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Green Monetary Policy Measures and Central Bank Mandates: A Comparative Political Economy Analysis

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Abstract

Climate change and the political pressure for urgent policy responses have stirred an intense debate as to whether central banks should adjust their monetary policy frameworks in support of the transition to a greener economy. Despite the seriousness of environmental issues and the seeming existence of monetary policy tools to address them, some economists and central bank officials argue that monetary authorities cannot, or should not, be responsible for making policies that act upon the source of those problems. Among other reasons, the adoption of green monetary policy measures can conflict with the primary monetary policy goals, compromise the political independence of central banks, and raise questions about the legitimacy and increased power of some of these banks. Yet, evidence shows that a number of monetary authorities have already adopted environmental criteria in their policymaking, resulting in an expansion of monetary policy toolkits and areas of responsibility. This article undertakes a comparative political economy analysis of the green monetary policy measures and legal mandates of 20 central banks, covering the period between January 2010 and January 2024. This article then examines the monetary policy decisions of two case study central banks, whose green strategies appear not to be fully aligned with their mandates. The empirical findings aim to contribute to the growing political economy literature and international debate on how central banks address pressures related to environmental concerns which, although vital to society and the planet, may pose challenges to conventional goals and established mandates.

Keywords

central bank mandates; climate change; green central banking; historical institutionalism; sustainable finance; unconventional monetary policy

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1. Introduction

Climate change and environmental degradation are critical issues of our time. While governments are the primary actors in matters related to economic and social welfare, the increasing severity of environmental issues and the slow implementation of climate commitments have led citizens, government officials, and leaders of organisations to call for a broader range of policy responses. In this context, an intensifying debate has been held as to the role of the central banks in the green transition given their prominent position and powerful tools to influence economic activity. The topic has received heightened attention in international forums and among central bankers. However, it continues to be surrounded by many questions about the extent to which monetary authorities should promote the greening of the economy and the financial system. It remains to be seen whether central banks will adopt a more proactive or vigilant approach to green policies, particularly if the selected options require significant changes in monetary policy frameworks, and whether central bank mandates—or their interpretation—will be revised to include considerations of environmental protection.

Drawing on the examination of 20 central bank monetary policy strategies and legal mandates between January 2010 and January 2024, this article's findings suggest that the greening of monetary policy is a highly complex process whose future is uncertain. For one thing, national and international pressures may instigate a growing number of central banks to act on climate change. For another, primary monetary policy objectives limit the ability of central banks to pursue environmental goals. Considering the Japanese and Swedish cases, the empirical findings further indicate that the incorporation of environmental factors into monetary policy decisions can be best understood through incremental patterns of policy change, notably layering and displacement forms of change, as conceptualised by historical institutionalist theorists. The results also highlight that the policy options adopted reflect the sustainable finance paradigm promoted by the Network for Greening the Financial System (NGFS)—a coalition of central banks and supervisory authorities formed in 2017 to enhance the green finance debate and strategic solutions (NGFS, n.d.). However, despite the extraordinary circumstances and the influential role of the NGFS in proposing policy reforms, pre-existing structures in the central bank narrowed the possibilities for innovation and shaped green monetary policy outcomes.

The remainder of this article is structured as follows: Section 2 relates the study to existing academic research that seeks to explain the opportunities and challenges of greening monetary policy and highlights some of the main empirical findings of this work. Section 3 introduces the study's research hypothesis and reviews the theoretical framework used to examine the rise of green monetary policy measures, which combines elements from historical institutionalism. The term "green monetary policy measures" refers to central bank policy decisions aimed at embedding environmental considerations in monetary policy operations—for instance, by establishing new policy instruments or reforming existing ones in ways that mitigate climate-related risks and provide financial incentives towards investments in firms, projects, or sectors that contribute to the quality of the environment. Section 3 further describes the methods and empirical material through which the environmental strategies adopted by each of the 20 central banks will be investigated. In support of the analysis, the study offers a new dataset on central bank green monetary policy responses (see Supplementary File 2) and a Green Monetary Policy Index (GMPI) that provides a more comprehensive overview of the degree of central bank involvement in environmental matters through monetary policy operations. Section 4 presents and discusses the results of the cross-case comparison,

showing the variations in mandates and the number and strength of the green policy measures adopted across countries and economic groups. Section 5 provides a historical institutionalist analysis of the monetary policy developments at the Bank of Japan (BOJ) and the Sveriges Riksbank, including a new theoretical explanation for the differences in approaches to environmental issues. Section 6 concludes by commenting on areas that require further consideration.

2. Debate Over Greening Monetary Policy

Leveraging the power of central banks to influence economic activity and their expanded monetary policy toolkits following the 2008 global financial crisis and Covid-19, many claim that central banks should make another substantive contribution, this time in the fight against climate change. By factoring environmental aspects into monetary policy decisions, central banks encourage the market to take the net-zero transition seriously and expand green investments (BOE, 2022b; United Nations Environment Programme, 2017). While definitions of "green" vary across jurisdictions, "green investments" can be broadly described as the financing of projects "aimed at energy efficiency, renewable energy development, sustainable water management, clean transport systems' development, sustainable agriculture, pollution prevention, and climate change adaptation" (D'Orazio & Popoyan, 2019, p. 28; see also Centre for Climate Engagement, 2024). Conversely, brown investments are linked to the allocation of financial resources to activities or assets that harm the environment. Given the environmental emergency, there is a "quasi-moral responsibility" to align central bank operations with the new sustainability values and practices, as with other public sector institutions (Șimandan & Păun, 2021, p. 1; see also Howarth, 2009). From a monetary policy perspective, studies show that the increasing frequency of natural disasters and uncertain public policy responses will demand significant monetary policy action and complicate inflation forecasts for policy decisions (e.g., Dollman et al., 2020; NGFS, 2020). On the financial stability front, there is widespread acceptance that "climate-related risks are a source of financial risk," negatively impacting the stability of the financial system, including the financial position of central banks (NGFS, 2018, p. 3). These risks are claimed to be on the rise due to the growing materialisation of climate-related hazards and national efforts to achieve the Paris Agreement goals (Breman, 2020). Moreover, a body of literature brought to light that financial firms can exacerbate climate risks themselves by substantially funding high-emitting firms (BOE, 2022a; Schnabel, 2021). The European Banking Authority (EBA) deploys the terms "outside-in" and "inside-out" approaches to climate change to describe the concepts of single and double materiality (EBA, 2021, p. 32; see also Stiroh, 2022). Whereas the former entails a more passive approach whereby financial institutions identify, measure, and manage the impact of climate change risks on the banks' profitability, the latter is a two-way approach that further considers the negative externalities of the banks' activities on the environment.

