Climate Risks, Just Transition, and Central Bank Policy for Sustainable Economic Growth

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Submitted: 6 December 2024 — Revised: 5 January 2025 — Accepted: 7 January 2025

Abstract

Climate change poses major challenges to the global economy and society, requiring coordinated efforts to alleviate its impacts. Given the nature of climate change, the adoption of central bank policies offers a more holistic strategy for managing and mitigating climate risks, thereby bolstering the resilience of the financial system and the economy. This paper aims to explore the critical tasks of coping with climate risks and proposes an integrated central bank climate regulatory framework to foster sustainable economic growth, by exploring the transmission mechanisms of central bank policies to support the establishment of just transition targets. The framework delineates three essential strategies, namely: (i) data, tools, and research, (ii) regulation and supervision, and (iii) climate transition policy. This paper shows that the central bank's climate policies to manage transition risks can navigate just transition and support the achievement of sustainable economic growth. The operationalization of these strategies extends beyond the traditional purview of central bank activities, necessitating a collaborative and synergistic approach among regulators and industry stakeholders to guide the global economy toward sustainability.

Keywords: climate risks; just transition target; sustainability; sustainable finance; sustainable economic growth; central bank policy
JEL Classification: O13; Q52; Q54; Q56; Q58

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1. Introduction

The concerning rise in global temperatures is acknowledged to stem primarily from the increase in greenhouse gas (GHG) concentrations resulting from anthropogenic activities over the years (IPCC, 2023). As a result, severe and disastrous weather events create physical risks to the economy and are increasing in frequency, intensity, and geographic spread. They disrupt the continuity of production and the supply of goods and services, which causes market imbalances.

Climate change is a barrier to economic development as it poses a formidable threat to the economy and society, requiring urgent and coordinated action to mitigate its impacts. According to a report by Aon (2021), extreme weather events have caused economic losses of US$5.1 trillion in the past two decades, and this figure could rise to 18% of global GDP by 2050 if no effective measures are taken (Guo et al., 2021). In its recent report, the WEF (2023) shows that climate and environmental risks are the core focus of global risk perceptions over the next decade.

Such awareness is increasingly spreading across the globe, affecting consumers and investors behavior. Investors and consumers are increasingly favoring more sustainable activities or products (Aulia et al., 2024). There is an urgent necessity for a rapid global transition away from high-emitting sectors to prevent the significant dangers of climate change from both environmental and socio-economic standpoints. Consequently, high-emitting sectors are expected to peak by 2030 and then decline steadily (International Energy Agency, 2023). The policies, particularly from the advanced economy, implemented to address climate change, are increasingly impacting the global economy (NGFS, 2024). The raising awareness, the changing behavior and policies create transition risks for firms, jobs and the national economy. These risks are further intensified by the responding disruptive technological innovations.

The physical and transition risks of climate change could potentially hinder the central bank's achievement of its inflation target and increase the risk of financial instability (Dikau & Volz, 2018). This underscores the need for the central bank to ensure that the financial system is resilient to the transition toward a low-carbon economy and is able to finance the transition efficiently (Carney, 2015). This eventually crystallized new wisdom regarding the important role of central banks in realizing sustainable economic development.

As the initial response to climate risks are considered insufficient (United Nations, 2024), the need to achieve green growth sustainably is pressing as the window to avoid global catastrophe is shrinking. The key to achieving sustainable growth lies in accelerating the scale-up of sustainable finance and ensuring that the transition process is managed properly to enable a just transition—leaving no one behind in the move toward a more sustainable world. Nevertheless, given the significant role central banks play in promoting sustainable economic development (Dikau & Volz, 2021), a robust framework to guide the integration

of central bank policy with climate risk considerations is still lacking.

This paper aims to explore the critical tasks to cope with climate risks and propose an integrated central bank regulatory framework to foster sustainable economic growth. Two main issues will be addressed. First, how to establish a pivotal linkage between concerted efforts to mitigate climate risks, on the one hand, and the central bank's responsibility in preserving financial system stability and supporting sustainable economic growth, on the other hand. Second, the impact of climate-related policies on transition risk management in supporting the achievement of sustainable economic growth.

The paper provides several contributions of thought and novelty, which can be seen from several strands. First, it seeks to bridge this gap by proposing a comprehensive framework designed to craft an optimal sustainable regulatory framework. Such a framework is envisaged not only to preclude the emergence of systemic risks associated with climate change but also to mitigate the challenges arising from the transition to a low-carbon economy. Second, by integrating climate risk into the broader regulatory framework, this proposed architecture aims to optimally fortify financial systems against the perils associated with climate change, ensure their resilience amid the transition to a low-carbon economy, and optimize the benefit of the transition to sustainability. Lastly, by addressing the current void in the literature and policy discussion, it also aspires to guide policymakers, financial regulators, and stakeholders toward proactive and effective strategies to navigate the complexities of climate-related risks and transitions.

Following this introduction, section 2 is the literature review that explores the context of central bank mandates on climate-related risks and contesting the generic concept of "just" transition to avoid an "unjust" transition, followed by section 3 that discusses the methodology. Section 4 presents the first theme of results and analysis of the study which are the conceptual frameworks of the roles of the financial sector players in achieving just transition. Recognizing the inadequacy of conventional central bank policies in managing climate risks, section 5 proposes the second theme of results and analysis of the study which are an integrated central bank climate regulatory framework for climate risks. This section discusses the potential sustainable regulations along with essential strategies for addressing climate risks and sustainability issues. This section also explores a hypothetical transmission mechanism on how climate-related policies affect the establishment of a "just" transition to support sustainable economic growth. Section 6 concludes the paper.

1.1. Contextualizing Central Bank Mandates on Climate-Related Risks

The main mandate or responsibility of most central banks in the world is to maintain low and stable inflation in the short to longer term, as well as maintain financial stability. However, in the last two decades we have noted a significant shift in the perceptions of academics and central bankers regarding the role of

central banks in addressing several issues "beyond stability", particularly those related to sustainable development and climate change. Many central banks have 'implicit' goals to support the achievement of sustainable economic growth, i.e. through regulations for sustainable development financing (Juhro, 2015).

Climate change directly impact the prices of goods and services and poses risks to financial system stability, thereby affecting the central bank's objectives of ensuring price stability, financial stability, and sustainable growth. These challenges have expanded expectations for central banks to address climate change, even beyond their traditional mandates (Eichengreen, 2021). Carney (2015) highlights the link between climate change, price volatility, and financial system stability, emphasizing the urgency of managing climate-related risks to prevent significant losses.

Some central banks in emerging markets and developing countries (EMDCs) have made significant progress in greening the financial system and addressing climate-related risks. They have achieved this by adapting existing policy tools and introducing new instruments to strengthen macroprudential regulation. This aligns with the broader mandates of many EMDC central banks, which include supporting sustainable development and aligning with government economic policies, in addition to their tradition focus on price stability (Juhro, 2023).

Those countries typically approach green finance and climate change through three main strategies. The first involves green credit allocation instruments, designed to channel credit towards green sectors. The second focuses on green regulatory instruments, such as prudential and macroprudential measures, aimed at safeguarding financial stability. Lastly, some countries implement other green central banking initiatives, such as developing green finance guidelines or establishing green bond markets (Dikau & Ryan-Collins, 2017).

Dikau & Ryan-Collins (2017) and Dikau & Volz (2021) also explore how existing traditions of financial intervention have influenced the approach of emerging markets toward green growth and credit allocation. Central banks in countries like India and Bangladesh, which historically engaged in centralized credit allocation policies, have incorporated green project categories – particularly renewable energy initiatives – into their priority loan programs. For example, Bangladesh's central bank green refinancing program has supported approximately 10% of the population to install home solar power systems.

In countries such as South Korea, Brazil and China, national development banks have played a more central role by providing credit support to green sectors, while the central banks focus on suppressing credit to carbon-intensive sectors. In Brazil, the central bank requires commercial banks to stress-test their lending portfolios against environmental and social risk criteria and to maintain additional capital reserves to cover these risks (Dikau & Ryan-Collins, 2017).

The growing need for sustainable financing further underscores the imperative for central banks and other financial regulators to assume a leadership role in this endeavor (Anwar et al., 2020). By regulating the banking sector, central banks can proactively influence private investment decisions, promoting green

finance through incentives for sustainable projects while limiting funding for carbon-intensive industries.

Furthermore, several cases demonstrate that environmental regulations imposed by environmental institutions are often weak or even ignored by economic actors. Consequently, environmental damage persists and worsens. In this context, central banks, with their substantial influence on the economy, are well-positioned to encourage economic actors to integrate environmental considerations into their profit-seeking activities within financial markets (Dikau & Ryan-Collins, 2017).

These above empirical and practical discourse has emphasized the important role of central banks in realizing sustainable economic development. However, this also poses a challenge for central banks, as they must encourage other financial institutions to actively support sustainable finance initiatives.

