks including among others ECB's strategic shift towards sustainability such as modification of its monetary operations, collateral frameworks and also company bond holdings. One very important element herein is related to ECB's efforts towards improved climate risk modeling and data collection which are necessary in order to understand as well as manage the economic impacts of global warming. These

actions indicate that the ECB is committed to sustainability integration into its core operations, signifying its influence on a sustainable transformation to a more resilient green economy.

This thesis presents a progression from theoretical frameworks and economic implications to practical responses and innovations in central banking. This represents an evolving understanding of the connections between climate change and finance systems as they illustrate both problems encountered and possibilities opened within climate change and finance sectors.

In conclusion, therefore, this thesis not only expands academic understanding about European Central Banks' role in times of changing climates but also provides workable pathways for proactive involvement of central banks in promoting economic development through environmental conservation. The findings highlight the pivotal role of central banks in navigating and shaping the economic responses to global climate dynamics, urging a continued and strengthened focus on sustainability within the financial sector.

II. CHAPTER 1

This thesis opens by delving into the dynamic shifts of Earth's climate, with a particular lens on the critical issue of global warming and its current impact. It offers an overview of the fundamental theories of climate change, including both natural processes and human influence. The focus then turns to the economic implications of climate change, presenting various models that predict how different degrees of warming could impact economic output.

In this thesis we scrutinize the potential risks and opportunities for the financial sector, detailing how climate change might affect everything from insurance to investments in fossil fuels. This chapter aims to lay a solid foundation for understanding the complex relationship between our changing climate and its economic consequences.

1.1 Climate Change Across Ages: Natural Variability and Human Impact

"The world's climates have changed in the past, are changing now, and there is every reason to expect that they will change in the future" as Hobbs observed in 1980.

Hobbs highlighted the constantly changing, dynamic, and complex nature of our planet's climate system. This continuous transformation is characterized by notable variations, both in space and over time, with the atmosphere frequently experiencing states of unrest and instability. These fluctuations result in spatio-temporal inequalities, which are a defining feature of our climate.

Throughout history, the Earth's climate has experienced profound changes, as evidenced by eras such as 100 million years ago, when dinosaurs meandered the planet with drastically different climatic conditions, including the prevalence of tropical vegetation near to the poles. In contemporary times, the focus has pivoted to the issue of global warming, a phenomenon confirmed by empirical evidence, including observations of rising global average air and ocean temperatures, the extensive melting of glaciers, and the rising of the global average sea level. This topic has gathered international attention through a myriad of meetings and conferences, despite these efforts, finding an effective measure to slow down these changes remains a hard challenge.

The terms 'climate change' and 'global warming' are frequently used as if they were the same, yet they refer to distinct phenomena.

The Intergovernmental Panel on Climate Change (IPCC) has defined climate change as to *"a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or*

longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. It can manifest as extreme climatic events or as gradual systemic change leading to a slow deterioration in environmental conditions until customary practices or habitation become nonviable"¹Singh further expanded this definition, depicting climate change as the range of variations and shifts in weather conditions over various durations, potentially resulting in a change of climate type, such as from warm and humid to warm and arid. ²

Climatic changes involve important mutations in the Earth-atmosphere system's balance of heat, moisture, cloud formation, and precipitation. These variations can be induced by external circumstances, such as changes in the Earth's orbit, solar variability, movements of the Earth's plates, and changes in the composition of the atmosphere, or by internal circumstances including the energy transfer between the atmosphere, hydrosphere, lithosphere, and cryosphere.

Nonetheless, the global warming we are facing today is mostly due to human activity, leading to a gradual rise in the temperature of the atmosphere and ground surface and impacting the Earth's radiation balance. ³

Despite climate variations being a natural manifestation in our planet's timeline, the significant changes observed nowadays, and the important impact of human activities generate notable worries.

In the past, climate changes were for the most part attributed to natural causes. In contrast, today, it is predicted that human actions will play a significant role in affecting future climatic changes. ⁴

The recent climatic variations, marked by the lowering of temperatures that have historically resulted in mass extinctions, highlight the crucial need for immediate intervention.

Nowadays, global warming amplifies the effects of climate change, impacting climatic systems worldwide and soliciting worries about widespread negative impacts. These embrace rising sea levels, glacier melting, ozone depletion, and coral bleaching, posing fatal threats to human life. Lastly, while climate change is an unavoidable factor in the natural history of the Earth, the current trends, mostly driven by human activities, highlight the need for urgent action to reduce

¹ IPCC Intergovernmental Panel on Climate Change, (2007)

² Singh, (2007)

³ Singh, (2007)

⁴ Mac et al., (1998)

global warming and adapt to its effects. By dealing with the core issue of global warming, we can work towards a more balanced and sustainable Earth, even as we accept that climate change will continue.

Climate change theories explore different explanations that examine the natural and anthropogenic factors influencing Earth's climate.

Theories related to solar behavior play a significant role. According to this theory, variations in the amount of energy the sun emits, influence the temperature of the Earth's atmosphere. Essentially, the sun due to its fluctuating nature, may induce warming or cooling periods on Earth, depending on how active it is.

In addition, there are theories about how the Earth itself changes and how these changes affect the climate.

The Wegner's Continental Drift Theory suggests that continents were previously merged in a giant supercontinent called Pangea, while the Plate Tectonic Theory explains that the Earth's surface is composed of moving plates⁵.

These theories highlight how changes in Earth's geology can result in significant climate transformations through the modification of continents and ocean positions.

These theories show how Earth's crust movements, land shapes, and weather are all connected. They explain that big ice ages happened at the same time as major Earth changes, like when mountains were formed.

The main point is that these big Earth changes can have an impact on the weather by affecting land elevation, thereby impacting ice formation potential and weather patterns.

Another theory focuses on human activities and how they impact the climate. Since the Industrial Revolution, we've been burning fossil fuels like coal and oil, cutting down forests, and engaging in activities that release a lot of gasses into the air. Gasses, such as carbon dioxide, nitrous oxide, and methane, capture solar heat, making Earth's atmosphere warmer, this process is known as the "greenhouse effect".

Global warming can lead to different problems and extreme weather patterns, such as ozone layer depletion, which protects us from the sun's harmful ultraviolet rays and the melting of polar ice.

Collectively, these theories provide a comprehensive overview of the different factors that influence Earth's climate, from solar variability and geological shifts to human-induced changes in atmospheric composition.

⁵ Wegener, (1912)

Understanding these theories helps us see the big picture of how our planet's weather systems work and how we are affecting them.

1.2 Economic Impacts of Climate Change

In the long run, climate change is predicted to have a negative impact on economic growth, although it might confer advantages to certain areas or sectors while imposing disadvantages on others.

This outcome is mainly attributable to the intricate connections among global financial, political, and economic systems, this guarantees that the adverse effects of rising temperatures spread extensively.

The economic consequences of climate change are presumed to emerge in different forms, including damages to private and public assets, reduction of productivity, massive migration, and increased security threats.

With increasing temperatures, the divergence between those potential beneficiaries and those who might suffer from its effects is predicted to increase, resulting in a more significant impact. One of the main effects of global warming in economic growth is anticipated to be the increased incidence and intensity of severe weather conditions, such as Hurricane Sandy that in 2012 destroyed New York, resulting in significant economic losses.

Another important threat is posed by the rising sea levels, which might cause interruptions to business processes and the destruction of residential areas.

The impact that climate change has on the economy can also be understood through economic theory, in particular by analyzing alterations in the global economy's production function. In the event that damages by climatic change diminish the capital stock, a fall in the economy's capacity for production would be evident.

This scenario would lead to a downward shift in the global production function, as is shown in Figure 1, implicating that the productivity per unit of labor would decline.

The reduction of food security, the spread of diseases, and compromised outdoor work conditions are factors that could decrease labor productivity and availability, worsening the situation by resulting in more social discontent and diminishing the overall efficiency of the workforce.

This scenario can be illustrated as a supply shock in economic terms, as shown in Figure 2, with global warming causing a decrease in supply at current market prices, leading to reduced output and elevated prices.