Despite the growing consensus about the financial risks brought about by climate change, the implementation of climate strategies has often been delayed due to data gaps, insufficient knowledge on how to manage climate risks, and a lack of legal clarification as to whether central banks can adopt climate-targeted instruments (NGFS, 2021a). In response to these issues, some central bank officials have shared the view that early intervention with imperfect information is less costly than a late intervention with precise methods and guidance (e.g., Kuroda, 2021a, p. 9). For the Vice-Chair of the Single Supervisory Mechanism, "the risk of doing too little too late is significantly larger than the risk of central banks and supervisors overstepping their mandate" (Elderson, 2021, para. 22). In support of this thinking, research has shown that monetary policy can help minimise "climate-induced financial instability" and curb "global

warming" via the deployment of nonstandard tools such as green quantitative easing and green collateral (Dafermos et al., 2018, p. 219; see also Chen et al., 2021; Chenet & Kalinowski, 2021; Couppey-Soubeyran, 2021; Schoenmaker, 2021). Ferrari and Nispi Landi (2022), as well as Abiry et al. (2022), further estimate a significant reduction in pollution levels should green quantitative easing be implemented early in the transition phase or if fiscal authorities fail to introduce an effective carbon tax. Yet, recent trends indicate a shift towards a more restrictive monetary policy, revealing the limited impact of central banks on climate change through quantitative easing.

Notwithstanding the pressing need to deal with the environmental crisis and the seeming availability of monetary policy tools to support that goal, concerns have been raised as to whether central banks should prioritise green investments. One line of criticism argues that "there can be no such thing as a green monetary policy" as it implies bringing into mandates areas that fall outside them (Issing, 2021, p. 188). Another strand of research holds that central banks can help mitigate environmental risks as part of their secondary mandates (Honohan, 2019). However, they cannot lead or be responsible for driving structural changes in what is produced and how (see also Chen et al., 2021; Cochrane, 2021; Dikau & Volz, 2021; Hansen, 2022; Honohan, 2019; Ozili, 2021; Șimandan & Păun, 2021). Some of the risks associated with central banks taking an active role in environmental matters can be summarised as follows: (a) the market neutrality principle, according to which central banks should not favour specific firms or sectors in the course of their investment operations, can be undermined if central banks favour green investments; (b) the limited expertise of central banks on climate change may lead to ineffective policies, damaging their credibility; (c) the successful implementation of green monetary policies can result in central banks being requested to intervene in other political and socioeconomic pressing areas; (d) the stretching of central banks' mission without a formal mandate can render their actions illegitimate and compromise their independence, to the extent that it results from political pressures from governments and other national and international organisations; and e) the potential expansion of legal mandates can overburden central banks with conflicting objectives and policy tools, turning monetary policy into a complex and incoherent policy area.

Irrespective of these arguments, evidence shows that several central banks have already incorporated green considerations into their monetary policy operations, particularly in emerging market and developing economies (EMDE), given their higher exposure to environmental issues and broader mandates (Dikau & Volz, 2021; D'Orazio & Popoyan, 2019). Regarding the advanced economies (AE), a change of paradigm seems to be underway (Mackintosh, 2019). After the former governor of the Bank of England (BOE) emphasised the financial risks of climate change in his 2015 speech on *Breaking the Tragedy of the Horizon* (BOE, 2015), several multilateral organisations and pressure groups have been established to enhance the sustainable finance debate. In parallel, a growing number of AE central banks have published strategies with instructions on how they intend to embed environmental criteria in their policy activities (see Supplementary File 2). On the occasion of the 2021 United Nations Climate Change Conference in Glasgow (UN COP26), the NGFS members further endorsed the Glasgow Declaration, whereby they committed to investigating how to integrate environmental considerations into monetary policy decisions (NGFS, 2021b). In this study, 17 out of the 20 central banks were members of the NGFS at the time of the UN event. Since then, the number of central bank pledges on climate change has expanded significantly, and all monetary authorities in this study became represented in the NGFS at the time of writing, except for the National Bank of Poland (NGFS, 2023). An increased engagement of central banks in the green transition is, therefore,

expected, which may reflect a change of paradigm from a more neoliberal approach focused on price stability to a more reformist perspective that further entails environmental targets (Dziwok & Jäger, 2021). Such a "new job" brings to the fore earlier debates about the legitimacy and increased power of some central banks (Moynihan, 2021, p. 31; see also Högenauer & Howarth, 2019; Langley & Morris, 2020; Șimandan & Păun, 2021).

