

The environmental turn in monetary regimes, the environmental state, and accumulation regime consistency*

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Abstract

As the ecological crisis intensifies, so do structural issues faced by contemporary economies. Amidst the institutional responses to this polycrisis, and although remaining controversial, the greening of monetary policy and financial regulation is spreading. Our paper takes stock of this environmental turn among monetary and financial authorities throughout the world, keeping in mind that such changes do not occur in an institutional vacuum and instead co-evolve with the other institutional forms governing the society. First, we assemble data from various sources to construct a comprehensive database of policies integrating environmental criteria into monetary policy and financial regulation to date. We then code the database according to relevant modalities surrounding 15 types of policy categories. We provide extensive descriptive statistics from the database characterizing the ongoing transformation of monetary regimes. We then utilize multiple factor analysis and clustering to characterize the main varieties of green monetary regimes. Finally, we employ econometrics to understand whether a country's likelihood to belong to a particular cluster can be explained by the particular institutional configuration surrounding its environmental state as well other factors, such as exposure to environmental issues or the GDP intensity in carbon-intensive activities. We conclude, based on these results, by discussing the consequences of the greening of monetary regime for social-ecological transformation in different institutional contexts as well as for the overall consistency and stability of capital accumulation regimes.

Keywords:

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1 Introduction

As the ecological crisis intensifies, so do structural issues faced by contemporary economies. Distributional conflicts crystallizing in income and wealth inequalities are well documented (Chancel *et al.*, 2022; Kuhn *et al.*, 2020; Piketty, 2013). They now extend to the distribution of environmental amenities, costs and benefits at local, national and international levels (Temper *et al.*, 2015, 2018). The decrease in productivity gains is still a major concern, even more so since the covid crisis. In this context, widespread discontent and distrust towards governmental bodies in democratic countries signal how existing institutions struggle to normalize socio-economic and political conflicts and antagonisms generated by finance-led globalized capitalism, including on ecological issues. The *ecological constraint* (Becker and Raza, 2000) — the set of limits and boundaries opposed by biosphere elements such as climate and biodiversity and by thermodynamic laws to economic processes, *i.e.*, the constraint the material world represents for capital accumulation — may exacerbate these endogenous tensions and contradictions. Amidst the institutional responses to this *polycrisis*, and although remaining controversial (Hansen, 2022; Oman *et al.*, 2022, 2024), the greening of monetary policy and financial regulation is spreading (Campiglio *et al.*, 2018; D’Orazio, 2022; Deyris, 2023; Massoc, 2024).

While still in its infancy, the green turn in monetary policy and financial regulation may mean more than merely a set of technical adjustments to central banks operations and risk management by financial institutions. Indeed, if history offers a guide, as in the case surrounding both the rise and the fall of the Bretton Woods order (Guttman, 2002), significant changes in the financial architecture may herald equally substantial mutations in the broader political economy, and institutional and productive structures of societies. Indeed, the advent of the Bretton Woods monetary system and era of tight financial regulation in 1944 appears *ex post* as the early steps of Fordist capitalism. International monetary and financial stability combined with cheap and abundant fossil energy fuelling high productivity gains, themselves enabling a social compromise made of primary and secondary distributions of income supporting both a high wage share and high investment. Such dynamic compatibility between supply, demand and the distribution of income ensured mass production-mass consumption synchronization and high growth rates in industrialized countries of the core of capitalism from the 1950s to the 1970s. The fall of Bretton Woods in 1971, adding to the decrease in productivity gains already weakening the fordist capital accumulation regime since the mid-1960s in some industrialized countries, retrospectively marks the beginning of finance-led globalized capitalism. The fordist social compromise started to erode with decreasing wage share and investment rate in industrialized countries : greater monetary and financial instability emerged and the predominantly domestic and productive capital accumulation patterns of Fordism got progressively superseded by the complementarity and mutual reinforcement between financial accumulation in core countries and the offshoring of industrial productions and productive accumulation to periphery countries with lower labour costs, in particular through the development of global value chains (Auvray and Rabinovich, 2019; Milberg, 2008; Milberg and Winkler, 2010). Such historical experience highlights the centrality of the monetary and financial system in shaping capital accumulation patterns over the long-term. This makes the monetary policy-structural change nexus a key research question (Altavilla *et al.*, 2024).

We can therefore wonder if the ongoing integration of climate and other ecological issues in monetary policy and financial regulation signals the early days of a new capitalism, where environmental issues would be at the core of renewed capital accumulation patterns. Needless to say, we are looking at historical processes whose broader significance may not become immediately apparent: the answer to this question will take shape over a few years or decades. Nevertheless, it is already possible to document and characterize ongoing evolutions in monetary and financial policies, and to discuss the possible implications for contemporary capital accumulation regimes.