The execution of the 'wider' mandates, however, requires a judicious approach, given the unique challenges posed by climate-related risks (Lamperti et al., 2021). In the dynamic landscape of climate-related financial risks, the efficacy of conventional microprudential policies becomes questionable due to the inherent uncertainty surrounding the complete realization of climate risks. The evolving nature of these risks challenges the suitability of traditional measures, necessitating a forward-thinking, well-defined regulatory framework and a strategic alignment (Pfister & Valla, 2021). Moreover, the limitations of microprudential policies are underscored by their exclusive focus on individual firms, failing to consider the broader systemic implications and intricate feedback loops triggered by climate shocks (Coelho & Restoy, 2023). Given the prolonged time horizon and the systemic nature of climate risks, the adoption of monetary and macroprudential policies emerges as a more apt and comprehensive strategy for effectively managing and mitigating these multifaceted threats, thereby enhancing the resilience of the financial system and the economy. Regrettably, the existing landscape reveals a dearth of a robust framework guiding the integration of central bank policy with climate risk considerations.

1.2. Contesting The Generic Concept of "Just" Transition

In response to the exigency of climate change, nations globally have committed to curtailing their emissions under the Paris Agreement—a pivotal accord aspiring to confine the escalation of global temperatures to well below 2°C, with a preference for limiting the increase to 1.5°C, relative to pre-industrial levels (UNFCCC, 2015). Each country's commitment to achieve their climate target is articulated through a Nationally Determined Contribution (NDC), delineating specific emission reduction targets and corresponding plans.

In making the transition, each country's context will be different and no two national transitions will be alike. Countries' economic structures and emissions profiles necessarily influence the policies their government implements and the most affected sectors. As a result, the relative impacts of the transition on sectors

in each region will vary considerably. For example, concerns over energy access in the context of energy transition, will appear different in countries rich in energy resources (whether fossil fuels or renewables) and those relying more heavily on imports (Montague et al., 2024).

A just transition is conceptually broad and context-specific, tailored to the unique needs of each region, sector, and community. Justice is a multi-faceted concept (OECD, 2024). The uneven distribution of transitionary costs and benefits is an issue in all countries but can manifest differently in developing countries. In industrialized nations, the focus is often on managing the decline of carbon-intensive industries like coal mining, while in developing countries, due to financing and data gaps, human capacity constraints, and governance challenges, the transition may involve tackling energy poverty and creating new opportunities in renewable energy sectors. Without careful planning, the transition could hinder growth and compromise competitiveness in some countries. Regardless of the context, a successful just transition requires a balance between environmental sustainability and social equity.

At the national level, a just transition acknowledges that the impacts of climate change—and the costs of carbon mitigation and adaptation—are unevenly distributed. It involves all affected parties and addresses these inequities to ensure political support for climate action, ultimately helping to avoid delays in achieving global net-zero goals. As recognized at the international level through its inclusion in the 2015 Paris Agreement, a just transition not only advances climate action but also contributes to progress on all Sustainable Development Goals (SDGs), particularly those related to affordable and clean energy, sustainable economic growth, reducing inequalities, and responsible production and consumption.

The transition to a low-carbon economy is essentially a global challenge that requires cooperation across borders. Developed countries, which have historically been the largest contributors to greenhouse gas emissions, have a responsibility to support developing countries in their transition. This includes providing financial and technical assistance, as well as addressing the potential spillover effects of their climate policies on developing economies. To address this, policies such as border carbon adjustments must be also carefully designed to ensure that they do not disadvantage developing countries (UNFCCC, 2023).

Climate action is a global undertaking, and supporting a just transition for developing countries requires a global perspective. Establishing fair emission reduction targets, however, is a complex process (Lo & Cong, 2022). Given that carbon emissions are presented as the global metric for tracking NDC achievements and progress (UNFCCC, 2024b), we argue that using absolute emissions alone fails to capture the true responsibility and impact differences between Advanced Economies (AEs) and Emerging Market Economies (EMEs). While

acknowledging that the absolute emissions metric[1] aligns with global carbon budget constraints and offers simplicity, we propose that a carbon intensity metric would provide a more comparable measure across jurisdictions and promote a more equitable and effective approach to climate action. This shift would create a more transparent framework that balances the rights and responsibilities of each nation, enabling the international community to make meaningful progress toward the Paris Agreement's long-term goals, advancing toward a low-carbon economy and achieving net-zero emissions.

The NDCs under the Paris Agreement, often rely on total annual figures in absolute terms (UNFCCC, 2024a). The discrepancy arises from the fact that AEs with extensive industrialization may exhibit high per capita carbon emissions, yet their absolute total annual figures could be low due to smaller populations. Conversely, EMEs might have low per capita emissions but high absolute total emissions due to larger populations. Recognizing that carbon emissions are an inherent outcome of essential human activities (Canadell et al., 2010), it is crucial to account for emissions on an individual basis to uphold the fundamental right of each person to emit. This perspective highlights the need for a more nuanced approach to carbon accounting—one that considers a global framework for individual rights to emit, promoting equity and fairness in addressing climate challenges worldwide.

Industrialization, however, has precipitated emissions beyond natural levels, exacerbating global warming and climate change. Therefore, the optimal instantiation of carbon objectives should penalize activities engendering carbon emissions, particularly those associated with environmentally deleterious industrial practices. Consequently, a pivotal strategy for effectuating a fair and efficacious transition lies in measuring carbon emissions as carbon intensity—a metric indicative of the amount of carbon emitted per unit of measurement. In the context of a nation, greenhouse gas emissions should be evaluated on a per capita basis. This approach recognizes the fundamental right of each individual to produce emissions necessary for survival, while concurrently penalizing excessive emissions resulting from environmentally detrimental industrial practices.

As illustrated in Figure 1, the five most populous countries globally (China, the U.S., India, Russia, and Indonesia) also stand out as the largest carbon emitters in absolute terms. However, a per capita analysis, presents a distinct perspective, with only the U.S. and Russia ranking among the top five. Specifically, it is observed that the per capita carbon emissions in South Korea are 92% higher than those in Indonesia. However, when evaluated in absolute terms, Indonesia's total emissions surpass those of South Korea by 177%. This suggests that carbon emissions in EMEs are primarily influenced by population size rather than

[1]Two prevalent approaches to presenting carbon emissions are: absolute total carbon emissions and carbon intensity. While absolute total emissions represent the total annual figures of carbon emissions, carbon intensity divides these emissions by a unit of measurement, such as carbon emissions per capita or financed emissions per million dollars of financing (UNFCCC Regional Climate Week, 2023).

industrialization.

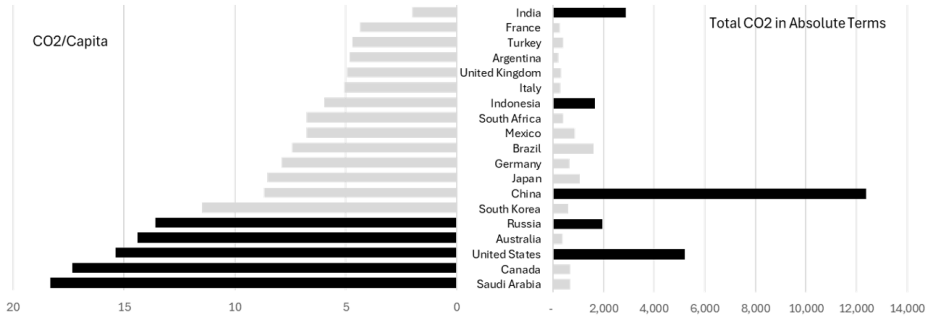

Figure 1: The Total and per Capita Carbon Emissions of G20 Members
Constructed by authors, Data source: Ritchie et al. (2023)

Examining specific examples, Indonesia emerges as the 5th largest coal-carbon emitter in absolute terms, behind China, South Africa, Australia, and Japan (Figure 2), yet it ranks 10th in per capita terms. Notably, Figure 2 reveals that some AEs, such as South Korea, Japan, and Germany, exhibit higher per capita coal-carbon emissions than certain EMEs, such as Indonesia and India, often criticized as environmentally unfriendly. Particularly, it is noted that the per capita coal consumption in Germany is 98% higher than that in Indonesia. Conversely, when considering the total coal carbon emissions in absolute terms, Indonesia exceeds Germany by 67%. This highlights the undeniable reality that AEs often reap benefits from industrialization at the expense of EMEs concerning global carbon emissions.