Figure 1: Global Production Function

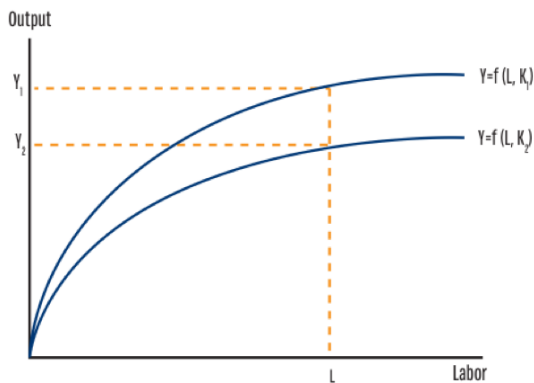
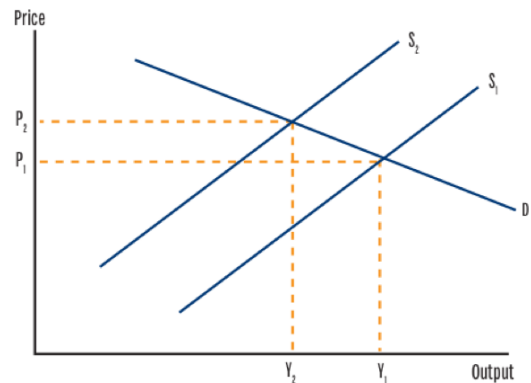


Figure 2: Supply and Demand Effects



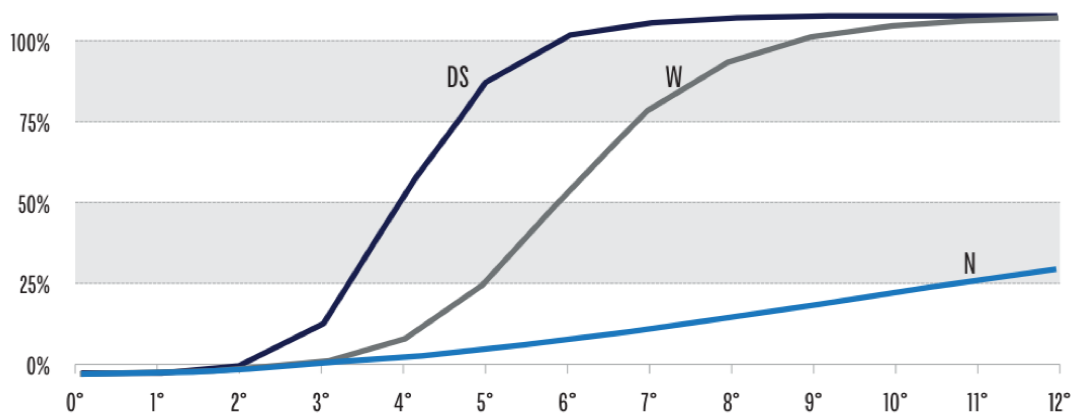
Source: Schroders Economics Team. For illustrative purposes only.

The analysis made by Covington and Thamotheram in 2015 delves into the topic of climate change functions, providing a quantitative evaluation of the economic threats posed by climate change.

These models illustrate the decline in annual economic output under various economic conditions, highlighting an inverse relationship between the level of warming and economic performance.

Although these models vary slightly in their prediction of damage escalation with climbing temperatures, they all predict a decline in annual economic output as the planet warms.

Figure 3: Climate Damage Functions



Source: Covington and Thamotheram (2015)

Climate damage forecasts at a given level of warming based on estimates by Dietz and Stern (2014), Weitzman (2012) and Nordhaus (2013)

Table 1: Climate Change Functions

| Warming | Climate damage | | |
|---------|----------------|-----------|-----------|
| | DS-damages | W-damages | N-damages |
| 1° | 0% | 0% | 0% |
| 2° | 2% | 1% | 1% |
| 3° | 14% | 3% | 2% |
| 4° | 50% | 9% | 4% |
| 5° | 81% | 25% | 7% |

Source: Covington and Thamotheram (2015)

Estimates of climate damage at varying degrees of warming. Climate damage is defined as the fractional loss in annual economic output at a given level of warming compared to output in the same economy with no warming.

Within the various climate damage functions, the “N-damages” model⁶, suggested by Nordhaus in 2013, indicates a continuous escalation in climate damage without reaching a critical point, thus allowing humanity additional time to reduce the negative impacts of global warming. According to this model, a 4°C increase in global temperatures is expected to result in a negligible decrease in yearly economic output.

In contrast, the “W-damages” model⁷, proposed by Weitzman in 2012, suggests a more significant impact, according to which, under the same climate warming conditions, the economic output would decrease by 9%. This model highlights serious threats for sectors such as insurance, agriculture, and forestry.

In the end, the "DS-damages" model⁸, proposed by Dietz and Stern in 2014, provides the most drastic scenario, according to which with a 4°C increase in Earth’s temperatures the annual economic output will drop by 50%. This model underlies the possibility of a crucial turning point that could impact economic development and quality of life, highlighting the necessity of efforts to address climate change and eventually prevent these consequences.

⁶ Nordhaus, (2013)

⁷ Weitzman, (2012)

⁸ Dietz and Stern, (2014)

1.3 Economic Risks and Opportunities of Climate Change in the Financial Sector

*“Climate change constitutes a major challenge, causing both threats and opportunities that will significantly affect the economy and the financial sector”*⁹ as Christine Lagarde, the European Central Bank President, highlighted.

The economic stability and the environment are closely linked and threatened by climate-change shifts, ranging from biodiversity losses to the escalation of natural calamities.

For the financial sector, climate change represents both risks and opportunities.

The impact of climate change on the economy can be divided into two primary types of risks: those stemming from physical changes in the environment such as calamities like flooding and storms, and those resulting from the transition towards a greener economy such as the increasing renewable energy adoption.

A rise in natural calamities, therefore physical risks, can significantly influence the insurance sector and potentially affect the wider economy. For instance, a fall in housing prices due to weather damage could lead to a decrease in consumer spending.

A US trading regulator estimated that the potential damage derived from climate change could be as severe as the consequences of the 2008 financial crisis.

The Bank of England suggested that transitioning to a greener economy could lead to fluctuations in asset value and higher costs, in particular affecting investments in fossil fuels, leading some organizations to withdraw their investments from industries such as coal to reduce risks,

Initiatives like the COP26 Private Finance Agenda, which supports the global transition to net zero, are fundamental in making aware of the interdependence of the economy and the environment and are encouraging them to incorporate climate considerations into their strategic agendas, as demonstrated by a report of the United Nations that cites *"The objective [of COP26] is that every professional financial decision will need to take climate change into account"*¹⁰ and *"The right framework for reporting, risk management and returns will embed these considerations and help finance a whole economic transition. To achieve net zero, every company, bank, insurer, and investor will need to adjust their business models for a low carbon world."*¹¹

⁹ Christine Lagarde, (2020)

¹⁰ United Nations, (2020)

¹¹ United Nations, (2020)

More transparency about climate issues helps finance companies make better choices about environmental risks. This effort is supported by laws like the EU's Non-Financial Reporting Directive, which requires big companies to share how their activities affect society and the environment.

While climate change poses significant risks to the financial sector, it simultaneously offers substantial opportunities for innovation and growth within the industry as Mark Carney, the Former Governor of the Bank of England and Special Envoy for Climate Action and Finance, argued in an interview in 2021, *"If climate change is an existential risk, which it is, and you are part of the solution, you are creating a tremendous amount of value"*¹².

Mark Carney declared that climate change is a big problem we all know is getting worse, however investing in innovative technologies and changing business practices to combat this threat, companies can generate significant value, representing a huge opportunity for the financial sector.

Similarly, Dr. Steve Cohen, who leads the Sustainability Management program at Columbia University, argues that the money we gain from new jobs, products, and industries created by protecting the environment is much greater than the cost of conservation efforts. He suggests that environmental protection isn't just good for the planet, it can also boost the economy.¹³

In conclusion, this first chapter has provided a comprehensive overview of the climatic transformations our planet has undergone and continues to face, highlighting both natural and anthropogenic variables. We have explored the main theories explaining climate change and underscored the economic impacts of these transformations, emphasizing how global warming affects various sectors of the global economy. This chapter has laid the groundwork for a deep understanding of the complex dynamics linking climate change to its economic consequences, setting the stage for a more detailed analysis of the central banks' role in responding to these phenomena. As we proceed in this thesis, we will focus on how financial institutions can mitigate risks and leverage opportunities presented by climate change, fostering a transition towards a more sustainable and resilient economy.

¹² Mark Carney, (2021)

¹³ Cohen, (2020)

III. CHAPTER 2

In the face of global challenges, particularly those posed by climate change, the role of central banks in maintaining economic stability and influencing environmental policies has never been more crucial. This chapter focuses on the European Central Bank, exploring its foundational mandate, mission, and strategic approaches within a world increasingly defined by environmental and economic interdependencies.

Established by the Treaty of Amsterdam in 1998, the ECB's main objective has been price stability which guides all its monetary policies and strategies. The chapter discusses this mandate embedded within the Treaty on Functioning of the European Union (TFEU) by looking at what constitutes price stability for the ECB through its operations of monetary policy. It also takes into consideration wider responsibilities of the central bank including prudential supervision aimed at safeguarding stability within the banking sector.

Moreover, we will scrutinize the ECB's monetary policy strategy, particularly its "two-pillar" approach, which combines economic analysis with monetary data assessment to maintain price stability effectively. This strategy not only supports clear decision-making within the ECB's Governing Council but also enhances transparency and fosters public trust, thereby reinforcing the ECB's commitment to its core objectives.

The chapter also deals with operational and strategic frameworks. It does this by exploring the secondary objective of the ECB which is supporting general economic policies within the Union while maintaining price stability as its main goal. This involves a nuanced analysis of how the ECB's activities align with broader economic, social, and environmental objectives set forth by the European Union, particularly in light of the pressing need for sustainable development and environmental protection.