3. Theoretical Framework and Research Methods

This article aims to complement existing research by applying a comparative political science analysis to a subject that has primarily been studied in financial and economic terms (Akomea-Frimpong et al., 2022). Based on the anticipated relationship between central bank mandates and monetary policy decisions, the study's main research hypothesis is drawn from one of the core concepts of historical institutionalism: Central bank mandates create a path dependency which significantly shaped the development of green monetary policy measures. Historical institutionalism is a recognised analytical framework used to theorise the processes by which institutions are devised, changed, and sustained over time and across different settings. Its theoretical elements emphasise the role of past events in explaining present structural configurations, the influence of critical junctures in the inception and reinforcement of path-dependent trajectories, and the value of studying long-time horizons to identify more subtle institutional change (see Capoccia, 2015; Capoccia & Kelemen, 2007; Fioretos, 2011; Fioretos et al., 2016; Krasner, 1984; Pierson, 2000; Sewell, 2005). In the present study, historical institutionalism is first deployed to evaluate whether legal mandates created a path-dependent structure that fundamentally impacted the adoption or non-adoption of a green monetary policy strategy. The concept of path dependency posits that once a decision is made in a particular direction, that course of action tends to be perpetuated over time due to "increasing returns" and "positive feedback," even if the chosen trajectory becomes inefficient (Fioretos, 2011, p. 377; see also Mahoney, 2000; Pierson, 2000). The awareness of path-dependent processes thus illuminates why institutions remain stable over an extended period, making it difficult for competing arrangements to supplant existing ones.

Central banks display features of path dependency while being bound to a limited set of powers delegated by governments to them. Those powers are stated in treaties and other legal documents, typically named mandates. While some mandates are limited to price and often financial stability, others allow a broader interpretation of the central bank's mission by including support for other macroeconomic variables or government policies, normally as a secondary objective. Either way, central bank actions and commitments must be clearly justified on the grounds of their previously set objectives, which legally constrain their policy decisions. This "lock-in" effect or institutional "stickiness" in the context of central banks aims to protect central bank powers and control their objectives (Pierson, 2000, p. 253; Thelen & Steinmo, 1992, p. 15). Specifically, it enables central banks to carry out their functions independently from political preferences and prevents them from interfering in matters that are under the responsibility of elected officials. Following this path-dependent logic, one could envisage limits to a central banking approach to environmental policy as follows: the most narrow mandates centred on price and financial stability would deprioritise green policy, whereas the broader mandates, which include the explicit support for economic variables—such as employment and production—or government policies, would benefit from increased policy space to adopt measures that contribute to green growth. This premise is based on scientific research that emphasises the implications of climate change on production, employment, and growth (e.g., Batten, 2018; Kahn et al., 2019;

Kruse et al., 2017; NGFS, 2020). In this line of reasoning, more vigorous actions would be expected from central banks whose mandates assign equal weighting to different macroeconomic goals, the so-called dual mandates. However, given the climate pledges announced by some central banks, the mandates of which do not explicitly instruct to support the real economy, the results reveal some surprising findings.

To understand the unexpected outcomes, Section 5 examines green monetary policy developments in two central banks with narrow mandates. What is observed across the two cases is that the environmental emergency did not yet imply the immediate breakdown of policy frameworks nor the creation of brand-new and durable arrangements, as suggested by the traditional accounts of critical junctures whereby "[j]unctures are 'critical' because they place institutional arrangements on paths or trajectories, which are then very difficult to alter" (Pierson, 2011, p. 135). Instead, evidence shows operational limits and backtracking of the green measures adopted due to policy incompatibilities. This scenario of policy change held within institution-specific constraints gave rise to a gradual pattern of institutional change, as conceptualised by scholars within historical institutionalism. Therefore, an analysis is made of the monetary policy options selected by these two central banks to address environmental issues in light of four main types of incremental change (see Fioretos et al., 2016; Mahoney & Thelen, 2009; Streeck & Thelen, 2005; Thelen & Conran, 2016): (a) layering or establishment of new rules atop or in tandem with existing ones—for instance, through amendments, revisions, or additions; (b) displacement or outright replacement of existing rules by new ones; (c) conversion or adaptation of extant rules towards new objectives (pre-existing rules remain but are reinterpreted); and (d) drift or the altered impact of established rules due to their deliberate non-adaptation to the evolving environment.

This study draws on the controlled comparative case study method to examine the interlinkages between environmental goals, central bank mandates, and monetary policy decisions. The method involves investigating a purposively selected number of central banks to gain a deeper understanding of their monetary policymaking (Gerring & Cojocaru, 2016). The multiple-case analysis comprises the green monetary policy strategies and legal mandates of the 10 largest AE and the 10 largest EMDE from January 2010 to January 2024. The countries were selected based on the World Bank's GDP estimates for 2020 and 2021 (The World Bank, n.d.), whereas the economic group (AE and EMDE) follows the IMF country classification (IMF, 2022). The starting year of the research period was chosen based on the first identified monetary policy tool to support environmental businesses, notably, the Bank of Japan's Fund-Provisioning Measure to Support Strengthening the Foundations for Economic Growth (Growth-Supporting Funding Facility). It consisted of a favourable credit line for investments in areas with growth potential, including "environment and energy business" and "business for securing and developing natural resources" (BOJ, 2010, p. 26). The cut-off date was decided upon more practical grounds related to the duration of the research. From the AE, the units of analysis are the monetary authorities of Australia, Canada, the euro area (EA), Japan, Norway, Sweden, Switzerland, the Republic of Korea, the UK, and the US. From the EMDE, the examination includes the monetary authorities of Brazil, China, India, Indonesia, Mexico, Poland, Russia, Saudi Arabia, Thailand, and Turkey. The decision to conduct medium-N research involving systemically important economies from two leading economic groups was considered beneficial to the whole study. First, the international standing of these countries is not only economic but also political. While all seven members of the G7 are represented in the research sample, 15 out of the 20 central banks were G20 members at the beginning of the study (Council of the European Union, 2021; G20 Italy, 2021). Given that climate action and sustainable finance have been policy priorities for both groups, the strategies adopted by

these dominant economies will likely shape practices worldwide. Second, a combination of AE and EMDE central banks can better represent the evolution of green monetary policies globally. Third, the confidence in the findings of a medium-N study is claimed to be greater than that of a single or a few case studies (Lieberson, 1991). Following Slater and Ziblatt (2013, p. 134), the "transferability" of an argument to other concrete situations is higher when explained in dozens of other cases.