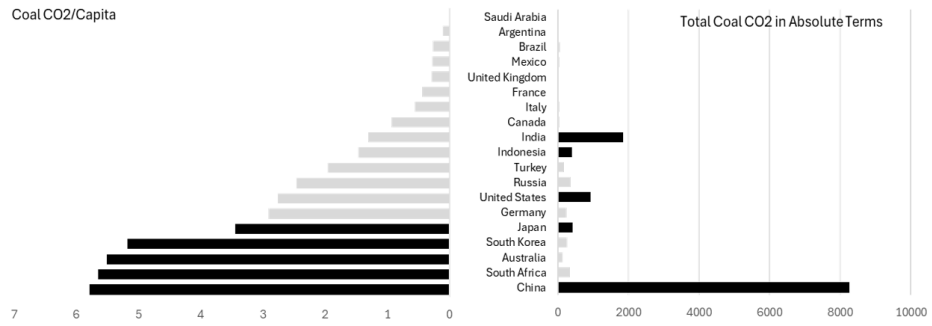

Figure 2: The Total and per Capita Coal-Carbon Emissions of G20 Members
Constructed by authors, Data source: Ritchie et al. (2023)

While the ultimate net zero target would be the same, the pathways leading to them diverge significantly. If we use the total emissions in absolute terms

as a benchmark, EMEs (with lower emissions per capita) may need to have a steeper curve in their transition plans, which is costly. On the other hand, AEs (with higher emissions per capita) may enjoy a flatter curve in their transition plans. Striking a balance becomes imperative; penalizing a nation solely for its higher population, and thus elevated carbon emissions, appears inequitable as it may entail higher costs per capita and erode EMEs' competitive advantages. Simultaneously, a nuanced consideration must acknowledge the imperative of penalizing industrialization, which amplifies carbon emissions beyond natural levels, thereby imperiling human lives and necessitating a commitment to mitigating environmental degradation. This dichotomy highlights the need for AEs to undertake more significant emission reductions than EMEs, following the principle of common but differentiated responsibilities and respective capabilities enshrined in the Paris Agreement. This nuanced assessment underscores the importance of considering both technological advancements and industrialization in evaluating a nation's carbon intensity profile.

There is growing recognition that a just transition must consider impacts not only within individual countries but also across borders and along international value chains. Carbon leakage is a key example of a potential spillover effect; this occurs when emissions rise abroad as a result of implementing or strengthening domestic climate policies (OECD, 2020). Leakage from developed to developing countries may happen through trade and investment channels if stricter climate policies in developed nations increase business costs and reduce returns on investment, while similar policies are absent in developing nations.

Other climate actions with potential spillover effects include recent large-scale green industrial policy initiatives in advanced economies, such as the United States' Inflation Reduction Act and the European Union's Green Deal Investment Plan (OECD, 2024). These policies offer significant potential for advancing low-carbon industries and supporting domestic jobs and industries from a political economy perspective. However, their domestic benefits may come at a cost to developing countries, which often lack the resources and capacity to finance similar large-scale programs (with exceptions like China, Indonesia, and some other large emerging economies). This dynamic raises the risk that low-carbon investments may favor advanced economies, widening the already substantial investment gap between developed and developing nations (Montague et al., 2024). Additionally, there is a risk that developing countries may face increasing exclusion from supply chains if they cannot meet the standards required to benefit from these government-supported industrial policies.

Consistent with the aforementioned perspectives, the adoption of carbon intensity as the pivotal metric in formulating and assessing environmental targets and achievements should also be applied to Financial Institutions (FIs) settings (PCAF, 2022). To optimize the role of FIs in achieving net-zero emissions while enhancing their business sustainability, it is recommended that FIs: (i) initiate climate actions by implementing measures to reduce their overall carbon emissions. This includes adopting resource efficiency strategies and other sustainable

practices; (ii) align their financial reporting with the guidelines established by the GHG Protocol (WBSCD & WRI, 2001) and to acknowledge their financed emissions. These actions would help reduce reputational risks for FIs and potentially increase profitability by enhancing their resilience to the evolving landscape of climate-related risks and regulatory frameworks. Unlike the absolute measure of carbon emissions, adopting a carbon intensity metric would not restrict financial institutions (FIs) in expanding their role to mobilize funds for sustainable projects. Larger FIs would not be penalized for having a more extensive financing portfolio if their carbon emissions per million dollars of financing are lower than those of smaller FIs.

Considering the developments and perspectives outlined above, the discourse of a generic just transition is challenged and lead to the complexities surrounding the narrative establishment of the transition targets and operations. The formulation of a well-defined regulatory framework and a strategic alignment the just transition targets emerge as indispensable for the attainment of climate-centric objectives and fostering sustainable economic growth. These foundational components should serve as catalysts, prompting businesses to harmonize their operational blueprints with the overarching transition agenda. Furthermore, the dissemination of these regulatory imperatives by authoritative bodies imbues them with credibility, enabling the persuasive influence necessary for inducing corporate entities to undertake transformative measures, irrespective of any explicit regulatory mandates or incentivization, which then explains prospective strategies for seamless integration within corporate organizational frameworks.

2. Methodology

The study was conducted using qualitative approach and follows methodology to theory/framework development. This study employs Grounded Theory Methodology (GTM) which is an extensive research methodology that is immensely active in numerous social science research fields. It is one of the most popular techniques applied in qualitative research (Figure 3). Grounded theory is an inductive methodology that provides systematic guidelines for gathering, synthesizing, analyzing and conceptualizing qualitative data for the purpose of theory/framework construction (Charmaz, 2001; Glaser & Strauss, 1967). Grounded Theory Methodology (GTM) aims to be inductive, the researcher does not normally start with a hypothesis (Charmaz, 2005), however, the aim is to discover the hypothesis through the analysis process, and the impression is to discover theory/framework (Strauss & Corbin, 1998). It is not essentially a kind of method, in most research it is rather a way of analyzing data that focuses on discovering things, and uncovering ideas (Strauss & Corbin, 1998). Grounded theory was defined by Charmaz (2006) as a method of conducting qualitative research that focuses on creating conceptual frameworks or theories through building inductive analysis from the data. Birks et al. (2013), defined GTM as mainly a process for theory extraction produced by data analysis. Theory is not

revealed; rather, theory is built by the researcher who sights the world via their own certain lens (Caiazza et al., 2021).

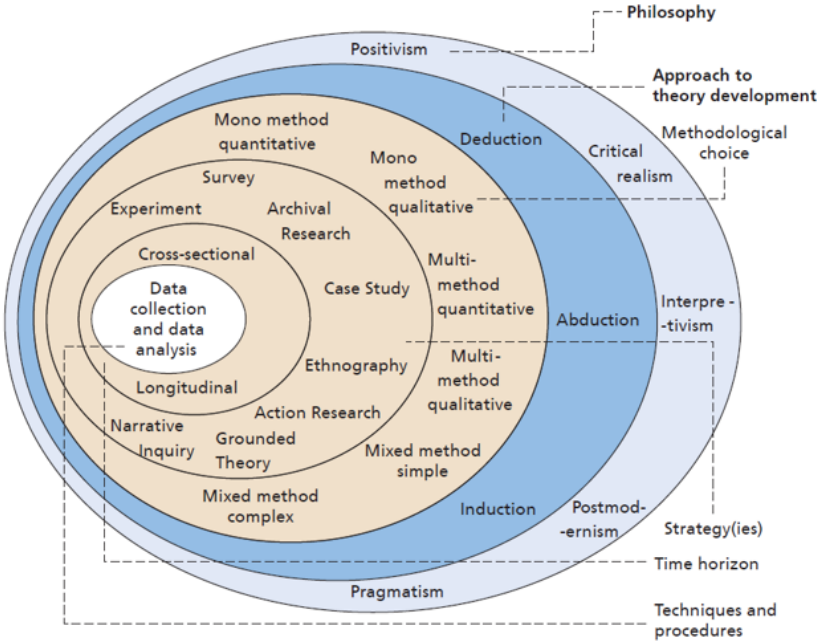

Figure 3: The Research 'Onion'
Source: Saunders et al. (2015)

The induction approach embeds in GTM is to explore a phenomenon, identify themes and patterns and create a conceptual framework (Saunders et al., 2015). Induction approach opposes deduction approach where the conclusion is derived logically from a set of general premises, the conclusion is true when all the premises are analytically true and logical coherence. However, there is no agreement in literature on best reasoning approach whether it is deductive or inductive. It is up to the characteristics of the research such as the emphasis of the research, the nature of the research topic, and researchers' preferences (Creswell, 20134; Saunders et al., 2015). In the qualitative research, the theory is generated by identifying themes and patterns and create a conceptual framework. This approach enables more credible, well-founded, and reliable, which advances the research (Kelemen & Rumens, 2008). Qualitative approach is the one method that is suitable answering the research question of "how" and "why" (Yin, 2014). The GTM procedures are as follows, stating the distinctive features of the grounded theory (Gibbs, 2018) (Figure 4). The study stats with inquiry shaping, followed by qualitative data collection, observation and analysis that are conducted simultaneously. Next, the researcher aims to discover the findings

through the analysis that adopts the inductive approach, which then followed by theoretical elaboration to refine and synthesize the findings. Towards the end of the research the aim will be to reach a more abstracted theoretical/framework understanding of the phenomenon being investigated (Al-Eisawi, 2022).