Part of this chapter is dedicated to an increasingly changeable argument surrounding climate change in connection with ECB activities. Here, they look at how the bank has been adjusting its strategies and tactics to factor in risks related to global warming which are now regarded as major threats not only against financial stability but also towards keeping prices steady. They go further into talking about what role monetary policy should play to facilitate transition into a low carbon economy while considering impacts on sustainability vis a vis financial stability.

In these discussions, our work will underline where the ECB balances between its established mandate and the new needs that arise from a world threatened by climate change. By examining the ECB's response to these challenges, we aim to provide a comprehensive understanding of its pivotal role in shaping not only monetary policy but also contributing to a more sustainable economic future.

2.1 The European Central Bank: Mandate, Mission, and the Pursuit of Price Stability

*"We keep prices stable and your money safe."*¹⁴

is the slogan of the European Central Bank (ECB) which summarizes its core mission.

Founded in 1998 through the Treaty of Amsterdam, the ECB is situated in Frankfurt and acts as the central bank for the 19 nations within the Eurozone. It is part of a larger network that makes up the European System of Central Banks (ESCB), which includes the national central banks of all 27 EU Member States. In addition, as outlined in Article 127 of the Treaty on the Functioning of the European Union (TFEU), the national central banks of countries using the euro and the ECB work closely together within the Eurosystem.

As the first sentence of Article 127 states *"The primary objective of the European System of Central Banks shall be to maintain price stability"*¹⁵ The primary objective is to ensure price stability throughout the Eurozone in the medium run, influencing the ECB's approach to monetary policy. The Article 127 TFEU establishes the mandate for this objective, as well as the authority of the ECB. In addition to its primary focus on monetary policy for securing price stability, the ECB also assumes responsibility for supervisory activities, specifically in the area of prudential supervision, to guarantee the stability of the banking sector.

According to the Treaty, price stability is the most important goal among the European Central Bank's objectives.

This prioritization of price stability reflects not only the ECB's primary concern but also the determining factor when in conflict with additional goals.

¹⁴ ECB

¹⁵ Article 127 of the Treaty on the Functioning of the European Union (TFEU)

The definition of "price stability" isn't provided in EU primary law, which allows the ECB the flexibility to define what price stability means for them, particularly in terms of measurable targets.

The Court of Justice of the European Union (CJEU) reviews the ECB's interpretations and measures regarding price stability, guaranteeing that such actions taken to achieve price stability conform with EU law.

According to the CJEU, the ECB is empowered to utilize three main approaches in its pursuit of its core objective of price stability. These include the ECB may define "price stability"; and it may adopt measures to pursue the price stability objective both directly *and* indirectly. The European Central Bank is tasked with the objective of maintaining price stability, as stated in the EC Treaty. However, the exact meaning of "price stability" is not explicitly defined. To address this, the ECB's Governing Council provided a definition in October 1998, which entails keeping the inflation rate below 2% over the medium term, based on the Harmonized Index of Consumer Prices (HICP) for the entire euro area. This definition was reaffirmed in May 2003 after a review of the ECB's monetary policy strategy. The Governing Council emphasized the importance of maintaining inflation just below 2% over the medium term to safeguard against deflation and ensure a steady value of money throughout the euro area. The HICP is utilized as it reflects the changes in prices for a typical basket of goods and services purchased by households.

The European Central Bank establishes a specific inflation target of "below 2%" to ensure price stability in the long run. Maintaining a slightly positive inflation rate serves as a precautionary measure against deflation risks. Additionally, the ECB recognizes the potential inaccuracies in measuring the Harmonized Index of Consumer Prices (HICP) and variations in inflation rates across the eurozone.

The term "medium term" is utilized to emphasize that the impact of monetary policy on inflation and prices requires time and cannot immediately address every unforeseen price fluctuation. Consequently, some degree of short-term inflation rate variability is anticipated and considered acceptable.

There are three main reasons why the quantitative definition of price stability is significant. Firstly, it provides clarity on the objectives of monetary policy, allowing everyone to understand the goals that the European Central Bank aims to achieve. Secondly, it offers a means for people to assess the performance of the ECB. When prices are not stable, it

becomes more apparent to everyone, and the ECB is then required to explain its strategies for resolving the issue. Lastly, it assists individuals in making predictions about future price movements. When people have confidence that prices will remain stable, it simplifies the ECB's role and enhances the effectiveness of their policies.

(i) Benefits of price stability

Price stability is extremely important for the economy as it ensures that the overall price level remains consistent and prevents long-term inflation or deflation. This has several benefits:

When prices are stable, it becomes easier for both consumers and businesses to notice any changes in the prices of specific goods or services. This clarity allows them to make smarter decisions about their purchases or investments, leading to a more efficient use of resources and ultimately boosting the overall productivity of the economy.

Investors feel more confident to invest without worrying about future price increases eating into their returns. This confidence reduces the need for inflation risk premiums, making borrowing cheaper and encouraging more investment. As a result, economic growth is stimulated.

Stable prices also mean that businesses and individuals are less inclined to spend time and resources protecting themselves against price changes, such as by collecting goods. This allows resources to be used in more productive ways that contribute to economic growth.

Inflation or deflation can exacerbate the negative impacts of tax and welfare systems, leading to economic inefficiencies. Price stability helps to avoid these issues, ensuring that the economy runs more smoothly.

Lastly, stable prices help to maintain social harmony by preventing the unfair redistribution of wealth and income that can occur with significant price fluctuations.

History has shown that high inflation or deflation can lead to social and political instability, so price stability is crucial in keeping society stable and cohesive.

In conclusion, a stable economy relies on maintaining price stability, where the inflation rate—the change in prices for goods and services over time—is neither excessively high nor extremely low. Slight increases in prices are crucial, they stop deflation and avoid the problems that come with high inflation for both people and businesses.

Stable, low, and predictable inflation fosters an environment where individuals and businesses can make more informed decisions about saving, spending, and investing. This predictability encourages economic growth, which leads to job creation and overall prosperity.

(ii) The ECB's monetary policy strategy and the "*two pillar*" approach

The European Central Bank (ECB) employs a comprehensive strategy for monetary policy to maintain price stability in the eurozone. This strategy serves a dual purpose: internally, it streamlines decision-making processes within the ECB's Governing Council by providing necessary information and analysis, while externally, it enhances transparency by justifying policy decisions to the public. This transparency not only increases the effectiveness of the policy but also underscores the ECB's dedication to its primary goal of price stability, thereby fostering trust in financial markets.

The primary responsibility of the ECB is to effectively manage the money within the eurozone in order to maintain price stability. This is achieved through the adjustment of interest rates, which in turn impacts the functioning of the economy and ultimately influences prices.

To fulfill its role to the best of its ability, the ECB employs a method known as the "*two-pillar approach*." This approach involves analyzing economic and monetary data in two distinct ways to assess the risks to price stability in the eurozone. By adopting this approach, the ECB ensures that no crucial information is overlooked.

The two pillars consist of economic analysis, which examines the factors that influence prices in the short to medium term, such as the state of the economy and financial conditions. This analysis takes into account how supply and demand in markets impact prices. The second pillar is monetary analysis, which focuses on the relationship between the quantity of money and prices over the long term. This serves as a means to verify the insights derived from the economic analysis in the short to medium term.

Through the utilization of these two pillars, the ECB ensures that it considers all relevant information in order to comprehend the risks to price stability. It adopts different perspectives and cross-checks information to make well-informed decisions on how to maintain stable prices. This approach also demonstrates to the public that the ECB employs a comprehensive and diverse analysis in its decision-making process, thereby reinforcing its credibility.

2.2 The European Central Bank's Secondary Objective: Balancing Price Stability with Support for General Economic Policies

The second objective of the European Central Bank, as expressed in the second sentence of Article 127 is “*Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union as laid down in Article 3 of the Treaty on European Union.*”¹⁶

In addition, the previously mentioned Article 3 (3) of TEU provides that the European Union shall work for “*the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment*”.¹⁷

Throughout its history, the European Central Bank (ECB) has never directly cited its secondary objective as a legal foundation for its monetary policy decisions. As a result, the specific scope and definition of the "general economic policies" that the ECB is permitted to support are still largely unexplored.

On one side, an interpretation of “economic policies” would only include those aimed at achieving balanced economic growth within the Member States and the EU, not considering objectives such as full employment, social progress, or environmental protection, which the Treaty assigns to distinct competencies.

On the other hand, a broader perspective would include all economic policies of both the EU and its Member States within the category of "general economic policies in the Union."

According to this perspective, “general economic policies” include not only fiscal strategies, such as taxation or expenditure controlled through budgetary procedures but also policies that have a broad impact on the economy.

Article 120 and Article 121(2) TFEU explicitly support the idea that economic policies include objectives related to the environment and society, not just the economy. Article 120 TFEU mandates that Member States design their economic policies to help achieve the Union's broader objectives as outlined in Article 3 of the Treaty on European Union (TEU) and within the broad economic guidelines mentioned in Article 121(2).

¹⁶ Article 127 of the Treaty on the Functioning of the European Union (TFEU)

¹⁷ Article 3 of the Treaty on European Union (TEU)

These Union's economic provisions are collectively required to aim for sustainable development, incorporating economic, social, and environmental principles.