All empirical data are publicly provided by central banks on their websites. This material has been complemented with information issued by other relevant organisations, extant literature, newspaper clippings, and two semi-structured interviews with monetary policy experts. In reading central bank mandates, the following premises have been considered: First, it is recognised that natural hazards and the transition to a low-carbon economy affect output prospects, production, and employment, as documented in the macroeconomic literature on climate change. Second, wider objectives, such as the economic and financial welfare of the country, provide central banks with greater discretion to implement new or redirect existing monetary policy tools towards green segments—whereas welfare entails dimensions such as environmental protection, economic welfare concerns consumption, and the environmental resources that enable that consumption (Reinsdorf & Quiros-Romero, 2020). Third, economic growth as a result of price stability is not considered a primary central bank objective per se, which remains to keep inflation low and constant aiming to foster economic growth. For example, the Reserve Bank of India Act states that "the primary objective of the monetary policy is to maintain price stability while keeping in mind the objective of growth" (Reserve Bank of India Act 1934, 2022). In this and other similar cases, this study assumes that maintaining stable prices makes it easier for political authorities to implement policies that promote green growth.

According to the observed results, the following four monetary policy instruments have accounted for environmental considerations: asset purchase programmes, collateral, credit operations, and foreign exchange investments. Yet, each instrument has been differently adjusted with green parameters, resulting in varying effects to promote green investments. To harmonise the multiple ways whereby the same policy instrument can be deployed to advance environmental goals and provide a clearer picture of each central bank's involvement in environmental matters, the study introduces a GMPI. The GMPI was inspired by the Green Macroprudential Index developed by D'Orazio and Popoyan (2019), although it follows a distinct categorisation to fit the purpose of this research. Under the GMPI framework, each monetary policy decision with an environmental component has been qualitatively evaluated and graded on a scale of 0 to 5 according to one of the following six categories: *not observed*, if no measure has been adopted or announced (GMPI = 0); *under consideration*, for announced measures without an implementation date (GMPI = 1); *on the agenda*, for formally committed decisions with a specific timeline of implementation (GMPI = 2); *facultative*, for established green arrangements with no binding force (GMPI = 3); *risk control*, for enduring measures that add green elements into existing policy tools to primarily protect central bank assets and operations from climate-related financial risks (GMPI = 4); *targeted*, for policy instruments exclusively created to promote environmental projects (GMPI = 5). The GMPI for each central bank results from the sum of the scores given to each policy measure implemented or announced up to January 2024. The final scores attempt to reconcile the quantity with the strength of the measures adopted by each central bank to facilitate the selection of two units of analysis for more detailed research. After assessing and assigning a score to each monetary policy decision that accounts for environmental aspects, it was concluded that central banks with a total score above 12 were the most actively engaged in greening their monetary policy

frameworks. Central banks with scores between 7 and 13 revealed a moderate level of involvement in green policymaking, primarily driven by risk management concerns. Central banks with scores between 1 and 6 proved a superficial approach to environmental factors. Central banks with an index score of 0 did not publicly consider the adoption of environmental considerations in their monetary policy decisions.

It is important to note that the GMPI scores are designed to offer a qualitative account of the level of central bank engagement in environmental issues through their monetary policy operations. Therefore, three relevant clarifications are necessary: First, the GMPI scores are not intended to measure the overall level of "greenness" of each central bank. A low score does not necessarily mean that these banks have not advanced an environmental strategy in other business areas, such as banking supervision, financial regulation, non-monetary policy portfolios, and corporate activities. Second, the GMPI scores do not aim to quantify the economic impact of the measures adopted or rank the best-implemented policies. Such an analysis would require a quantitative or econometric study, the scope of which goes beyond this research. Third, the study does not address the extent to which central banks put the announced measures into practice or the unlikely scenario in which they implement measures that have not been communicated. Although this study acknowledges the possibility of "cheap talk," the primary focus of the analysis is to comprehend why and how central banks started considering environmental factors in their decision-making, irrespective of their practical implementation. Supplementary File 1 contains additional information about the research methodology, including the search strategy, classification of monetary policy instruments, GMPI categories, and interview quotes. Finally, the empirical section provides an overview of the consistency of central bank green monetary policy arrangements with the breadth of their mandates using a typical and deviant case study selection approach. A typical or "expected" case confirms a stable and predictable relationship between central bank mandates and green monetary policy outcomes (Rohlfing, 2012, p. 114). A deviant or "anomalous" case does not hold such an anticipated relationship, suggesting that mandates do not clearly explain the adoption of or resistance to green monetary policy strategies (Rohlfing, 2012, p. 114).

4. Empirical Findings of the Cross-Case Analysis of 20 Central Banks

The empirical data points to the following results regarding the classification of central bank mandates and the evolution of green monetary policy decisions between January 2010 and January 2024 (see Table 1 for a summary overview and Supplementary File 2 for detailed information per central bank): Three out of the 10 AE central banks are not explicitly instructed to support variables from the real economy or government policies (the BOJ, the Bank of Korea, and the Swiss National Bank). Two AE central banks present features of dual mandates (the Reserve Bank of Australia and the Federal Reserve System), whereas five AE central banks are directed to contribute to economic policies or promote economic welfare, at least as a secondary objective (the Bank of Canada, the BOE, the ECB, the Norges Bank, and the Riksbank). Six of the 10 EMDE central banks entail narrow policy mandates focused on price or currency stability (the People's Bank of China [PBC], the Reserve Bank of India, Bank Indonesia, the Banco de México, the Bank of Russia, and the Bank of Thailand). One EMDE central bank entails economic growth along with price and financial stability (the Saudi Central Bank). And, three EMDE central banks operate with hierarchical mandates (the Central Bank of Brazil, the National Bank of Poland, and the Central Bank of the Republic of Turkey).