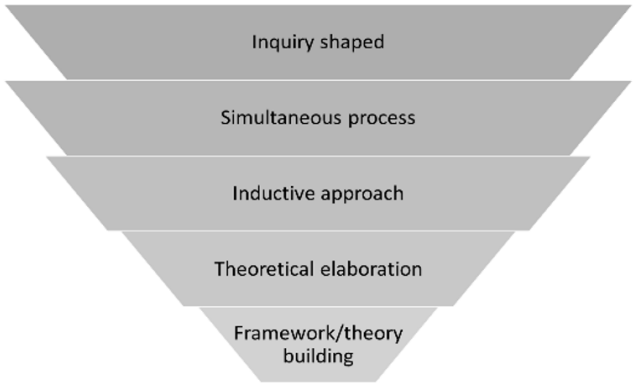

Figure 4: The Core Elements of GTM Analysis
Source: Al-Eisawi (2022)

3. Result and Analysis

3.1. Conceptual Frameworks of the Roles of the Financial Sector Players in Achieving Just Transition

Transitions are complex (World Economic Forum, 2024); many mistakes can be made even with the best of intentions and the best of international best practice to hand. What works well in one region can backfire in another. Due to the complex nature of transitions, a long-term, place-based and multi-pronged policy approach may be best suited to the task. This approach is best founded on an iterative and innovative learning process, informed by constant monitoring through inclusive social dialogue and thus changes flexibly to suit regional needs. However, these challenges also present opportunities for innovation and collaboration. The transition to a low-carbon economy opens avenues for research and development, particularly in clean energy and sustainable practices, which can enhance national competitiveness in the global market. By investing in new technologies and aligning thiss process with just transition targets, countries can create jobs in emerging industries and foster economic growth.

The financial sector is instrumental in enabling a just transition by providing capital for sustainable investments and facilitating risk-sharing mechanisms. To accelerate the scale-up of sustainable finance, financial institutions (FIs) play a pivotal role in mobilizing funds and acting as central counterparties to connect

investors with firms. Given the significant opportunities in global sustainable investments, FIs can leverage their position to drive the transition through efficient sustainable financing. This emphasizes the importance of concerted efforts to develop a robust sustainable finance ecosystem. FIs, including banks, investment funds, and development banks, are crucial in directing investments toward green projects that not only reduce carbon emissions but also create jobs and promote social welfare (Figure 5).

A growing number of financial institutions are incorporating environmental, social, and governance (ESG) criteria into their investment decisions to align with sustainability goals (Selvaraju & Robins, 2024). To maximize impact, FIs must integrate just transition principles into their operations, supporting projects that create equitable opportunities for affected communities, ensuring transparency, and promoting accountability in fund allocation. By doing so, the financial sector can help manage risks such as stranded assets and job losses in fossil fuel-dependent industries while advancing sustainable development.

Innovative financial instruments such as green bonds and sustainability-linked bonds and blended finance are gaining traction as mechanisms to raise capital for projects that support the transition to a low-carbon economy (OECD, 2024). These financial products not only attract environmentally conscious investors but also help mobilize resources for initiatives that contribute to a just transition. However, it is essential to ensure that these instruments are aligned with rigorous sustainability standards to prevent greenwashing and ensure real environmental and social benefits (UNFCCC, 2023).

Coordination and collaboration between public and private sector players is key to achieve a just transition. Public and private sector players need to increase the supply of capital for a just transition by consciously allocating capital to just transition-aligned projects and activities, promoting engagement, advocacy and partnerships and establishing and maintaning a robust sustainable finance ecosystem. They should also accelerate the demand for capital by influencing companies to align with just transition objectives through corporate engagement and stewardship.

Private sector investment is key to mobilising the necessary funds to transition to a net zero economy. Banks, investors, insurers and asset owners have levers at their disposal to allocate capital for a just transition and influence the transition process taking place in the real economy. On top of that, public finance is fundamental for channeling capital toward just transition goals. The mandates of national and international public finance institutions often explicitly include social and environmental sustainability goals, positioning them to lead just transition initiatives. Development finance institutions are key in emerging markets, where investment needs are greatest, social safeguards tend to be weaker, and access to capital can be challenging. Given the complementary mandates, roles, and tools to drive change, cooperation and partnerships between public and private actors are essential to ensuring sufficient investment for a just transition. Development finance institutions, with their ability to provide patient capital and

absorb higher levels of risk, play a catalytic role by attracting additional private sector capital through blended finance solutions (ILO & LSE Grantham Research Institute, 2022).

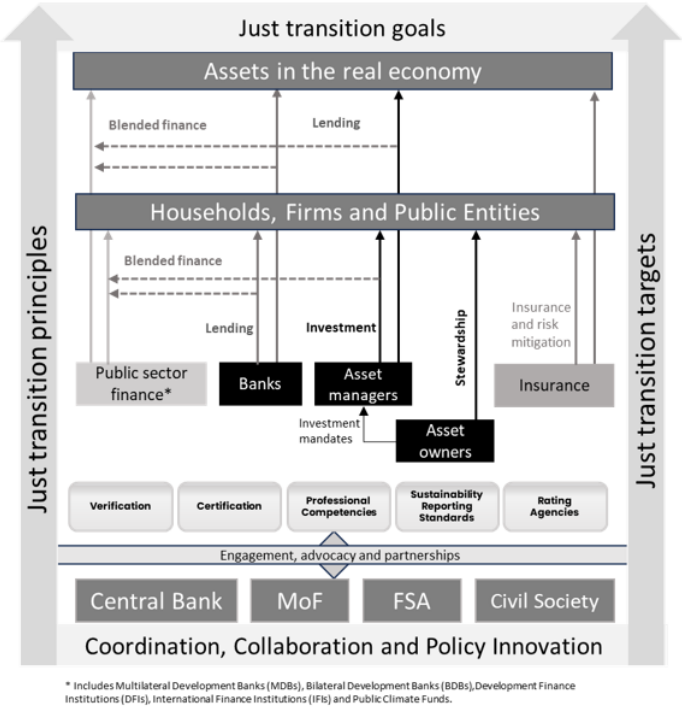

Figure 5: The Roles of the Financial Sector Players in Achieving Just Transition
Source: Authors, adjusted from (ILO & LSE Grantham Research Institute, 2022)

International cooperation, therefore, is crucial in addressing the challenges of a just transition. Developed nations can share best practices and provide financial support to developing countries, enabling them to leapfrog to cleaner technologies without repeating the mistakes of the past. This cooperation can take the form of technology transfer, capacity building, and financing for sustainable development projects (UNFCCC, 2023).

The discussions on some major country experiences (China, India, Latin America countries, and Central-Eastern European countries) bring to light the general adoption of three principal strategies as their approach to achieving just transition to support sustainable economic growth (See Appendix 1). The three principal strategies are as follow.

- *First*, a strong commitment from the government and other authorities is vital for the ongoing efforts for a just transition. It provides clear vision and goals,

policy coherence across various sectors, investment prioritization including just transition dedicate funds that can be used to support affected workers and communities, providing social safety nets and retraining programs. Investments in education and training programs can help workers adapt to new job opportunities in the green economy.

- *Second*, effective governance and institutions. Robust institutions are needed to develop and implement effective policies, regulations, and standards. Engaging with workers, businesses, and civil society organizations is crucial for building trust and ensuring a fair transition. Transparent and inclusive decision-making processes can help build public support for the transition. Regular monitoring and evaluation of policies and programs are essential to ensure accountability and adjust strategies as needed.
- *Third*, collaborative partnerships. Partnerships between governments, businesses, and civil society organizations can leverage resources and expertise to accelerate the transition. International cooperation is essential to share best practices, facilitate technology transfer, finance flows, and capacity building, particularly for developing countries.

Therefore, a just transition is essential to ensuring that the global shift toward a low-carbon economy is fair, inclusive, and sustainable. By balancing environmental, social, and economic considerations, governments, businesses, and financial institutions can work together to create a future that benefits both people and the planet. The transition will not be without its challenges, particularly for workers and communities reliant on fossil fuels, but with the right policies and support systems in place, it can create new opportunities for sustainable growth and development. The role of international cooperation, the financial sector, and sector-specific strategies cannot be understated. These stakeholders must work collaboratively to ensure that the transition to a green economy leaves no one behind and that the benefits of a sustainable future are shared equitably. The transition is complex, but it is also an opportunity to build a more resilient, just, and inclusive global economy.