The European Central Bank follows a hierarchy of objectives, with its main focus on ensuring price stability, which is more important than its secondary objective of supporting general economic policies within the Union.

It is crucial to emphasize this distinction since the ECB is only permitted to assist in general economic policies, but only if this assistance does not compromise its main goal of maintaining price stability.

The Treaties prohibit the ECB from giving equal importance to its primary and secondary objectives, highlighting the crucial importance of maintaining price stability.

In practice, this implies that the ECB should choose the policy that more aligns with the Union's overall economic policies.

Nevertheless, in cases where the policy alternatives do not equally contribute to maintaining stable prices, it is imperative to prioritize the option that more effectively guarantees this fundamental objective.

The European Central Bank's efforts are recognized for their ability to address both monetary and economic goals concurrently, recognizing the close relationship between the two.

It is contended by some that this connection implies that support for general economic policies should always accompany measures aimed at achieving price stability, which is the primary objective. However, a more commonly accepted interpretation suggests that the ECB could, in theory, rely solely on the secondary objective when implementing monetary policy measures, as long as these measures do not compromise price stability. This argument, though not yet examined by the Court of Justice of the European Union (CJEU), finds support in the phrasing of Article 127(1) TFEU, stating the ECB "shall support the general economic policies" without compromising its main goal of price stability. The drafters of the Treaty decided to focus on certain goals, saying "without prejudice to" to show there might be conflicts between these goals. This means that when working on the second goal, it's not always necessary to work on the first goal at the same time, as long as they don't conflict with each other.

Article 127(1) of the Treaty on the Functioning of the European Union (TFEU) assigns the European Central Bank (ECB) the role of supporting the Union's overall economic policies. However, this does not mean the ECB can set these policies by itself. Essentially, the ECB is not authorized to independently create economic policies or directly achieve specific targets such as full employment, social progress, or environmental protection that these policies may pursue. Therefore, when the ECB discusses its work towards its secondary objective, it should clarify that its actions are intended to indirectly assist the Union's wider objectives, rather than directly supporting them.

This restriction prevents the European Central Bank (ECB) from trying to support "general economic policies" that are so broad that defining and supporting them would mean making its own policy decisions. For instance, policies aimed at achieving "social justice and protection," as mentioned in Article 3(3) of the Treaty on European Union (TEU), would require the ECB to decide on its own what "social justice" means. This is beyond what the ECB is allowed to do under Article 127(1) of the Treaty on the Functioning of the European Union (TFEU).

The recognition that climate risks pose a financial risk has initiated significant debates on the role of central banks in addressing climate-related risks and the actions they must take. These discussions have shifted how people view the role of central banks, from just focusing on risks to a wider role of aligning with government policies to help transition to a low-carbon economy. In February 2021, Frank Elderson, a member of the Executive Board of the European Central Bank, emphasized the ECB's secondary goal to support "the sustainable development of Europe based on [...] a high level of protection and improvement of the quality of the environment" and stated that achieving this goal is "*a duty, not an option*"¹⁸.

By the end of 2021, projections indicate that the world will experience a 2.7°C increase in average global temperatures. To prevent critical tipping points that could lead to widespread ecological, climatic, and economic crises, it is imperative to limit this temperature rise to 1.5°C, as highlighted by Masson-Delmotte.¹⁹ Achieving this goal requires an estimated additional global energy investment of 15 trillion US dollars by 2050, according to the International Renewable Energy Agency (IRENA)²⁰. The success of the transition to a low-carbon economy will play a crucial role in determining the economic stability risks we face.

Climate change impacts, such as extreme weather events and shifts in climate patterns, can lower labor productivity, interrupt supply and food chains, and result in capital destruction. Furthermore, central banks have been highlighted in the Network for Greening the Financial System in 2020 the significant impact climate change would have on crucial macroeconomic indicators, including economic growth and price stability.

To prevent severe damages due to climate change, a shift to a carbon-neutral economy is essential.

If managed orderly, this transition can significantly reduce physical risks in the long term. On the other hand, if we don't manage this transition properly, it could pose significant risks to the financial system.

Monetary policy operations are crucial in the transition to a low-carbon economy by influencing the funding conditions of firms. Firms with assets eligible for monetary policy

¹⁸ Elderson, (2021)

¹⁹ Masson-Delmotte et al, (2019)

²⁰ International Renewable Energy Agency (IRENA), (2019)

operations enjoy more favorable conditions. This is due to financial institutions placing higher value on assets accepted by central banks, thus increasing their price or reducing their yield. Consequently, monetary policy operations affect resource allocation in the economy by incentivizing investments in or loans to firms with assets recognized for these operations.

Since asset eligibility largely depends on their risk category, if climate risks are not adequately priced by markets, current policies disproportionately favor firms with significant climate risks by providing them with better funding conditions.

Therefore, central banks are charged with adjusting their monetary policy operations to prevent the current misallocation in the economy and to ensure climate risks are adequately considered.

As central banks deal with the financial threats from climate change, they are finding themselves at the center of efforts to make the economy more environmentally friendly. This connection is key to facing wider economic issues and uncertainties.

2.3 Climate-related risks and monetary policy

The relationship between climate change and monetary policy is becoming increasingly important. On one hand, economic variables relevant to monetary policy and the financial sector are impacted by climate-related risks, challenging central banks in achieving their objectives of price stability. On the other hand, there's a debate on whether the way central banks control money could help fight climate change without deviating from their main goal.

To comprehend how climate change impacts monetary policy, it is essential to understand the distinct features of climate-related risks. Traditionally, the central bank's response to demand and supply shocks varies significantly. For instance, positive demand shocks, which increase GDP and inflation, can be effectively managed by the central bank through tightening monetary policy to mitigate inflation and prevent the economy from overheating. In contrast, negative supply shocks create a dilemma because they increase prices while decreasing GDP. This poses a challenge as tightening monetary policy to control inflation can worsen the negative output gap.

Climate-related risks present a complex mix of negative supply and demand shocks, placing policy makers in the position of stabilizing inflation and preserving economic

activity. Extreme weather events, acting as negative supply shocks, such as the destruction of crops and infrastructure, primarily push prices up, leading to subsequent negative demand shocks as uncertainty impacts investment and consumption decisions.

Moreover, the shift towards mitigating climate change could lead to long-lasting changes in inflation rates. The effects of climate change and new policies bring a lot of uncertainty to how inflation will behave, with prices becoming more unstable and inflation staying high as we move towards a greener economy.

The relationship between climate change and monetary policy is intricate, as it can lead to both inflationary and deflationary forces. The impact on inflation rates is still uncertain and will probably rely on various factors such as the timing of climate policies, their scope, intensity, and their influence on economic growth.²¹ This uncertainty presents a difficulty for central banks in developing an efficient monetary policy approach.

It's critical to identify the specific mechanisms through which climate change affects central banking operations, as these will significantly influence the execution of monetary policy. Notably, climate change can impact monetary policy through two primary channels: *(i) the transmission mechanism of monetary policy* and *(i) the natural rate of interest*.

(i) Climate change and the transmission channels of monetary policy

Monetary policy has a big impact on the economy and prices, but predicting its effects precisely is difficult because of various factors and uncertainties involved. For instance, Schnabel²² pointed out that financial institutions might end up lending less if they face losses from climate change risks or if they're stuck with assets that suddenly lose value. Central banks themselves aren't immune to such losses, either from buying securities or through the collateral they accept in monetary operations.

As Drudi highlighted in 2021,²³ the transmission channels of monetary policy, which are the interest rate channel, the credit channel, the asset price channel, the exchange rate channel and the expectation channel, are all affected by climate change.

²¹ Dafermos et al., (2021); Boneva et al., (2022)

²² Schnabel, (2021)

²³ Drudi, (2021)

1) Interest rate channel: Typically, alterations in interest rates have an impact on individuals' saving and investment behaviors. However, in light of the climate risks, individuals may opt to save more as a precautionary measure, while businesses may reduce their investments, regardless of any decrease in interest rates aimed at stimulating expenditure.

2) Credit channel: Banks can face significant challenges due to climate change. In the event of severe weather causing damage to properties or businesses, the repayment capacity of loans diminishes, causing banks to become hesitant in lending due to the increased risk involved. Consequently, this can result in a higher number of unpaid loans, adversely impacting the financial stability of banks.

3) Asset price channel: Climate change has the potential to significantly impact the value of investments. This can occur either through direct destruction caused by extreme weather events or sudden declines in value due to swift policy changes aimed at addressing climate concerns. Consequently, banks may face challenges in providing loans, and both households and businesses may be influenced in their financial decision-making. An illustrative scenario is the depreciation of properties located in flood-prone regions, which could result in reduced spending by individuals.

4) Exchange rate channel: Climate change could potentially impact the way currencies operate in the worldwide market. For example, if the risks from climate change alter what a country can produce or if climate regulations impact trade, it might cause fluctuations in currency values. Nations dealing with the harsh effects of climate change may experience a decline in their trading conditions.