As Figure 1 (in Supplementary File 3) illustrates, the period between 2010 and 2019 witnessed the first monetary policy instruments geared towards green investments. Eight of the 11 measures adopted during

this time were implemented in the AE—Japan, Switzerland (with two main policy measures), Norway, the EA, Korea, Sweden, and the UK—and three in the EMDE—India, China, and Indonesia. The steady moves up to 2020 contrast with the increased number of measures adopted in 2021, which continued through 2022, albeit to a lesser extent. The boldest AE moves came from the BOE, the BOJ, the Riksbank, and the ECB (see Figure 2 in Supplementary File 3). All four central banks published climate roadmaps under the argument that acting on climate change falls within their primary, secondary, or both mandates (BOE, 2023; BOJ, 2021a; European Central Bank, 2021; Sveriges Riksbank, 2020c). From the EMDE, the high GMPI score for the PBC reflects changes in the bank's monetary policy remit to promote the greening of the Chinese economy and financial system. Consequently, the bank launched two green lending facilities (The People's Bank of China, 2022). The third green credit line launched in 2021 came from the BOJ (BOJ, 2021c). Surprisingly, both central banks hold what this study classifies as a narrow mandate. The year 2021 was marked by a number of historical events that contributed to an intensifying engagement of central banks in the environmental emergency, as highlighted in various central bank publications. Prominent among them is the UN COP26, which brought together ministers of finance and central bank senior officials to catalyse green finance (BOE, 2020; United Nations Framework Convention on Climate Change, 2021b). On this occasion, 16 out of the 20 central banks in this study published a pledge or strategy on climate change and supported the NGFS Glasgow Declaration (NGFS, 2021c). In addition, 146 of the 192 Paris Agreement signatories presented new or revised plans to reduce greenhouse gas emissions by mid-century, while the G7 and G20 simultaneously elevated climate change action as one of their top priorities (Bank of Canada, 2022; United Nations Framework Convention on Climate Change, 2021a).

Considering the monetary policy tools created or adjusted with green parameters (see Figure 3 in Supplementary File 3), asset purchase programmes represent the main instrument of intervention in the AE (28% out of the total number of green monetary policy measures adopted across AE and EMDE), followed by foreign exchange operations (21%). In the EMDE, green considerations have typically resorted to the selection of investments or counterparties in foreign exchange investments (21%), followed by credit operations (10%). The incorporation of environmental considerations into asset purchase programmes was not explored in this study's EMDE central banks. This finding is plausibly linked to the limited EMDE green bond market and central bank involvement in domestic asset purchases. Regarding the forthcoming green monetary policy measures (see Figure 4 in Supplementary File 3), six central banks intend to undertake new or additional green adjustments. From the AE, the ECB, the Bank of Korea, and the Riksbank proposed fine-tuning their collateral frameworks towards green segments. The Bank of Korea further mentioned the prospect of adjusting the current Financial Intermediated Lending Support Facility in favour of green investments. The BOE has been considering including climate risks in the assessment of counterparties for lending operations, while the Bank of Canada—of which there were no records of previous green monetary policy decisions—has been examining options to incorporate climate elements into its market operations. Although not included in Figure 4 (in Supplementary File 3), due to its rather speculative nature, the ECB does not rule out the possibility of establishing green lending, once data becomes more robust and monetary policy expansionary (Elderson, 2023; Schnabel, 2023). From the EMDE, the Bank of Thailand announced a potential credit facility to support small and medium enterprises in the green transition.

The GMPI scores offer additional insights into the green monetary policy event. As shown in Table 1, three of the top five central banks most visibly engaged in environmental-targeted decisions are located in Europe—the BOE, the ECB, and the Riksbank—and two in Asia—the PBC and the BOJ. As for the remaining

Table 1. Cross-case comparison using a typical and deviant case study selection approach, as of January 2024.

Unit of analysis	Economic group	Scope of the mandate	GMPI	Case study type
UK	AE	Broad (secondary)	22	Typical
EA	AE	Broad (secondary)	20	Typical
China	EMDE	Narrow	16	Deviant
Sweden	AE	Broad (secondary)	15	Typical (Deviant before Jan. 2023)
Japan	AE	Narrow	14	Deviant
Thailand	EMDE	Narrow	11	Typical
Brazil	EMDE	Broad (secondary)	9	Typical
Korea	AE	Narrow	9	Typical
Switzerland	AE	Narrow	7	Typical
Norway	AE	Broad (secondary)	4	Deviant
Australia	AE	Broad (dual)	3	Deviant
India	EMDE	Narrow	3	Typical
Indonesia	EMDE	Narrow	3	Typical
Mexico	EMDE	Narrow	3	Typical
Poland	EMDE	Broad (secondary)	3	Deviant
Canada	AE	Broad (secondary)	1	Deviant
Russia	EMDE	Narrow	0	Typical
Saudi Arabia	EMDE	Broad (dual)	0	Deviant
Turkey	EMDE	Broad (secondary)	0	Deviant
US	AE	Broad (dual)	0	Deviant

Source: Author's own work.

central banks in this study, and notably the 11 monetary authorities with scores below 7, there is a clear reluctance towards greening monetary policy despite some holding institutional conditions more conducive to green-based instruments. This holds especially true for the central banks of Australia, Saudi Arabia, and the US, the mandates of which include coequal monetary and economic objectives. Most strikingly, the multiple-case analysis suggests that there is no clear linkage between formal objectives and green monetary policy outcomes since central banks with similar mandates have responded differently to environmental pressures. It is reasonable to conclude that the role of central bank mandates has not been particularly strong in explaining monetary policy decisions in the environmental field, undermining this study's hypothesis whereby central bank mandates create a path dependency which significantly shaped the development of green monetary policy measures. Due to length constraints, this contribution cannot undertake an individual case study analysis of what motivated central banks with narrow mandates to advance an environmental agenda and held back central banks with wider objectives. Instead, the following section examines the formation and institutional design of green monetary policy measures at the BOJ and the Riksbank, the two most climate-responsive AE central banks with an originally narrow mandate. The value of comparing two central banks that adopted environmental standards in their monetary policymaking derives from offering a range of possible variations on how monetary policy frameworks have effectively supported the green transition, the findings of which can be cautiously generalised to predict green monetary policy developments in other central banks with narrow mandates.