3.2. An Integrated Central Bank Regulatory Framework for Climate Risks

The issues of welfare and economic sustainability are basically inseparable from the role of the central bank in discharging its duties to achieve and maintain price stability, such as economic growth, full employment, and income equality, as well as environmental/climate change issues. From a central bank policy perspective, the meaning of achieving stability needs to be directed in the context of supporting sustainable economic growth, "stability for sustainability" (Juhro, 2023). Dikau & Volz (2018) distinguish five central bank policy strategies in different areas to achieve several sustainability goals, through microprudential and macroprudential policies, financial market development, credit allocation, as well as soft power and guidelines.

While central banks globally are recognized for their roles in climate actions; – that integrating climate considerations into monetary and macroprudential policies could be the game-changer for sustaining economic growth, concrete initiatives are still a work in progress. The Green Central Bank scorecard of Green Central Bank initiatives (Eames & Barmes, 2022) shows that the adoption of groundbreaking green monetary and financial policies is lagging[2]. The absence of a well-defined climate-related regulatory framework is further underscored by the Financial Stability Board (FSB), which designates supervisory and regulatory practices as the final piece in its roadmap (FSB, 2021).

Figure 6 depicts an integrated climate regulatory framework with the goal of preserving financial system stability in order to support sustainable growth. There are two blocks of thinking underlying this framework. First, this framework is based on the premise that climate-related policies and initiatives are integrated parts of a macroprudential policy framework. Therefore, this strategy should address financial system stability from several policy domains, e.g. time-varying, countercyclical, and structural perspectives; which become the anchor for the implementation of the central bank policy mix. The central bank policy mix emphasizes that the central bank should assess not only the macroeconomic and risk outlooks but also detect macro-financial imbalances in the financial system. Monetary policy responses still need to be directed toward achieving price stability taking into account the financial instability and risk outlook looking ahead, complemented with macroprudential policy and capital flow management. Beyond the central bank, the policy mix is extended by strengthening coordination with the government and related agencies to ensure financial system stability and support overall macroeconomic stability and structural reforms of the nation (Warjiyo & Juhro, 2019).

It is worth noting that safeguarding financial system stability is the objective for macroprudential policy (MPP) calibration, whereby for the case of Indonesia, Bank Indonesia utilizes the three-pronged macroprudential strategies, – (i) maintaining financial resilience by mitigating risk propagation from interconnectedness and contagion; (ii) managing balanced and sustainable intermediation to tackle procyclicality; and (iii) supporting financial inclusion and sustainable finance; which are considered more appropriate approach for emerging market economies. The three-pronged strategies complement each other and will not contradict as the ultimate objective is to achieve financial stability.

Second, a pivotal linkage between the financial system stability framework and the support of climate policies and initiatives, given climate-related risk drivers (transition and physical) that impact economies. In the fast-evolving

[2]The green central banking scorecard in 2024 ranked Bank Indonesia 9th among the G20 countries. The Green Central Banking Scorecard, produced by Positive Money, scores and ranks the full range of green policies and initiatives adopted by G20 central banks. The analysis is based on a literature review, expert consultations, and bilateral interactions with central bankers and supervisors (https://greencentralbanking.com/scorecard/).

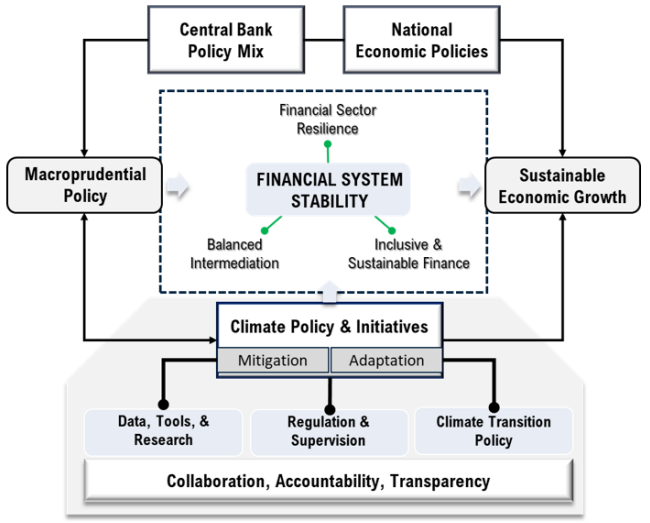

Figure 6: Central Bank Climate Regulatory Framework
Source: Authors

landscape of climate change, two main strategies take the spotlight, namely climate mitigation and climate adaptation. Climate mitigation involves the active reduction or prevention of greenhouse gas emissions to curb the impact of climate change (IPCC, 2022b). On the flip side, climate adaptation calls for adjustments in processes, practices, and structures to either cushion potential damages or seize opportunities arising from the changing climate (IPCC, 2022a).

The framework delineates three essential strategies for addressing climate risks, namely: (i) data, tools, and research, (ii) regulation and supervision, and (iii) climate transition policy. The operationalization of these strategies extends beyond the traditional purview of central bank activities, necessitating a collaborative and synergistic approach among regulators and industry stakeholders to guide the global economy toward sustainability.

3.2.1. Data, Tools, and Research

Despite the comprehensive collection and publication of financial and economic data by central banks worldwide, a glaring gap exists in the availability of data relevant to climate risk assessment and strategy formulation. Hence, the collection of data related to climate risk is integral to the development of robust financial strategies that can withstand the economic impacts of climate change (G20 SFWG, 2021). As shown in Figure 7, we propose several initiatives that central banks could undertake to address this deficiency.

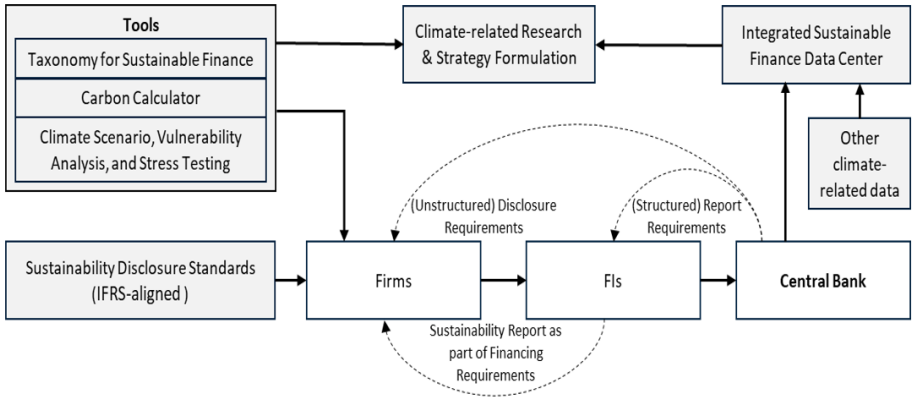

Figure 7: Sustainable Finance Data, Tools, and Research Framework
Source: Authors

First, central banks can facilitate a just transition by advocating for the widespread availability of comprehensive climate-related data (Calice & Demekas, 2024). In doing so, central banks could spearhead the acceleration of the development of the International Financial Reporting Standards (IFRS)-aligned Sustainability Disclosure Standards (IFRS Foundation, 2023). By mandating Financial Institutions (FIs) to submit structured climate-related financing reports, central banks could indirectly encourage FIs to require firms' sustainability reports as part of their financing requirements. This initiative could significantly enhance the transparency and accountability of firms in their climate-related activities. Furthermore, central banks could also play a crucial role in facilitating the development of a blockchain-based integrated and open-access data center. This initiative could enhance data reliability and trust, stimulate the growth of the voluntary carbon market, and foster the expansion of the green financial market. The data center should integrate various climate-related data maintained by other agencies. For instance, in Indonesia, the national climate observatory system managed by the Meteorological, Climatological, and Geophysical Agency (BMKG), and the national natural disaster data center managed by the National Agency for Disaster Countermeasure could provide essential data for assessing climate-related risks.

Second, central banks could take a central role in developing tools to assist firms in preparing sustainability reports. These tools are crucial in providing comparable and high-quality climate-related data. A taxonomy for sustainable finance could help firms classify their activities, a vital component in sustainability reporting. Furthermore, some central banks, such as HKMA and Bank Indonesia, are developing a carbon calculator that could assist firms in calculating their carbon footprints, enabling them to set, track, and achieve emissions targets. The availability of climate scenarios and analysis could also aid firms in assessing

climate-related risks and developing mitigation and adaptation strategies (NGFS, 2018).

Climate stress testing is also an important tool for assessing the banks' resilience to the physical and transition risks. Unlike the usual financial stability stress testing, climate stress testing does not focus on short-term shocks that may result in a financial crisis, but more on forward-looking scenarios with different rates of transition that result in various levels of severity. The central banks and FIs can take insight from this exercise by knowing the pocket of vulnerabilities in terms of sectors, types of FIs as well as individual FIs that have gaps to mitigate physical and transition risks, and finally achieve climate transition goal.

Furthermore, despite the extensive contributions of central banks in various fields of research, a noticeable gap persists in climate-related research (Carè et al., 2023). Strengthening climate-related assessments involves leveraging existing global initiatives and actively engaging in knowledge-sharing and collaboration with academia, research institutions, and relevant stakeholders. This collaborative approach could significantly enhance our understanding of climate-related risks and inform the development of effective mitigation and adaptation strategies.