5) Expectation channel: The anticipation of how individuals perceive the future alteration in interest rates has a direct impact on the present long-term rates. This, in turn, has a significant influence on both spending patterns and pricing strategies. However, the introduction of climate change introduces a level of uncertainty, making it challenging to determine whether price fluctuations are a result of increased demand or decreased supply.

Consequently, this complicates the management of monetary policy, particularly if efforts to address climate change are not seamless.

In essence, climate risks can disrupt the effectiveness of monetary policy by altering the economic and financial environments it targets. This disruption can influence various sectors, including asset valuations, market stability, the lending capabilities of banks, and the financial decisions of businesses and consumers.

(ii) Climate change and the natural interest rate

The natural interest rate is crucial for guiding monetary policy because it represents the ideal real interest rate where the economy is balanced, inflation is stable, and production is at its peak. Understanding this rate enables policymakers to assess the influence of their decisions on the overall state of the economy.

Over the past few decades, especially in the last 40 years, there has been a significant decrease in the natural interest rate in developed economies, with a decrease of approximately 5 percentage points, as estimated by the International Monetary Fund²⁴. This trend is largely due to factors like slower productivity growth and people living longer, though government spending and financial elements have also played a part. Studies have shown that these long-term trends have caused a significant drop in the rate, with changes in life expectancy and productivity being key factors.²⁵

Climate change complicates predictions about the future direction of this natural rate. It influences factors like productivity, labor supply, and savings or investment behaviors due to increased uncertainty. The impact is varied – it could reduce the workforce and productivity as health problems arise from extreme temperatures, or it might drive the adoption of new, more efficient technologies following disasters. Yet, with the escalation of climate-related risks, individuals might opt to save more and invest less, potentially further lowering the natural rate. Additionally, government expenditures on environmental initiatives could elevate interest rates by boosting the demand for capital.

To summarize, the natural interest rate has been declining over the last four decades due to various factors such as aging populations and lower productivity growth. However, the

²⁴ International Monetary Fund (2023)

²⁵ Eggertsson et al., (2019); Brand et al., (2018)

inclusion of climate change introduces new uncertainties. Although it is difficult to determine the exact impact on the rate, it is probable that it will exert further downward pressure.

In conclusion, this chapter has highlighted the critical role of the European Central Bank in addressing the economic challenges posed by climate change. The ECB's primary mandate of ensuring price stability remains central, but its strategies now also encompass broader economic and environmental objectives. Through its "two-pillar" approach and adaptive monetary policies, the ECB aims to balance price stability with support for sustainable development. As climate-related risks increasingly impact economic stability, the ECB's proactive measures and strategic adjustments are essential in guiding the eurozone towards a resilient and green economy.

IV. CHAPTER 3

Climate change is no longer a distant threat; it is an immediate challenge impacting all sectors of the global economy, including monetary policy and financial systems. In this chapter, we delve into the critical role of the European Central Bank in this new environmental reality. As the guardian of eurozone monetary stability, the ECB finds itself at the forefront of the fight against climate change, tasked with the dual mandate of ensuring price stability while supporting the European Union's transition to a climate-neutral economy.

This chapter explores the innovative ways in which the ECB has integrated climate change considerations into its operational framework and decision-making processes. We begin by examining the ECB's recent strategic shifts towards incorporating climate risk assessments in its monetary policy and supervisory roles. By focusing on the ECB's adjustments to its monetary operations, collateral frameworks, and corporate bond holdings, we illustrate how the institution aims to promote a greener economy and mitigate the financial risks posed by climate change.

Furthermore, we assess the ECB's initiatives to enhance its climate risk modeling and data collection, which are crucial for understanding the economic impacts of climate change. This chapter also highlights the ECB's proactive efforts in conducting comprehensive climate risk stress tests, essential for evaluating the resilience of the financial system to environmental shocks.

Lastly, the European Central Bank, under the leadership of President Christine Lagarde, has laid out an ambitious plan to recalibrate its monetary and operational strategies. This strategic shift is aimed at aligning the institution with the necessities imposed by a warming climate and environmental degradation. The upcoming sections will delve into the ECB's forward-looking objectives and expected actions, as set out in the "Climate and Nature Plan 2024-2025". The focus will be on the concrete steps the ECB plans to take to mitigate climate risks, integrate sustainability into its core functions, and support the transition towards a more resilient and green economy, thus ensuring that its policy framework remains robust and relevant in the context of environmental imperatives.

3.1 ECB's Strategic Actions to Tackle Climate Change Impacts on the Eurozone Economy

“Climate change actually has an impact on price stability. If we fail to measure externalities, if we fail to anticipate drought, if we fail to anticipate variations of prices of food, of energy, of services, then we are not doing our job.”²⁶

Christine Lagarde, Interview with the Financial Times, July 7, 2020

As mentioned by the President of the European Central Bank in this interview, the ECB is strongly connected with climate change and thus has recently decided to include climate change considerations in its decision-making and daily operations.

This action recognizes the increasing importance of climate change; however, our understanding of climate change remains incomplete, especially how natural disasters affect the economy and prices within the eurozone. While there's no doubt that climate change is increasing the frequency and severity of natural disasters, finding evidence of its direct effect on the eurozone's overall prices is challenging.

It is crucial to address this knowledge gap as it plays a crucial role in the ECB's ability to make well-informed decisions regarding monetary policy in light of the climate crisis. The research made by the German Institute for Economic Research highlights some important factors that the ECB should take into account in this era affected by climate change. First, as the climate keeps changing, it is anticipated that there will be increased pressure on prices in the eurozone. This will pose a challenge for the ECB in maintaining inflation at its desired level. Second, the research indicates that the influence of natural disasters on prices may differ depending on the type of products. This implies that individuals who invest more in items that are more likely to become pricier following a catastrophe will experience a greater impact compared to others. Third, due to the diverse impact of natural disasters on prices in different countries, it will be quite difficult for the ECB to control inflation uniformly across the eurozone. Finally, given these difficulties, the ECB must think about how it can use its policy tools to help reduce carbon emissions and align financial markets with climate goals.²⁷ This is crucial for preventing severe climate change and ensuring the ECB can maintain price stability.

²⁶ Christine Lagarde, (2020)

²⁷ German Institute for Economic Research ,(2021)

The EU has set ambitious goals to become climate-neutral by 2050, as part of the European Green Deal and the European Climate Law.

Measures implemented to reduce carbon emissions will likely have complex effects on inflation and the economy, which could make the ECB's job even more complicated. As the EU progresses towards achieving a net-zero economy, it will experience notable transformations that might impact inflation in the short and long run. Hence, the ECB must evaluate the influence of climate change on price stability and be ready to assist the European Union in its journey towards achieving a climate-neutral economy in every possible manner.

A question that naturally arises is:

“What is the ECB doing to address climate-related risks?”

1. Adjusting monetary policy operations

The European Central Bank is making moves to improve its monetary policy procedures. By updating operations, the ECB has shown that it wants to better understand risk assessment and management of climate risk exposure. It also wants to know how climate change considerations are represented in credit ratings it utilizes. Additionally, the ECB tries to take into account how climate change may affect the way its asset purchases and collateral framework should be used.

The Governing Council of the European Central Bank has decided on further steps to integrate climate change considerations into the Eurosystem's monetary policy framework. These include adjusting corporate bond holdings and the collateral framework within the Eurosystem's monetary policy portfolios; introducing climate-related disclosure requirements; and enhancing risk management practices.

These measures support two objectives: firstly, in line with the Eurosystem's primary goal of maintaining price stability, they aim to better reflect climate-related financial risks on the Eurosystem balance sheet; secondly, in line with the ECB's secondary objectives, they aim to support a green transition of the economy consistent with EU climate neutrality goals. Furthermore, these measures incentivize companies and financial institutions to increase transparency about their carbon emissions and reduce them.

ECB President Christine Lagarde said: *“With these decisions we are translating our commitment into tangible action. Within our mandate we are implementing further concrete steps to incorporate climate change considerations into our monetary policy operations. As part of our ongoing work on our broader climate agenda, we will take further actions in due course to align our activities with those of the Paris Agreement.”*²⁸

As part of its strategy to work climate change into its monetary policy framework, the European Central Bank has outlined a series of initiatives. These efforts are targeting the decarbonization of corporate bond holdings, adjustments to the collateral framework and improved risk assessment and management practices.

- Corporate Bond Holdings:

The Eurosystem is on a mission to gradually decarbonize corporate bond holdings. It will not only look for superior climate performance during major redemptions in coming years but will preferentially reinvest with these issuers. Companies with superior climate performances have lower greenhouse gas emissions, more aggressive carbon reduction targets and enhanced climate-related disclosures. This technique, called “tilting,” looks to increase assets on the balance sheet with better climate performance while decreasing them with poorer performance relative. The ECB expects this approach will mitigate financial risks related to the environment and encourage issuers to improve on disclosing their information and reducing their carbon emissions.