Therefore, our paper seeks to take stock of the extent and potential implications of this environmental turn among monetary and financial authorities throughout the world, keeping in mind that such changes do not occur in an institutional vacuum and instead co-evolve with the other institutional forms governing the society. To get at the complexities of these mutual interactions, we make use of Regulation Theory's conceptualization of accumulation regimes and modes of regulation. The emphasis is on the existence of institutional complementarities and tensions between the *monetary regime* and other institutional forms that mutually reshape one another in the context of changes in the accumulation regime (Jeffers and Plihon, 2022). The concept of monetary regime is used in different ways in the literature. At the most abstract level, it can be defined as the institutional form regulating the diverging interests between lenders and borrowers (Mazzotta, 2019). This is in line with Regulation theory's approach to institutions as institutionalized compromises normalizing the conflicts and contradictions generated by economic processes over time (Aglietta, 2015; Boyer and Saillard, 2002a). At more concrete levels, it can be defined as the degree of central banks' independence or focus on inflation stabilisation (Banerjee *et al.*, 2022), or more broadly, as the set of monetary and financial policies governing and ensuring the permanence of the monetary system (Guttman, 2002; Tcherneva, 2017): the rules regulating credit and money creation, financial regulation, the role of the central bank as lender of last resort, the exchange rate regime and the openness of the balance of payment's financial account.

Drawing from the abstract definition, greening monetary regimes can thus be understood as attempts to remediate tensions and contradictions arising from, or exacerbated by, the ecological constraint weighing on the capital accumulation regime, as they manifest *within* the monetary regime and *between* the monetary regime and other institutional forms or accumulation patterns. The article therefore also emphasizes the relation between the monetary regime and other institutional forms such as the form of the state. From this perspective, we engage with the growing literature on the environmental state, conceived broadly as the set of administrative, regulatory, financial and knowledge structures for environmental governance and the management of society-environmental relations (Duit, 2016; Duit *et al.*, 2016; Meadowcroft, 2005). The literature on the environmental state discusses at length the complementarity with the welfare state (Douai and Montalban, 2012), but the relation between the environmental state and the monetary regime remains to be investigated (Bailey and Jackson, 2023).

We proceed in three steps. First, we assemble data from various sources to construct, to our knowledge, the most comprehensive database of policies integrating environmental criteria into monetary policy and financial regulation to date. We then code the database according to relevant modalities surrounding 15 types of policy categories (greening of asset purchasing programs, green credit policies, etc.). We provide extensive descriptive statistics from the database

characterizing the ongoing transformation of monetary regimes. We then utilize multiple factor analysis and clustering to characterize the main clusters of green monetary regimes. Finally, we employ econometric techniques to understand whether a country’s likelihood to belong to a particular cluster can be explained by the particular institutional configuration surrounding its environmental state as well other factors, such as exposure to environmental issues or the GDP intensity in carbon-intensive activities. We conclude, based on these results, by discussing the consequences of the monetary regime-environmental state nexus for social-ecological transformation in different institutional contexts as well as for the overall consistency and stability of capital accumulation regimes.

The remainder of the article is as follows. Section 2 introduces briefly Regulation theory as the political economy framework of the article and discusses the emergence of green central banking and financial regulation as a new branch of the environmental state in this regulationist perspective. Section 3 describes the methodology: the construction of our data is explained, as well as the empirical strategy. Section 4 characterizes current green monetary regimes in terms of the policies implemented and analyses the reasons leading countries towards a specific type of monetary regime. Section 5 investigates the relation between the monetary regime and other areas of regulations and discusses implications of greening the monetary regime for capital accumulation regime consistency and stability. The conclusion recalls the main insights and open towards future research avenues.

2 Greening monetary regimes: the emergence of central banks and financial regulators as a branch of the environmental state?

2.1 Monetary regime and form of the state: central banks and environmental state

Regulation Theory offers a framework for understanding institutional change and national variety under capitalism. Economic dynamics are embedded in specific institutional forms which, when successful, reflect durable social compromises and ensure a degree of stability to a given *accumulation regime*, or “the set of regularities that ensure the general and relatively coherent progress of capital accumulation” (Boyer and Saillard, 2002b, p. 334). This success, however, is always relative, as even seemingly stable accumulation regimes continually differentiate the interests of individual and collective agents who may become dissatisfied through a re-evaluation of their expectations (Aglietta, 2015; Amable and Palombarini, 2009). Social conflict, in short, cannot be permanently neutralized, but it may be temporarily managed in a *mode of regulation* that features coherent complementarities between the main *institutional forms*.

The principal institutional forms studied by regulation theory concern the wage–labor nexus, the form of the state, the competition regime, the insertion in the international regime, and the focus of this article, the monetary regime. As mentioned in the introduction, the monetary regime consists of the rules governing money and credit creation, domestic financial regulation, lender-of-last-resort mechanisms, exchange rate management and the international transfer of

financial assets (Guttmann, 2002; Tcherneva, 2017).