3.2.2. Regulation and Supervision

The role of central banks in addressing climate risks has been a topic of debate, especially considering that most of these institutions were established before the emergence of climate-related concerns. Consequently, their existing mandates do not explicitly include climate considerations. According to Anwar et al. (2020), while did not directly relate to sustainable finance, 70 out of 135 central banks worldwide have a "sustainable" mandate, with approximately 47 central banks already implementing green measures. In 2023, Indonesia enacted a law mandating the Ministry of Finance, Financial Services Authority, and Central Bank to support sustainable finance. Specifically, the law authorizes Bank Indonesia to regulate and develop sustainable finance and empowers the Financial Services Authority to regulate and supervise carbon exchange. Presuming that central banks are endowed with a climate mandate; they can implement three distinct types of regulations as depicted in Figure 8.

Firstly, it is imperative to enhance the macroprudential instruments to bolster climate mitigation and adaptation strategies, including both price and non-price instruments. Instruments such as liquidity incentives, in terms of reducing reserve requirements for banks that lend to the green sector, are examples of instruments that relate to the pricing of credit. For instance, Bank Indonesia has implemented this type of instrument through its Macroprudential Liquidity Incentive policy (or KLM), which reduces banks' reserve requirements based on the bank's achievement in providing loans to green activities. Other instruments such as Green Loan-To-Value (LTV), Green Down Payment, and Green Credit Allocation, are prevalent as non-price instruments in this domain. The Green LTV serves as an incentive mechanism instituted by central banks that permits banks to offer mortgages for eco-friendly houses with a higher loan-to-value ratio than

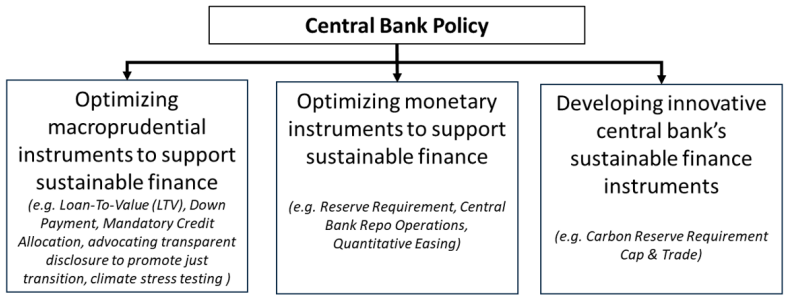

Figure 8: Central Bank Policy Options
Source: Authors

mortgages for non-green properties. Similarly, a Green Down Payment allows a lower down payment for electric vehicle ownership loans than automotive ownership loans for non-green alternatives. Green Credit Allocation mandates banks to designate a specific fraction of their loans towards environmentally friendly activities. This instrument is frequently incorporated as a component of a more extensive credit allocation scheme, typically associated with priority sector lending. This approach encourages financial institutions to increase their green lending practices, thereby promoting environmentally sustainable activities.

The central banks can also promote a just transition in the financial sector by advocating the implementation of standardized disclosure of green transition plans for firms and FIs. For instance, the regulation can obligate firms and FIs to disclose not only the transition plan that aligned with the national plan toward net zero emission but also require transparent information on how the firms and FIs reduce the inequality impact on their employees, suppliers, and other relevant stakeholders. Such requirements can provide a comparison between firms and FIs that may shed light on the credibility of each transition plan, particularly in supporting a just transition toward sustainable goals.

Secondly, the optimization of monetary instruments to bolster climate mitigation and adaptation is crucial. The Green Reserve Requirement, Green Central Bank Repo Operations, and Green Quantitative Easing are typical examples of such instruments. The Green Reserve Requirement serves as an incentive, offering a relaxation of reserve requirements for banks engaged in green lending. On the other hand, Green Central Bank Repo Operations incentivize banks by providing lower repo rates for those involved in green lending. In the context of Green Repo Operations, central banks can also consider green bonds as collateral that are subject to a favorable rate. Incorporating climate-related criteria into collateral eligibility frameworks can encourage financial institutions to hold more sustainable assets. In another case, central banks may permit the refinancing of

green mortgages, combined with standard central bank repo collaterals, with lower rates. Other variations of Green Repo Operations are employed by limiting brown securities as eligible repo transactions. Furthermore, central banks can conduct Green Quantitative Easing by prioritizing the purchase of green bonds and other sustainable assets as part of their quantitative easing programs, supporting the growth of green finance markets.

Thirdly, the introduction of an innovative mechanism to enhance green lending is imperative. Currently, the amalgamation of a carbon tax and carbon trading is perceived as a fundamental component of climate mitigation strategies. This regulatory framework can be adapted and implemented within the financial sector. In this regard, central banks could instigate a carbon reserve requirement cap and trade as the primary climate instrument. Under this proposed initiative, banks would be mandated to maintain a reserve in central banks, calculated on the basis of their environmental sustainability. This reserve could be diminished by purchasing credit points from other banks, which have been awarded by central banks for their green initiatives. Given the comparative financial advantage of acquiring credit points as opposed to maintaining a non-interest-bearing carbon reserve, the envisaged model envisions the establishment of a novel carbon reserve market. The functioning of this market, in conjunction with a transparent central bank roadmap governing the cap (e.g., gradual reduction of the cap each year), is anticipated to exert a guiding influence on banks' lending preferences. Furthermore, it is expected to foster heightened competition among banks, resulting in more favorable interest rates for loans extended in support of environmentally sustainable initiatives.

While the green initiatives of central banks could significantly contribute to the attainment of climate targets, it is crucial to recognize that poorly crafted initiatives may yield adverse consequences. Such initiatives could disrupt the prevailing business model and increase non-performing loans. Consequently, central banks must strive to uphold a balance between quality and sustainable financing. Moreover, the adoption of robust climate supervision principles, as outlined by the Basel Committee on Banking Supervision (BIS, 2022), is also recommended.

3.2.3. Climate Transition Policy

Climate-related risks present a long-term challenge with repercussions that transcend the financial system. Given the systemic nature and protracted timeline of these risks, it is posited that a macroprudential policy approach is most suitable. However, for the realization of optimal outcomes, it is imperative to synchronize the central bank's transition policy with national transition strategies. As shown in Figure 9, we propose three pivotal areas where central banks, in conjunction with other agencies, can make substantial contributions.

First, identification of transitional activities and investments. Central banks should elucidate guidelines for the identification of transitional activities and investments. The G20 Sustainable Finance Working Group (SFWG) has delineated

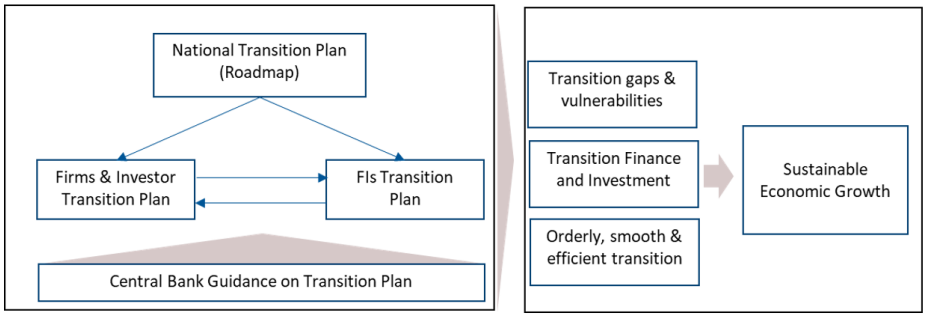

Figure 9: Central Bank's Role in Promoting Climate Transition Plan
Source: Authors

two primary transition approaches: the principle-based and the taxonomy-based (G20 SFWG, 2022). The principle-based approach offers a framework for identifying green firms predicated on transition objectives rather than sectors. For instance, a firm could be classified as green if it demonstrates the capacity to reduce carbon emissions beyond a certain threshold, as per the transition roadmap, in contrast to a business-as-usual scenario. This approach maintains sector neutrality, thereby averting abrupt disruption in any specific sector. It advocates for the application of technology for sustainable practices across sectors, inclusive of brown sectors, and facilitates comparable carbon measurement across jurisdictions. In contrast, the taxonomy-based approach is reliant on a predefined list of specific activities that bolster climate transition, typically categorized by sector. However, these taxonomies lack comparability among nations and, if not meticulously designed, could precipitate a disorderly transition for a specific sector and decelerate economic growth.

Second, the development of a transition roadmap. Central banks should formulate a transition roadmap that aligns with the national transition agenda. This roadmap, replete with clear targets, can serve as a blueprint for FIs in the creation of their transition roadmap and strategy. The existence of a credible roadmap could incentivize FIs to metamorphose into green FIs in anticipation of prospective actions from central banks. Consequently, the green transformation of FIs may transpire even prior to the enforcement of central bank regulations.