- Collateral Framework:

Although this initiative may take a bit longer than others, it’s designed for long term effects that could save a lot of money over time. The Eurosystem plans on establishing limits for high carbon entities as collateral in Eurosystem credit operations. Initially, they'll limit marketable debt instruments issued by non-financial corporations but could expand if data quality improves across other types of assets. Their goal is also geared at mitigating any future risks towards finance and is expected by the end of 2024. Before full implementation of this initiative, several tests will be conducted first.

²⁸ Lagarde, (2020)

- Climate-related disclosure requirements for collateral:

From 2026 onwards, once the Corporate Sustainability Reporting Directive (CSRD) is fully implemented, the Eurosystem will exclusively consider marketable assets and credit claims from companies and debtors who adhere to the CSRD as collateral. This condition aims to improve transparency and provide more accurate information for financial institutions, investors, and the general public. While the CSRD does not currently encompass all types of assets eligible as collateral, like asset-backed securities and covered bonds, the Eurosystem is actively promoting the adoption of enhanced and standardized climate-related disclosures for these assets too.

Moving forward, the European Central Bank is determined to consistently assess the effectiveness of the measures mentioned earlier. This evaluation will concentrate on a number of important goals: firstly, confirming that these measures align with the ECB's monetary policy objectives; secondly, ensuring that these actions, within the scope of its authority, continue to aid the process of reducing carbon emissions in line with the Paris Agreement and the European Union's climate neutrality targets; thirdly, adapting to advancements in climate data and climate risk modeling, as well as changes in regulatory frameworks; and finally, addressing additional environmental challenges while still prioritizing its responsibility of maintaining price stability.

Corporations and governments both have crucial roles in addressing climate risks by improving transparency in disclosures and meeting commitments to reduce carbon emissions. The ECB's climate action plan, announced in July 2021, is key to this effort. It's important for the ECB to stay aligned with the climate roadmap and be flexible to adjust to any changes in EU legislation timelines. Additionally, the ECB is expanding its focus beyond monetary policy to include banking supervision, financial stability, economic analysis, data collection, and corporate sustainability. By working in these areas, the ECB aims to manage financial risks related to climate change, promote sustainable finance for a smooth transition to a low-carbon economy, and use its expertise to encourage positive changes in economic behavior.

2. Conducting climate stress testing and assess climate-related financial risks

As a regulatory authority, the European Central Bank must conduct yearly stress tests on the entities it supervises as part of its Supervisory Review and Evaluation Process (SREP), in accordance with Article 100 of the Capital Requirements Directive IV (CRD IV).

The European Central Bank conducted a comprehensive climate risk stress test, released on July 8, 2022, evaluating the resilience of the Eurosystem balance sheet, supervised banks, and the broader economy to climate-related risks. The aim is to help understand systemic risks that financial markets face from changes in environmental conditions so as to improve decision-making processes. Additionally, the ECB explored the economy's and financial system's dependency on natural ecosystems.

Andrea Enria, Chair of the ECB's Supervisory Board, highlighted that despite some advancements since 2020, euro area banks still inadequately incorporate climate risk into their stress-testing frameworks and internal models. He emphasized the urgent need for these institutions to enhance their climate risk assessment capabilities by closing existing data gaps and adopting sectoral best practices. The stress test was described not as a capital adequacy exercise but as a learning tool for both banks and supervisors, aimed at improving the sector's preparedness for climate-related risks and identifying best practices for managing these risks.

*“This exercise is a crucial milestone on our path to make our financial system more resilient to climate risk,” and “We expect banks to take decisive action and develop robust climate stress-testing frameworks in the short to medium term.”*²⁹

A total of 104 significant banks participated in the test, which was organized into three modules: the banks' own climate stress-testing capabilities, their reliance on carbon-emitting sectors, and their performance under various scenarios across different time horizons. The

²⁹ Enria, (2020)

third module, a more detailed bottom-up stress test, was limited to 41 directly supervised banks to maintain proportionality.

The initial findings revealed that about 60% of banks lack a comprehensive framework for climate risk stress-testing. Furthermore, most banks do not yet integrate climate risk into their credit risk models, and only 20% consider it when issuing loans. The second module indicated that nearly two-thirds of banks' income from non-financial corporate customers is derived from greenhouse gas-intensive industries. It also highlighted the banks' dependence on a small number of large counterparts for their "financed emissions," increasing their exposure to transition risks.

The stress tests in the third module evaluated the banks' potential losses from extreme weather events and transition scenarios over various time frames. The tests confirmed that physical risks such as droughts, heatwaves, and floods have a heterogeneous impact across banks, primarily influenced by sectoral activities and geographical locations of exposures. The stress test estimated that credit and market losses in the short-term disorderly transition and the two physical risk scenarios could total approximately €70 billion for the 41 banks involved. However, this figure likely underestimates the actual risk, given the limited scope of exposures considered and the rudimentary nature of the models used.

The stress test results will inform the Supervisory Review and Evaluation Process qualitatively, with no immediate impact on capital requirements through Pillar 2 guidance for the year. Banks received individual feedback and are expected to align their actions with the best practices that the ECB plans to publish later in 2022. This exercise underscores the ECB's commitment to guiding European banks through the green transition and complements other supervisory activities focused on integrating climate-related and environmental risks into banks' strategies, governance, and risk management.

In addition, the European Central Bank has released the outcomes of its comprehensive climate stress test, which evaluated over 4 million global companies and 1600 euro area

banks on climate change impacts. The analysis was conducted under three different policy scenarios to assess the effects. The findings show that early adoption of green policies can benefit both firms and banks as they facilitate transition towards carbon neutrality.

Likewise, the stress test also highlighted that climate risks, including physical and transition risks, tend to affect specific regions and sectors disproportionately.

Specific areas of high physical risk vulnerability may suffer from very frequent severe natural catastrophes leading to their credit defaulting. Physical risks refer to economic damages in terms of increased occurrences and intensification of natural disasters within Europe with various regions facing e.g., floods in the North or heat stress and wildfires in South Europe. This implies that it will be costly for industries such as mining or electricity which have higher emissions since they will incur more expenses likely to increase their probability of defaulting in the short-to medium-term.

However, there are great opportunities associated with transitioning towards a cleaner economy. Eventually, these long-term gains will outweigh any upfront costs through energy efficiency savings and low total energy bills resulting from early actions.

Luis De Guindos, Vice-President of the ECB, emphasized that there is an early need for an orderly transition aimed at minimizing green transition costs as well as addressing direct consequences of future natural calamities. He cautioned against doing nothing about this because it would lead to physical risks increasing nonlinearly due to the irreversible nature of global warming.³⁰

In case no measures are taken on climate change issues, euro area banks could face severe implications. According to a stress test held by the system, expected losses on corporate loan books may rise sharply approaching critical levels over the next thirty years or so. This means that by 2050 if we assume a “hot house world” scenario based on severe climate change, corporate loan portfolios on average may have an 8% higher probability of default than in case of gradual transition. By 2050, the most vulnerable portfolios might see their probabilities of default rise by a third compared to 2020, which represents a five-fold increase relative to the average portfolio value in the same situation.

³⁰ De Guindos, (2021)

3. Enhancing our modeling and data

In an era that is marked by urgency in responding to climate change, the European Central Bank has been proactive in resolving this issue. The ECB has partnered with national central banks of all EU Member States in order to adequately address the multifaceted implications of climate change on economic and financial stability within the region. Consequently, this joint initiative resulted in the development of harmonized statistical indicators specifically designed for climate-related analyses across the euro area. These indicators were first introduced in January 2023 as evidence of ECB's dedication to embedding climate risk factors into its monetary policy framework and financial stability assessments. They are focused on a range of climate-related dimensions at initial stages with emphasis being placed on 'Sustainable finance'. This was subsequently expanded in November 2023 to include further breakdowns that offer greater insights into sustainable financial practices and their related impacts. The ECB expects "Carbon emissions" and "Physical risks" indicators' updates in the first half of 2024 reflecting a dynamic approach to enhancing these instruments in response to evolving data needs and methodological advances.

However, challenges exist as regards their creation. Because capturing and interpreting climate data are complex tasks, these indicators currently have significant limitations and are therefore produced as experimental statistics. In saying this, it must be noted that these statistics should be considered cautiously due to their infancy stage as well as ongoing efforts aimed at improving their reliability and scope as labeled by "Experimental Statistics". Nevertheless, despite these hardships, they form part of a comprehensive strategy by the ECB towards addressing climate change; indeed they not only help us understand better but also mitigate against potential risks associated with global warming while serving as building blocks for a green economy. Improved quality and accessibility of data concerning environmental issues will make them more transparent; thus facilitating more informed decisions from policymakers, financial institutions or even ordinary people during moments when climatic circumstances are uncertain.

4. Ensuring banks manage climate-related risk

As a banking supervisor, the ECB ensures that banks follow a secure and cautious method in identifying, evaluating, and managing risks related to climate and the environment, while also maintaining transparency in disclosing their exposure to such risks.