5. The case study of Japan and Sweden

According to this study's definition of a narrow mandate, the Bank of Japan Act lacks explanatory elements for the bank's strategy on climate change (BOJ, 2021a; Bank of Japan Act, 1997). Yet, the BOJ holds the fourth position in the GMPI (14), just after the UK, the ECB, and the Riksbank; the three of which with GMPI scores of 22, 20, and 15, respectively, by virtue of their secondary mandates. From this perspective, the BOJ represents not only a deviant choice but also an extreme one in that it shows the maximum "deviantness" vis-à-vis other AE central banks with narrow mandates (Seawright & Gerring, 2008, p. 302). In pursuing its green agenda, the BOJ implemented a new credit line with the explicit objective of supporting the country's efforts in mitigating climate change (BOJ, 2021e). To date, the BOJ and the PBC are the only two units of analysis that have introduced lending programmes specifically designed to support achieving carbon neutrality. Paradoxically, both central banks are instructed to safeguard the stability of prices which is, in theory, a very focused mandate. It is one thing to manage climate-related risks and quite another to enact policies that target the root cause of those risks. Moreover, the BOJ was the first central bank in this study to implement a monetary policy instrument with an environmental scope, the Growth-Supporting Funding Facility, in 2010. This policy experience may have influenced how the bank later responded to the environmental crisis. Against this background, the BOJ represents an interesting case study to explore how the bank is attempting to accomplish its environmental strategy within the constraints of its narrow mandate.

The Riksbank holds the third-highest GMPI score among the AE central banks, ranking after the UK and the ECB. Although the three banks feature multiple monetary and economic objectives, which provide greater flexibility to adopt unconventional policies "in the interest of macroeconomic stabilisation and crisis management," the Riksbank is still an unexpected case that merits further investigation (Begg, 2013, p. 58; see also Meyer, 2001). The bank adopted a new act in January 2023 that explicitly accounts for production and employment as a secondary objective. However, the Riksbank's sustainability strategy was set in 2020, prior to the newly expanded mandate (Sveriges Riksbank, 2020b). The Riksbank and the BOJ were thus able to adopt environmental criteria and goals despite the theoretically limited mandates and heterogeneous approaches. Moreover, the new mandate made the Riksbank's contribution "to Sweden's climate transition clearer" (Sveriges Riksbank, 2023a, p. 26). According to the bank, "for all measures taken by the Riksbank, there must be support in law, which also applies to sustainability measures" (Sveriges Riksbank, 2023a, p. 27). This recent modification in the legal text pulled the former deviant central bank towards a typical one, opening a new field of explanation for how a deviant case resolved problems related to the lack of legal conditions to support green public policies by expanding the scope of its mandate. Yet, an overhaul of the mandate can be a difficult and radical option to implement in other contexts.

The BOJ and Riksbank's new environmental strategies and changed policies provide very certain and unique evidence that the green turn was effectively possible in both banks, notwithstanding their commitment to price stability. However, the policy responses to climate change did not imply neglecting the banks' primary goals or disrupting operating procedures—quite the contrary. The interaction of new green finance ideas and interests with the central banks' main goals and formal structures created a model of bounded green monetary policy whereby past institutional arrangements offered opportunities for policy innovation but set boundaries for the type of innovation possible. Reflecting on the BOJ case, the bank's most impressive climate-targeted instrument established in 2021, the Climate Response Financing Operations displaced the multipurpose Growth-Supporting Funding Facility launched in 2010 to counteract an economic recession

(BOJ, 2010, 2021b, 2021e; Kuroda, 2021a). Yet, the measure is temporary—the BOJ's climate financing facility is scheduled until March 2031 (BOJ, 2021d)—conditional on monetary policy needs, and designed in ways that seek to minimise the bank's involvement in the selection of companies to protect the market neutrality principle (BOJ, 2021b, 2023). The transition between the two tools was itself incremental insofar as they overlapped for some months: the first disbursement of the Climate Response Financing Operations was planned in December 2021, whereas the last disbursement of the Growth-Supporting Funding Facility was scheduled for June 2022 (BOJ, 2021b, 2021d). The inclusion of Japan Climate Transition Bonds in the BOJ market operations has been inhibited by the small issuance of these assets (Interview 1a).

The Riksbank preferred risk protection tools over more exclusive or targeted ones, in line with the bank's pre-existing instruments. Specifically, the large-scale asset purchases initiated in 2015 and reinforced during the pandemic to stimulate economic growth were adjusted in ways that emphasised green investments (Interview 2a). However, security purchases were discontinued in 2023 due to a restrictive monetary policy, meaning that the environmental support through asset purchases was also transient (Sveriges Riksbank, 2024). When it comes to the incorporation of green criteria into foreign currency operations, both banks have made them subordinate to other fundamental decisions concerning the risk and return profile of the banks' portfolios (BOJ, 2021a; Sveriges Riksbank, 2023b). Against this background, the BOJ and the Riksbank lend stronger support to a gradual pattern of change in central bank goals and operations linked to their support for the green transition. Empirical evidence also suggests that the two cases cannot be understood through one pattern of incremental adaptation only. Instead, there is a process of layering of environmental criteria on core policies and displacement of pre-established structures. Most notably, new environmental factors were carefully added to existing foreign exchange activities and asset purchase programmes along with other risk management metrics. For its part, the BOJ Climate Response Financing Operations fits well within the displacement type of change as it replaced the preceding Growth-Supporting Funding Facility. This observable result is crucial in the analysis as it implies a clear scenario of policy change rather than a reinterpretation or deliberate non-adaptation of existing policy tools to the surrounding context, as the proponents of conversion and drift mode of institutional change maintain (Hacker et al., 2015). The historical analysis further shows that environmental criteria can be weakened and even halted in the interest of monetary stability, revealing the limited contribution of monetary policy to environmental targets due to conflicting monetary and environmental objectives.