Third, evaluation of green investment needs and their funding. With a credible transition plan at the national and individual levels, central banks could conduct a more robust assessment of the need for green investment and their funding, the analysis of the structural consequences emanating from the transition, and the advancement of the macroeconomic modeling framework with an emphasis on climate aspects (GFANZ, 2022). This step is instrumental in ensuring a smooth, orderly, and efficient transition to a green economy, minimizing any potential disruptions to the economy.

3.3. Transmission Mechanism of Climate Policies

While economists acknowledge that climate change may hinder sustainable economic growth, there is also concern that the shift toward a low-carbon economy could adversely affect economic growth and social well-being. For instance, in Indonesia, the coal and power sector face an increased risk of default due to the energy transition (Rishanty et al., 2023). Additionally, Rishanty et al. (2024) demonstrate that adopting circular economy practices can mitigate these challenges and contribute to a more sustainable future. Therefore, it is imperative to develop a just and orderly climate transition strategy to minimize potential economic and social disruptions, and *thus* to deliver fairer outcomes, as the world transitions towards a low-carbon economy.

Even though a just transition is essential to avoid disruption, however, the public sector's financial contributions are anticipated to fall short of the sustainable investment requirements needed to attain the just transition. Thus, the majority of climate change financing is projected to originate from the financial sector. Consequently, the successful financing of the transition heavily relies on the active participation of financial institutions (FIs). As shown in Figure 10, the central bank climate regulatory framework which delineates three essential strategies; – namely: (i) data, tool, and research, (ii) regulation and supervision, and (iii) climate transition policy –, plays a pivotal role in the work of just climate transition, by incentivizing FIs to scale up their green financing and, in doing so, encouraging their debtors to become greener in order to get easier access to financing.

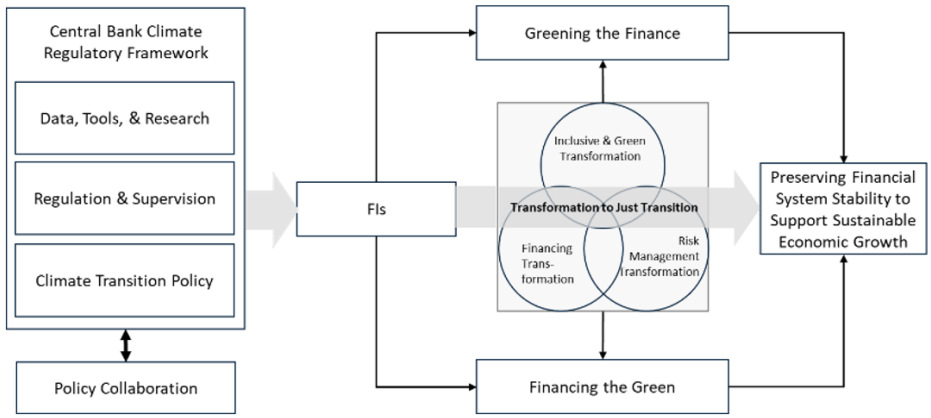

Figure 10: Transmission Mechanism of Central Bank Climate Policy
Source: Authors

In line with global emission quantification standards, FIs are required to proportionally calculate and acknowledge the emissions emanating from the activities or projects they finance, known as financed emissions (Scope 3). Con-

sidering that the majority of FIs' assets are in the form of financing, each of which has associated carbon emissions that FIs must acknowledge, FIs are among the largest contributors to carbon emissions. Hence, the reduction of FIs' carbon emissions is integral to the success of national emission reduction.

Since the source of FIs' carbon emissions is financing, the most effective way to reduce their carbon emissions is to increase the share of low-emission financing. Thus, banks are expected to offer incentives to low-emission debtors and disincentives to high-emission debtors to reduce emissions. While this will help FI to build resilience by mitigating physical and transition risk, this will also accelerate the green ecosystem by stimulating firms to transition towards greener operations to secure easier and more affordable access to financing. Consequently, the carbon emission reduction actions of FIs can trigger a positive domino effect on other sectors to collectively achieve the national emission reduction target.

Furthermore, to align FIs' operations with the just transition agenda optimally, we identify three essential transformation agendas that FIs need to adopt. *First*, FIs should transform their financing portfolio by increasing the share of sustainable financing. FI is expected to provide incentives and disincentives to sustainable-friendly vs non-sustainable-friendly debtors and accelerate industry transformation toward a sustainable ecosystem. *Second*, FIs should transform their risk management practices by integrating climate-related risk considerations into the strategy formulation. In this area, FIs need to consider necessary actions when developing their own transition scenarios, and inform FIs about the credibility of their transition plans. *Lastly*, FIs need to adopt inclusive and green transformation. In this area, FIs need to align their financing strategies with the social and climate aspects to sustain their long-term growth. The growing concern about the just transition, thus social inequality and other sustainable development issues, is expected to boost the market growth.

Ultimately, the operationalization of three policy strategies, along with the adoption of a transformation agenda, to navigate just transition extends beyond the traditional purview of central bank activities, necessitating a collaborative and synergistic approach among regulators and industry stakeholders. We believe that this mechanism fulfills sufficient conditions in managing financial system stability, and is thus, in line with efforts to pave the way towards sustainable economic growth.

4. Conclusions

Climate change poses major challenges to the global economy and society, requiring immediate and coordinated efforts to alleviate its impacts. Given the extended time horizon and systemic nature of climate risks, the adoption of a more integrated policy strategy offers a more holistic strategy for managing and mitigating these complex threats, thereby bolstering macroeconomic and financial system resilience. The urgency for sustainable financing underscores the pivotal role central banks and financial regulators must play in this endeavor. While central

banks are globally recognized for their roles in climate action, tangible initiatives are still in the developmental stage. The Green Central Bank scorecard (Eames & Barmes, 2022) indicates that pioneering green monetary and financial policies are lagging. With climate-related risks yet to fully materialize, traditional climate adaptation safeguards such as capital and liquidity requirements are deemed sub-optimal (Coelho & Restoy, 2023). Thus, central banks will have a pivotal role in developing a state-of-the-art climate policy to support the just transition agenda.

This paper proposes a climate regulatory framework for central banks, which includes three primary strategies aimed at achieving climate objectives. The first strategy involves the development of a data collection, tools, and research framework specifically designed for central banks. The second strategy focuses on identifying policy options for central banks that would encourage traditional banks to transition into green banks. The final strategy delves into the climate transition policy, discussing three crucial actions: the transition approach, the transition roadmap, and climate assessment.

This paper shows that the central bank's climate policies to manage transition risks can navigate just transition and support the achievement of sustainable economic growth. Given that FIs are among the largest carbon emitters globally due to financed emissions, reducing FIs' carbon emissions is a critical step in achieving the transition agenda. The central bank climate regulatory framework is expected to play a vital role in this process by incentivizing FIs to increase green financing and thereby facilitating the transformation of firms into green entities. To optimize the transmission mechanism, FIs should adopt a three-pronged transformation agenda: inclusive and green transformation, risk management transformation, and financing transformation. This approach, necessitating a collaborative and synergistic approach among regulators and industry stakeholders, will ensure a comprehensive and effective transition towards sustainable practices.

In this regard, providing guidelines by central banks and other regulators, such as transition plan guidelines for financial institutions and businesses in the real sector, which outline how these entities can develop effective mitigation and adaptation financial strategies to remain resilient amid intensifying climate and nature-related risks, is vital. Central banks and other regulators can also be active in promoting climate-related capacity-building initiatives to support the development of a sustainable finance ecosystem within the country. Last but not least, given the limitations of this study in addressing the research question qualitatively, further research using various approaches to complement this study is essential to understand the nature of problems and related policy interlinkages more comprehensively.

Declaration of Conflicting Interests

Conclusions, opinions, and views in this paper are based on the authors' perspective and do not constitute official conclusions, opinions, and views of Bank

Indonesia.

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Appendix 1:

In this part, we can learn deeper on the complexity of the just transition policies implementation from real-world cases from some country experiences.

China's experience in achieving just transition offers valuable lessons for other countries. Since assuming power in 2012, President Xi Jinping has commanded a shift from GDP-centric growth to a model prioritizing growth quality and environmental sustainability. By combining top-down policymaking with bottom-up innovation, China has demonstrated the potential to accelerate the transition to a sustainable economy. All of these are supported by technology development, institutional strengthening, product innovation, well-coordinated macroeconomic regulations and policies, and a stable green finance ecosystem (Zeng et al., 2022). In an effort to build a strong green financial system, the Chinese government together with the PBC have created Green Finance Pilot Zones in several regions since 2017. With green finance pilot zones, the government together with the PBC and other related parties can replicate with various improvements in other expansion areas (South China Morning Post, 2021).