Climate change poses significant risks to the banking sector, manifesting both through direct physical threats, such as extreme weather events, and transition risks associated with shifting towards a low-carbon economy. Regulatory bodies overseeing European banks are committed to ensuring that these financial institutions effectively identify, manage, and disclose both existing and emerging risks, particularly those related to climate change. This regulatory vigilance helps banks fortify their resilience against both climatic and economic shifts, thereby bolstering the overall safety and stability of the euro area's banking sector and the broader financial system. This approach reflects a proactive stance in safeguarding financial systems against the unpredictable impacts of global climate change.

3.2 Horizon 2024-2025: The ECB's Future Strategies for Climate Resilience

“A hotter climate and the degradation of natural capital are forcing change in our economy and financial system. We must understand and keep up with this change to continue to fulfill our mandate.”³¹

said the ECB President Christine Lagarde.

In light of the urgent challenges posed by climate change and environmental degradation, the European Central Bank, guided by President Christine Lagarde, has proactively expanded its strategic and operational frameworks to address these pivotal issues. The announcement of the "Climate and Nature Plan 2024-2025" on January 30, 2024, marks a significant commitment by the ECB to adapt its policies and practices to the realities of a changing planet. This comprehensive plan delineates several key initiatives aimed at integrating environmental sustainability into the fabric of financial and economic policymaking.

The European Central Bank has announced an expansion of its climate change initiatives, highlighting three primary areas of focus for the years 2024 and 2025, as shown in Figure 4 and 5. These include: assessing the impacts and risks associated with transitioning to a green economy, particularly focusing on the related costs and necessary investments; evaluating the escalating physical impacts of climate change and the economic implications of adaptation strategies for a warming planet; and exploring the risks associated with the loss and degradation of natural environments, examining how these risks interact with climate-related issues and their potential effects on the ECB's operations within the economic and financial systems.

Each area addresses specific challenges and outlines targeted actions. For the transition to a green economy, the ECB commits to intensifying its analysis of transition funding effects, green investment necessities, and the broader economic implications of these shifts, such as impacts on labor markets, productivity, and economic growth. These insights will inform enhancements to the ECB's macroeconomic modeling frameworks, ensuring they reflect the nuances of a green economy.

³¹ Lagarde, (2024)

Regarding the physical impacts of climate change, the ECB plans to deepen its examination of how extreme weather events influence inflation and overall financial stability. This involves integrating climate-related variables into climate scenarios and macroeconomic projections, which will aid in assessing the potential economic and financial disruptions if adequate adaptation measures are not implemented.

On the issue of nature loss and degradation, the ECB recognizes the intertwined relationship with climate change and is set to explore the economic and financial implications further. This includes studying the role of ecosystems in economic stability and how their degradation could pose significant risks to financial systems.

Moreover, the ECB is set to launch its eighth Environmental Management Programme, aiming to achieve its 2030 carbon reduction targets. This initiative includes incorporating eco-design principles into the upcoming series of euro banknotes and considering environmental impacts in the design of a potential digital euro.

The ECB's renewed focus and expanded efforts follow a comprehensive review of its initial climate actions initiated with its 2022 climate agenda. Adjustments to the work plan reflect the evolving environmental landscape, improved data availability, and advancements in analytical methodologies. These ongoing and future actions are designed not only to enhance the ECB's climate-related indicators, risk monitoring, and disclosures but also to ensure that the ECB continues to play a pivotal role in developing climate-related policies within European and international forums.

Looking forward, the ECB remains steadfast in its commitment to regularly reviewing and adapting its actions to ensure they effectively address the challenges posed by environmental and climate issues while fulfilling its broader mandate. This forward-thinking approach highlights the ECB's role as a pivotal player in promoting sustainable economic growth and financial stability in an era marked by significant environmental challenges.

Figure 4: European Central Bank's Climate and Nature Plan 2024-2025

| | | H1/2024 | H2/2024 | H1/2025 | H2/2025 | |
|--|--|---|--|---------|---------|--|
| Continue and expand | Macroeconomic and financial stability analysis | Incorporate green transition policies into conjunctural analysis and macroeconomic models | | | | |
| | | Further develop risk monitoring and the macroprudential policy framework, and continue work on sustainable finance | | | | |
| | Stress testing and scenarios | Contribute to the Fit-for-55 stress test | | | | |
| | | Chair the workstream of the Network for Greening the Financial System on Scenario Design and Analysis, leading the development of short-term scenarios and the provision of regular updates and improvements of long-term scenarios | | | | |
| | Monetary policy strategy and implementation | Implement climate-related pool limits in the collateral framework assuming all technical conditions are in place | | | | |
| | | Introduce climate-related disclosure requirements in the collateral framework from 2026 | | | | |
| | | Consider climate change in the preparation of monetary policy decisions | | | | |
| | Banking supervision | Assess and follow up on banks' alignment with ECB supervisory expectations | | | | |
| | | Perform various supervisory actions on climate and environmental aspects, including preparatory work on transition planning | | | | |
| | Climate-related data | Regularly expand and release updates of climate change-related indicators | | | | |
| | | Acquire and provide climate-related data and integrate climate data points into the ECB's own data collections | | | | |
| | Payments, banknotes and market infrastructure | Consider environmental aspects in the preparatory phase of the design of a digital euro | | | | |
| | | Consider the relevance of environmental risks in the oversight of financial market infrastructures | | | | |
| | | Eco-design of the next euro banknote series and of banknotes with 100% organic cotton by 2027 | | | | |
| Environmental performance of the ECB's own operations and portfolios | Implement the Environmental Management Programme for 2022-2024 to continuously improve the ECB's environmental performance | | Publish and implement the Environmental Management Programme for 2025-2027 to continuously improve the ECB's environmental performance | | | |
| | Continue to green the ECB's non-monetary policy portfolios and disclose progress | | | | | |

A Strategic Roadmap outlining key initiatives and timelines for integrating environmental sustainability into macroeconomic frameworks, stress testing, monetary policies, banking supervision, data management, payment systems, and operational practices.

Figure 5: European Central Bank's Climate Action Framework 2024-2025

| | | H1/2024 | H2/2024 | H1/2025 | H2/2025 |
|----------------------|---|--|---------|---------|---------|
| Initiate and explore | Focus area 1: Navigating the transition to a green economy | <ul style="list-style-type: none"> Analyse the effects of transition funding and risks on the monetary policy transmission mechanism Explore, within our mandate, the case for further climate change considerations in monetary policy instruments and portfolios Assess green investment needs and its funding Analyse the structural consequences stemming from the transition Advance the macroeconomic modelling framework with a focus on climate aspects | | | |
| | Focus area 2: Addressing the increasing physical impact of climate change | <ul style="list-style-type: none"> Take further steps to integrate climate change impacts into climate scenarios and the analytical framework used for macroeconomic projections Explore the impact of climate adaptation, including the insurance protection gap Improve the availability of data to support physical risk analysis | | | |
| | Focus area 3: Advancing work on nature-related risks | <ul style="list-style-type: none"> Further explore the economic and financial implications of biodiversity loss and the degradation of nature | | | |

Initiatives and Strategic Focus Areas for the Transition to a Green Economy, Addressing Climate Change Impacts, and Tackling Nature-Related Financial Risks across two-year horizons.

In conclusion, this chapter has delved into the European Central Bank's strategies for integrating climate change considerations into its operations. The ECB has made significant strides in incorporating climate risk assessments into its monetary policy, adjusting corporate bond holdings, and enhancing risk management practices. By conducting comprehensive climate risk stress tests and improving climate-related data collection, the ECB aims to bolster the financial system's resilience against environmental shocks. Under the leadership of President Christine Lagarde, the ECB's "Climate and Nature Plan 2024-2025" outlines ambitious steps to support a sustainable, low-carbon economy, ensuring that its policies remain robust and relevant in the face of climate change.

V. CONCLUSION

This research has addressed how the European Central Bank integrates climate change concerns into its operating and decision-making framework. We detailed how the bank is reshaping its monetary and operational policies to build a greener and more resilient economy by analyzing certain ECB initiatives.

Christine Lagarde, the leader of the ECB, has acknowledged that climate change has significant consequences on price stability as well as the broader economy. As a result of this recognition, several important steps have been taken to incorporate climate into the heart of ECB's operations. One of them was changing monetary policy operations at the ECB. The ECB in its monetarist policy operations began integrating climate risks by decarbonizing corporate bond holdings as well as adjusting collateral frameworks to better reflect financial risks due to climatic changes. The goal of this is to encourage issuers to improve climate disclosures and reduce carbon emissions through preferential treatment for assets with superior climate performance.

Furthermore, comprehensive stress tests regarding climate risk have been done by the central bank's authority on the Eurosystem balance sheet and supervised banks in relation to other economic actors exposed to such hazards all over Europe. These stress tests have highlighted the need for banks to enhance their climate risk assessment capabilities and incorporate climate risk into their credit risk models. This proactive stance not only prepares the financial sector for potential climate impacts but also sets a standard for other financial institutions to follow.

Moreover, enhancing climate risk modeling and data collection has also been a focal point for the central bank. In conjunction with national central banks, it developed harmonized statistical indicators relating to environmental issues across euro area countries which aim at increasing quality and accessibilities for this type of information useful in decision-making by policymakers, financiers or even members of parliament. It is an initiative that shows transparency commitment among others while addressing ecological transformations within such institutional frameworks.