Another central observation of this contribution is that previous nonconventional instruments seen as temporary measures to ensure market liquidity during economic downturns—namely, the BOJ's Growth-Supporting Funding Facility and the Riksbank's expansion of its balance sheet—became necessary and salient parts of the momentary policy toolkits to pursue climate goals. In other words, the green policy measures adopted were built on and benefitted from the functioning, security, and "positive feedback" of an older monetary policy structure without completely altering its purpose or execution (Mahoney, 2000, p. 523). Arguably, adding new green elements to tools that have been approved and tested in response to previous crises is easier than creating entirely new ones. Drawing on the notions of path dependency, new instruments can impose uncertain returns and significant economic costs if current assumptions about climate change risks are proven wrong and the measures adopted turn out to be inefficacious. Therefore, it is reasonable to think that central banks preferred to channel responses to new environmental goals through piecemeal changes in established frameworks, as they enabled a relatively immediate action on climate change, albeit cautiously. This incremental type of response could be somehow expected since the

environmental crisis is a new and evolving event, monetary policy's ability to protect nature is limited, its effects are uncertain (Interview 1b), and governments are the chief levers in driving green economic growth. Borrowing from Moschella and Tsingou (2013), in the context of divided governance, change is more likely to happen gradually. Moreover, relying on earlier policies and practices lessens public opposition and political contestation as the newly created elements can be placed and understood within the banks' existing arrangements (Fioretos, 2011). As Weir (1992, p. 194) puts it: "the way a policy is packaged plays an important role in maintaining the diffuse support or acceptance necessary to protect it from challenge." This may hold particularly true in a domain surrounded by doubts as to whether central banks have a legal basis to pursue environmental goals. Consequently, some institutional constraints may have been accepted and even valued in the process of greening monetary policy. This result is consistent with previous findings about the prevalence of incremental reforms within financial institutions (e.g., Fioretos, 2011; Moschella & Tsingou, 2013).

Considering the factors leading to the rise of green monetary policy measures, the historical review of the BOJ and the Riksbank suggests a combination of two main drivers: the insufficient public policy responses to growing environmental risks and the influence of international agencies, especially the NGFS, in building and promoting alternative green finance solutions. The BOJ's groundbreaking lending facilities established in 2010 and 2021 echo a concerted effort with the Japanese government to achieve specific economic goals. Notably, the Growth-Supporting Funding Facility sought to revert a cycle of economic stagnation by substantiating a list of activities with growth potential, including the environment, as defined in the 2009 New Growth Strategy (BOJ, 2010; Prime Minister's Office of Japan, 2009). The Climate Response Financing Operations launched in 2021 replaced the longstanding Growth-Supporting Funding Facility to support "Japan's actions to address climate change," as per the national Green Growth Strategy to achieve carbon neutrality by 2050 (BOJ, 2021e, p. 20, 2021b; see also Kuroda, 2021a; The Government of Japan, 2021). As the BOJ former governor elucidated:

> ...[T]ransforming the [carbon-growth] model into a decarbonised one in less than three decades is a challenging task...[it] will require not only a large amount of capital and R&D investments over a long period but also the financing of those investments. Against this background, the Bank has recently decided to introduce a new operation to provide funds to financial institutions on favourable terms against various investments or loans they make to address climate change. I hope this new operation will serve as a catalyst to boost private sector efforts to address climate change. (Kuroda, 2021b, Section 2)

The availability and attractiveness of new green finance ideas were crucial to the bank's climate strategy design (BOJ, 2021a). Particular emphasis has been placed on the recommendations of the G20 and Task Force on Climate-Related Financial Disclosures (TCFD), which the Japanese government and the BOJ have been advocating since the country held the G20 presidency in 2019—"Energy Transitions" and TCFD guidelines were among the Group's main agenda topics (BOJ, n.d.; G20 Japan, 2019; Kuroda, 2019; Ministry of Finance Japan, 2019). Following the growing number of acute climate events in Japan, the bank decided to join the NGFS in November 2019 to "enhance its understanding" of and contribute to the international debate on climate change (BOJ, 2019, Interview 1c-d). Favourable credit lines against TCFD disclosure requirements and inclusion of environmental criteria in foreign exchange investments and asset purchases were among the policy options proposed by the NGFS, which the bank came to implement (Interview 1d; NGFS, 2021a).

When it comes to the Riksbank, it is not so much how the country defined its environmental goals that determined the Riksbank's sustainability strategy. After all, Sweden contributes less than 0.1% to global CO2 emissions, whereas Japan has been among the 10 most emitting countries (Climate Watch, n.d.; Friedrich et al., 2023; Interview 2b). The historical account of the Riksbank brings to the fore the importance of investigating international politics and the work of specialised organisations to understand policy change. Evidence shows that the NGFS warning about climate change financial risks and the techniques that can be deployed to minimise those risks are particularly imprinted on the bank's sustainability discourse and policy choices (e.g., Brattström & Gajic, 2022; Breman, 2020, 2021; Finansinspektionen & Sveriges Riksbank, 2021; Interview 2c). Accordingly, the bank has grounded its sustainability strategy on the legal principle of managing public money in a prudent and efficient manner, as required by Chapter 9 of the previous Riksbank Act 1988 (Sveriges Riksbank, 2020a; The Sveriges Riksbank Act 1988, 2015, Chapter 9, Article 1(a)). The new strategy further aimed to avoid undermining the effects of green public policies through the bank's activities and compensate for the lack of effective global carbon-reduction measures to fight climate change (Breman, 2020; Sveriges Riksbank, 2020b, 2021). A key observation from this analysis is that the Riksbank maximised the wider scope afforded by Chapter 9 of its older act to develop a monetary policy response to climate change. This is an indication of how the interpretation of mandates can drive policy innovation when there is a strong commitment towards specific causes.