In 2016, the PBC and 6 other authorities issued "the Guidelines for Establishing the Green Financial System" (PBC, 2016). The Guidelines 2016 is the world's first comprehensive guideline to support green finance, which consists of guidance on policies incentivizing green sectors and restricting polluting sectors - some incentives for green sectors: 1) re-lending facilities by PBC, 2) green guarantee program, 3) interest subsidies for certain projects financed by loans, and 4) Green Development Fund. As part of the Guidelines 2016 (PBC, 2016), the PBC established the Green Finance Committee (GFC) which coordinates and outlines the implementation of the Guidelines 2016. The GFC then established 20 GFC representative offices in various regions in China. To support more structural changes, the Chinese government then made green finance part of the 5 Development Concepts of "Green Transformation" and became a broader consensus in Chinese society.

The PBC alone has various policies to establish a sound green finance ecosystem (Wu, 2022). Since 2016, the PBC has used macro-prudential assessments (MPA) to measure the systemic risk and performance of commercial banks with 17 indicators in 7 areas: leverage, assets and liabilities, asset quality, pricing, liquidity, external debt risk, and credit policy. Banks with a high portion of green credit and issuing green bonds get extra points and generate higher interest income. The PBC issued several monetary policy incentives to direct more capital flows to green projects that fall into 4 aspects: re-lending facility, re-discounting facility, Macro-Prudential Assessment (MPA), and expansion of the scope of eligible collateral.

Starting in 2018, the PBC began to recognize qualified green bonds and green credits as collateral for the Medium-Term Lending Facility (MLF) provided by the PBC, which was later expanded to the Short-term Lending Facility (SLF) and Pledged Supplementary Lending (PSL). In 2020, the PBC introduced the Green

Financial Performance Evaluation Plan of Financial Institutions, among others, to encourage information disclosure and third-party verification in strengthening the green bonds market. In 2021, the PBC issued the Guidelines for Financial Institutions Environmental Information Disclosure, which is the standard for green finance information disclosure in China. Starting in 2021, the PBC has provided low-cost funds within the framework of the carbon emission reduction facility (CERF) to achieve the carbon peaking and carbon neutrality targets in 2030 and 2060. This monetary policy instrument aims to mobilize more social funds to reduce carbon, support the development of clean energy, energy conservation, environmental protection, and other relevant sectors. This targeted monetary policy and the provision of low-cost funds have contributed to stable credit growth. PBC also published several other regulations and guidance related to green finance .

Nevertheless, China's various successes in developing green finance are overshadowed by the risk of default in the banking sector. The results of the PBC's stress test in 2021 indicated that some banks face the risk of default due to the possibility of higher climate-related costs in several carbon-intensive industries such as thermal power plants, steel and cement. To mitigate the risks that may occur, the PBC continues to refine policies and innovations in green finance programs to support the use of clean and efficient coal.

Lessons from **India** in achieving just transition is represented through strategies for investors to establish practical applications, foster trust, and create a solid foundation for widespread adoption in alignment with national priorities (Selvaraju & Robins, 2024). The strategies include: (i) encouraging companies to use the Indian Business Responsibility and Sustainability Reporting (BRSR) disclosure regime as a homegrown framework for reporting on just transition; (ii) promoting capital allocation towards the just transition by harnessing India's green, social, sustainable and sustainability linked (GSS+) bond market; and (iii) supporting the integration of just transition principles into transition plans and transition finance.

Lessons from **Latin America Countries (LAC)** efforts in achieving just transition, to fund a green transition the region must levy further resources through environmental taxes, emissions trading systems and provide a step-by-step phase-out of fossil-fuel subsidies. To mobilize the vast amount of funds needed for the green transition, the pool of stakeholders and tools will also have to be enlarged. In LAC, the Green, Social, Sustainable and Sustainability-linked bonds market has been growing since 2015 reaching an accumulated USD73 billion in September 2021 (OECD et al., 2022). Total climate-related development finance from bilateral, multilateral (MDBs and other multilateral funds), and private donor sources in LAC reached USD 17 billion in 2020 (OECD et al., 2022).

To continue scaling up debt market instruments, governments in the region must work on innovative approaches, for instance issuing green bonds in local currency or fostering digital and technological advances. The latter can increase debt markets' transparency and make capital much more traceable. While

sovereign green bonds can foster investment for the energy transition, leveraging private finance, they also need financial backup from an enhanced fiscal space.

In 2021, Colombia became the first emerging economy to issue a sovereign green bond in local currency in its domestic market (TES Verdes). To achieve it, the government carried out co-ordinated work between the Ministry of Finance and Public Credit and the National Planning Department, together with other public-sector entities. This process also received technical support from the World Bank and the Inter-American Development Bank (IDB). The first portfolio of eligible green expenditures amounted to COP 2.3 billion (Colombian peso), distributed across 27 projects and 6 categories. Of these, 40% are focused on water management, 27% on the transition of transport towards a cleaner and more sustainable system, 16% on the protection of diversity, and 14% on the transition to non-conventional and renewable energies. The remainder was distributed over waste and circular economy, and sustainable agricultural production. This type of investment allows the country to provide resources for initiatives with a high socio-environmental impact, thereby strengthening its capacity to respond to unexpected climate and environment events. This type of initiative also facilitates the arrival of new investors (Ministerio de Hacienda y Crédito Público, 2022).

Developing digital crowdfunding platforms. In line with the advances in digital transformation in the region, public and private stakeholders can use digital technology as an instrument to mobilise small amounts of domestic savings for sustainable infrastructure investment. Municipalities, along with private finance-sector investors, can come together to develop a digital crowdfunding platform that entails responsible blockchain-based project bonds. The platform can be used to raise finance, while the blockchain is able to record transparently and to certify the use of proceeds, the sustainability impact and the revenue streams of the project.

Lessons from **Central and Eastern European countries** efforts in achieving just transition. ***Bulgaria***. In the face of the high climate risk, if no action is taken, Bulgaria's entire economic growth might be potentially wiped out by 2050 (The World Bank Group, 2021). However, energy transition in Bulgaria is a delicate topic, and coal phase-out has thus far not been a priority for the institutions at the decision-making level. The just transition process in Bulgaria shows how guaranteeing social dialogue and participation does not necessarily imply ensuring the transparency of the information generated. The authorities in charge have involved stakeholders and have gathered inputs from them in the just transition process, but no information has been provided to these actors on what from their comments has been incorporated in the plans. This reveals that the process in Bulgaria is not transparent and that access to relevant information has not been ensured. Nevertheless, a just transition process is in place and running, though at a slower speed than in other countries.

The Czech Republic. The Czech Republic developed its just transition plan within what is referred to as the 'Transformation Platform' (OECD et al., 2022). It is administered by the RE:START department of the Ministry of Regional

Development. There is a Statute and Rules of Procedure on the proceedings of the Transformation Platform, which formalises the way in which it conducts its activities. The members of the Transformation Platform range from trade unions, trade associations, local and regional governmental bodies, ministries (Transportation, Finance, Culture, Labour and Social Affairs, Regional Development, Industry and Trade, Education, Youth and Sports, and the Environment), renewable energy associations and industry/employers' groups. Eventhough the process in the Czech Republic is becoming more transparent, however, the role of the Transformation Platform is relatively weak – its members can comment on and discuss the plans, but there is no formal voting procedure on individual aspects.

Poland is an immensely interesting case study for just transition dynamics. The recipient of the largest share from the Just Transition Fund (JTF), it presents the case of strong trade unions, political reluctance at the national and regional level as well as a clear need for action given the importance of fossil fuel industries for economic and labour development. There are pockets of well-organised, effective and visionary just transition activity at the regional and local level. Eleven mayors of Polish cities are signatories to the Declaration of Mayors on Just Transition and active in the Forum of Mayors (WWF, 2020). The case of Poland highlights the importance of starting early, involving a variety of stakeholders, procuring genuine buy-in from relevant institutional actors as well as the support from strong private sector entities. The Just Transition process in Poland also demonstrates the significant social and political hurdles that this endeavour has to overcome:, some people think a 'just transition is a slow transition'. This attitude may foster a sense of security and stability among those employed in the coal sector, but it does not contribute to decarbonisation and continues to lock in economic activities that are increasingly struggling to compete.

Slovakia's experience, particularly in the Upper Nitra region, is a formidable example of a well-managed just transition process. The experience confirms the effectiveness of starting early and supporting the process with strong political will from local governments and setting up dedicated governance bodies at the national level (the beneficiary ministry). The Slovak case also highlights that referring to clear and strong national energy strategies is a catalyst for just transition plan development, helping to overcome divergent visions between stakeholders and generating common deadlines and objectives. However, in Slovakia, some challenges persist. One of the main ones refers to the design of the just transition plan itself, which favours big stakeholders (big municipalities, big companies, etc.) who hold the technical, financial, and human-capital capacity for proposal drafting and project management, to the detriment of SMEs and small municipalities (Rösch & Epifanio, 2022).