ECB supervises banks so that they can adopt safe and prudent approaches when identifying, assessing and managing exposures linked with global warming. This involves disclosing their exposure to these risks in a transparent manner thereby making the financial sector more resilient to climate and economic changes. The ECB carries out strict supervision of banks, which is intended to ensure that not only are they aware of climate change risks but are taking preventive measures against them.

The future “Climate and Nature Plan 2024-2025” by the ECB outlines some key measures aimed at integrating environmental sustainability further into its policies and practices. This includes assessing the impacts and consequences of moving towards a green economy, evaluating the heightening physical effects of global warming as well as exploring threats from degradation and loss of ecosystems.

The ECB’s approach towards climate change in its operational framework is therefore a huge move towards a sustainable and strengthened economy. Consequently, the bank protects financial stability by adjusting its monetary policies to incorporate climate risks modeling and building up banks capacity to manage such risks with another aim of environmental friendliness. The findings of this thesis support the need for an inclusive and future-oriented monetary policy within the context of climate change. As the ECB continues to refine its strategies and actions, it will play a pivotal role in shaping a greener and more resilient financial system for the future.

VI. BIBLIOGRAPHY

CHAPTER 1

1. Chakraborty, S., Pattanayak, A., Mandal, S., Das, M., & Roychowdhury, R. (2014), An Overview of Climate Change: Causes, Trends and Implications, I.K. International Publishing House Pvt. Ltd. (New Delhi).
https://www.researchgate.net/profile/RajibRoychowdhury/publication/262804698_An_Overview_of_Climate_Change_Causes_Trends_and_Implications/links/6102493a169a1a0103c3bb32/An-Overview-of-Climate-Change-Causes-Trends-and-Implications.pdf
2. US EPA (2024), "Climate Risks and Opportunities Defined", US EPA (Washington, D.C.) accessed at <https://www.epa.gov/climateleadership/climate-risks-and-opportunities-defined>
3. University of Bath (2024), "Risk vs opportunity: the relationship between the economy and climate change", University of Bath (Bath) accessed at <https://online.bath.ac.uk/content/risk-vs-opportunity-relationship-between-economy-and-climate-change>
4. Schroders (2016), "The impact of climate change", Schroders (City) accessed at <https://mybrand.schroders.com/m/01053abe732aa4a1/original/The-impact-of-climate-change.pdf>
5. Mark Carney (2021), "Investing in Net-Zero Climate Solutions Creates Value and Rewards", United Nations accessed at <https://www.un.org/en/climatechange/mark-carney-investing-net-zero-climate-solutions-creates-value-and-rewards>
6. Mark J. Koetse, Piet Rietveld (2009), Department of Spatial Economics, VU University, De Boelelaan 1105, 1081 HV (Amsterdam), accessed at <https://pdf.sciencedirectassets.com/271737/1-s2.0-S1361920909X00039/1-s2.0-S136192090800165X/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEGoaCXVzLWVhc3QtMSJGMEQCIDI3dNemaoHocvZ0xEPSTo7yo5oGhOfJNm32grXOQ4AiBeeWBrhDiLZELTwhEVikG0XMGf%2FIdGwudNfaKjZ%2BViSSqzBQhzEAUaDDA1OTAwMzU0Njg2NSIMG0ccQeJ1jDipXUwjKpAFm0uiHbI8smULLgxHRNzWseTUkU2ZTVL9KS3%2FXTWhayrYfr8yDyaSGpgopEZjYgDwWEi0FDNxwXyeyisfK%2Fo9J0RNquKfV0qzBMx1WRG7RXlv%2BDKmpKJJV8im9%2B%2F5Xn7bXAzgMaH3s%2FCm%2FMUstoBiPXBRUZzJqaaLBrY4J6Lvc%2B6jFqqrpbpUZWDIWzwQbh1ZTSahg3moaZKNslinTEPSSkmb9QqUthBwHRoSkJA5CqSmVNCwI9djN3ynNT7cQhKUVjbRuVkkNNNBA%2BoZmsjHF%2BTcHN6RLCVpr04Lt7i%2FURiIrIFGm%2FhWJQm4hIGNgoUhGFE1K%2FOGJdIMaCN1ruTpqgokm5zVRTIPd46ppoNhaDGYCAMjY4lqPSB8iFI4QF9sFgT0oqiCOst7eJfRHldF6PPsVFy2ViKzdlRTnifE87hYoEzLs5m2YJEKV6gsRRONztTIOeqizQbhS0vyucO4soa2xatA49%2FBmNmJ>

https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200227_1~5eac0ce39a.en.html

7. Lagarde, Christine (2020), "Climate Change and the Financial Sector", Speech at the launch of the COP 26 Private Finance Agenda, European Central Bank, accessed at https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200227_1~5eac0ce39a.en.html

CHAPTER 2

1. Euronext (2022), "European Central Bank (ECB): Role, Functions and Objectives", Euronext News, accessed at <https://www.euronext.com/en/news/european-central-bank-ecb-role-functions-and-objectives>
2. Ioannidis, Michael, Hlásková Murphy, Sarah Jane, & Zilioli, Chiara (2021), "The Mandate of the ECB: Legal Considerations in the ECB's Monetary Policy Strategy Review", European Central Bank Occasional Paper Series No. 276, SSRN, accessed at <https://deliverypdf.ssrn.com/delivery.php?ID=75410300900406612610608611701610811108905508604501603212501904701507704401901600000010804101008007017039072092048025018098074117123112123068022073043010112120090108000085024080095086083064126089030084085031118083102107110102068020&EXT=pdf&INDEX=TRUE>.
3. European Central Bank (2024), "Climate Change and the ECB", European Central Bank, accessed at <https://www.ecb.europa.eu/ecb/climate/html/index.en.html>
4. Fontana, Olimpia (2024), "What Role Does the ECB Play in Addressing Climate Change?", Centro Studi sul Federalismo Research Paper, March 2024, ISSN: 2038-0623, ISBN: 979-12-80969-13-2, accessed at https://csfederalismo.it/images/2024/Research-paper/CSF-RP_ECB-Climate-Change_Fontana_March2024.pdf
5. European Central Bank (2006), "Monetary Policy Instruments", European Central Bank, accessed at https://www.ecb.europa.eu/ecb-and-you/educational/shared/img/MP_0806_300dpi-textsheet.en.pdf
6. European Central Bank (2024), "Climate Change and the ECB", European Central Bank, accessed at <https://www.ecb.europa.eu/ecb/climate/html/index.en.html>
7. European Central Bank (2024), "Introduction to Monetary Policy", European Central Bank, accessed at <https://www.ecb.europa.eu/mopo/intro/html/index.en.html>
8. Treaty establishing the European Community (Amsterdam consolidated version) (1997), "Article 105", Official Journal C 340, accessed at <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:11997E105:EN:HTML>

9. IPCC (2018), "Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty," Intergovernmental Panel on Climate Change, accessed at (https://www.researchgate.net/profile/PeterMarcotullio/publication/330090901_Sustainable_development_poverty_eradication_and_reducing_inequalities_In_Global_warming_of_15C_An_IPCC_Special_Report/links/6386062b48124c2bc68128da/Sustainable-development-poverty-eradication-and-reducing-inequalities-In-Global-warming-of-15C-An-IPCC-Special-Report.pdf).

CHAPTER 3

1. European Central Bank (2024), "Managing Climate-Related Risks", European Central Bank, accessed at https://www.ecb.europa.eu/ecb/climate/managing_mitigating_climatel_risk/html/index.en.html.
2. European Central Bank (2022), "ECB takes further steps to incorporate climate change into its monetary policy operations", European Central Bank, accessed at <https://www.ecb.europa.eu/press/pr/date/2022/html/ecb.pr220704~4f48a72462.en.html>.
3. European Central Bank (2022), "Banks must sharpen their focus on climate risk, ECB supervisory stress test shows", European Central Bank Supervision, accessed at <https://www.bankingsupervision.europa.eu/press/pr/date/2022/html/ssm.pr220708~565c38d18a.en.html>.
4. European Central Bank (2022), "Banks must sharpen their focus on climate risk, ECB supervisory stress test shows", European Central Bank Supervision, accessed at <https://www.bankingsupervision.europa.eu/press/pr/date/2022/html/ssm.pr220708~565c38d18a.en.html>.
5. European Central Bank (2024), "Climate change-related indicators", European Central Bank, accessed at <https://www.ecb.europa.eu/stats/all-key-statistics/horizontal-indicators/sustainability-indicators/html/index.en.html>.
6. European Central Bank (2022), "Climate change and banking supervision", European Central Bank Supervision, accessed at <https://www.bankingsupervision.europa.eu/about/climate/html/index.en.html>.
7. European Central Bank (2024), "ECB steps up climate work with focus on green transition, climate and nature-related risks", European Central Bank, accessed at <https://www.ecb.europa.eu/press/pr/date/2024/html/ecb.pr240130~afa3d90e07.en.html>.