As even this brief review of the Japanese and Swedish cases illustrates, the greening of monetary policy frameworks has been a challenging process. For one thing, institutional change is evident in that green considerations gathered momentum and remained significant in assessing investments, even if temporarily and constrained by other monetary policy criteria. For another, green considerations cannot be entirely sustained to safeguard the banks' overarching goals, which remain subject to keeping "long-term inflation expectations…firmly anchored around the inflation target" (Sveriges Riksbank, 2023b, p. 30). Therefore, the measures adopted are time-limited and can be weakened or suspended while in force. Three other elements significantly influenced policy results: First, pre-existing nonstandard monetary policy tools created strategic opportunities that both banks exploited to pursue environmental goals. Second, the green shift is also a narrative about policy learning and acceptance of new sustainable finance ideas, with the NGFS laying the groundwork for possible green monetary policy solutions. Third, despite the emergence of innovative ideas and interests, extant structures and primary objectives proved instrumental in shaping monetary policy outcomes, suggesting that history influenced central bank institutional developments in the environmental field.

6. Conclusion

This article reviews and examines the green monetary policy strategies and formal objectives of 20 major central banks. Evidence shows that monetary authorities have increasingly formulated and implemented monetary policy measures in ways that directly support the low-carbon transition, even if the effectiveness of such measures is yet to be fully estimated and understood. The multiple-case analysis further reveals the following expected and counter-intuitive findings: First, as expected, the most climate-responsive central banks appear to have a secondary mandate that supports unconventional green monetary policy measures. However, and second, climate strategies have proven hard to implement by central banks with dual mandates which, theoretically, would have more leeway to pursue environmental objectives. Third, the greening of monetary policy has also occurred in contexts where institutional conditions appear at odds with

such developments, in the so-called narrow mandates. This is relevant evidence showing that historical institutionalism explains green monetary policy developments to a certain degree but not entirely, thereby weakening this study's research hypothesis: Central bank mandates create a path dependency which significantly shaped the development of green monetary policy measures. To enhance the understanding of the medium-N research, the study examines two central banks that did not conform with the hypothesised relationship between the scope of the mandate and the environmental strategy adopted.

The BOJ and the Sveriges Riksbank elucidate two contexts where the green policy turn was possible, notwithstanding their originally narrow mandates. Spurred by a growing concern with climate risks and the imperative need to accelerate the green transition, both banks were able to set in motion new investment and policy strategies that offered incentives towards a Paris-aligned economy—whether central banks should be tasked with providing this incentive in the first place appears to be still a matter of debate. However, the environmental emergency did not fundamentally change the banks' mission and aims. Evidence shows that historical legacies assisted in explaining the green monetary policy options adopted. Notably, both central banks sought institutional solutions for the environmental problem within existing arrangements, which limited what they could implement and do for the environment. Legal, legitimate, and technical considerations account for piecemeal changes in monetary policy toolkits, namely layering and displacement forms of change. Furthermore, environmental criteria can be "delayered" and the climate-targeted instruments suspended whenever monetary and environmental ends are not compatible. Enduring solutions would require an expanded and legitimate monetary policy toolkit that reconciles multiple and intersecting monetary policy goals. For now, the usefulness of attempting to "green" monetary policy seems to rest on setting an example and encouraging the market to enhance their transition plans. The within-case examination further demonstrates that the adoption of environmental standards was not solely determined by a functionalist explanation related to the desire to keep prices stable or protect the financial position of central banks. In addition to risk management purposes, environmental considerations emerged as a response to addressing a collective action problem, serving the needs of governments to stimulate green growth. This appears particularly evident in contexts where the environmental topic is institutionalised in a broad range of economic and social domains. In Sweden, the national government not only implemented a determined Climate Policy Framework but also effectively amended the statutes of the bank in ways that more explicitly support climate action (Government Offices of Sweden, 2021). The BOJ continued on the same legal grounds throughout the research period. The bank's climate strategy resulted from a longstanding tradition of government support, which involves offering preferential loans for certain economic activities.

To strengthen the validity of these findings and significantly contribute to theory development, further comparative analysis is needed to corroborate the institutional dynamics discussed in this contribution or capture new ones. For instance, it would be relevant to explore whether the changing environmental problem and the growing availability of data will drive more significant and long-lasting changes in future monetary policy decisions, or if such changes will prove to be ineffective or institutionally impossible to implement. It would also be worth conducting additional central bank case studies in other regions of the world to identify the incentives and hindrances encountered, as well as whether those banks adopted or failed to adopt environmental factors in their monetary policymaking. Other potential areas for future research include investigating the mechanisms through which informal organisations and ideational change shaped central bank green policy preferences. As the evidence came to demonstrate, during a time of

increasing environmental concerns, the creation of the NGFS succeeded in influencing some of the largest central banks to rethink their role in the green transition and scale up green finance. However, it is not yet clear why central banks with dual mandates did not undertake any green adjustment in their monetary policy frameworks, despite the growing consensus over climate risks, their holding more favourable institutional conditions to promote green segments, and being part of the NGFS, "a coalition of the committed" (Elderson, 2021). To address this topic, the application of qualitative comparative analysis can provide a differentiated research design to identify the sufficient conditions that lead to green monetary policy outcomes. I hope this study expands the historical-comparative literature with novel evidence about the inception and structure of unconventional central bank monetary policies and proposes a framework that stimulates further research on green monetary policy issues at a global scale.

Conflict of Interests
The author is currently on unpaid leave from one of the central banks in this study. The bank is neither of the two case study central banks nor is it sponsoring this study, which the author has undertaken as an independent researcher at the University of Luxembourg.

Data Availability
Research data can be found in the Supplementary File 2.

Supplementary Material
Supplementary material for this article is available online in the format provided by the author (unedited).

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