Typically, durable accumulation regimes feature institutional complementarities between the rules governing the monetary regime and those of other institutional forms. For example, the *belle époque* era dominance of the currency principle pegging money creation to the gold holdings of the central bank was complementary with the international gold standard and with a wage-labor nexus that permitted large swings in wages and employment levels. The post-war Fordist period, however, featured a focus on maintaining employment and production levels and thus produced a monetary regime featuring targeted credit policy, public regulation of finance, administered interest rates and capital controls accompanying the international gold exchange standard (Jeffers and Plihon, 2022). In each case, the monetary regime features both an internal coherence (regulating the divergence of interests within a monetary regime between debtors and creditors), and an external complementarity with the overall mode of regulation (the regulation of monetary phenomena is consistent with the regulation of divergent interests in other institutional forms such as those between capital and labor).

Despite the many strengths of regulation theory, it has only more recently begun to apply its insights to the environmental underpinnings of accumulation regimes. Notably, Cahen-Fourot (Cahen-Fourot, 2020) has postulated a sixth institutional form of the social relation to the environment dedicated to the regulation of the divergent interests in capitalist societies between capital accumulation cycles and natural ecological cycles. On this terrain, there are fertile grounds for a conversation with the growing literature on the environmental state, which can be broadly defined as a situation in which “the state’s role in managing social– environmental interactions becomes a continuous focus of political argument and contestation” (Duit *et al.*, 2016).

Drawing on parallels with the historical emergence of the welfare state, Meadowcroft (Meadowcroft, 2005) has argued that environmental states should be similarly expected to differ throughout space and time as a patchwork of path dependent and contradictory programs reflecting given configurations of social compromises. It is generally recognized that many states have already developed a set of institutions to provide the knowledge, administration, redistribution and regulation of environmental problems and thus already qualify as environmental states (Duit, 2016). Various typologies of existing environmental states have therefore been provided in the literature (Christoff, 2005; Koch and Fritz, 2014; Meadowcroft, 2005), even if no state has yet taken the further step to setup a “green state” or an “ecostate” that would systematically privilege environmental aims over conflicting societal ones (Bailey, 2020; Eckersley, 2004). In a critical engagement with the literature, Hausknot (2020) has evoked the concept of a glass ceiling in environmental transformation as “a structural barrier that marks the line until which environmental reform is compatible with functional requirements of the state and beyond which this compatibility gives way to functional tension, conflict, and outright contradiction” (Hausknot and Hammond, 2020, p. 3).

Such a critique raises the issue of institutional complementarity between environmental states and other key institutions of an accumulation regime, something relatively neglected in the environmental state literature, aside from the discussion of the compatibility with types of welfare states (Douai and Montalban, 2012; Koch and Fritz, 2014). Concerning a possible connection with the monetary regime, Bailey and Jackson (2023, p. 896-897) speak of a “central bank lacuna in the analysis of green state transformation”, where debates on the environmental state have

“historically elided the role of central banks and monetary policy.” We therefore pick up on their call (p. 898) for a research agenda considering the “institutional variation and convergence of central banks across the global economy on the governance of the instability resulting from the ecological crisis and economic transitions.” We do so by considering more closely the variation in the recent green turn in monetary and financial policy around the world, before relating it to differences within and between the monetary regime and other institutional forms across countries.

2.2 Integrating environmental criteria in monetary policy and financial regulation: rational and proposals

While few central banks have been able to ignore the turn toward engaging in some manner with ecological considerations, there are nonetheless considerable differences in possible approaches. [Oman *et al.* \(2022, 2024\)](#) elaborate four normative approaches underpinning central bank practices. The first view holds that environmental issues are best managed by legislatures, through carbon pricing or other mechanisms, and that the intervention of monetary authorities is either unnecessary or a “second best” solution. From this point of view, monetary authorities are more likely to restrict their environmental-management activities to what [Baer *et al.* \(2021\)](#) call “informational” measures. Informational measures aim at providing relevant environment-related financial information to market actors, which could modify behavior of private actors through modifying incentives or providing a greater awareness of exposure to environmental risk. Mandatory climate or environmental disclosures, such as the EU’s Sustainable Finance Disclosures Regulation (SFRD) that came into effect in 2021, are the main informational instruments consistent with this first normative view.

A second view which has become more widespread in recent years corresponds to what [Baer *et al.* \(2021\)](#) refer to as “prudential” policy motives. That is, as it has become widely recognized that climate change poses risks to the stability of the financial system, central banks and financial authorities should be concerned with climate change from a systemic risk perspective. This concerns not only the effects of extreme weather events (physical risks) but also the growing realization that the low-carbon transition may entail transition risks, triggered by technological shocks such as the fast replacement of fossil fuels by renewable energy or climate policy shocks through sudden evolution and changes in environmental and climate policies, laws and regulations ([Bowen and Dietz, 2016](#); [Monasterolo *et al.*, 2017](#)). Stranded assets, or environmentally harmful assets suffering unexpected or premature write-offs ([Caldecott *et al.*, 2016](#)), are by no means limited to the fossil fuel sector but feature substantial cascade effects to the overall stock of productive capital in many countries ([Cahen-Fourot *et al.*, 2021](#)). Policies falling under the prudential umbrella associated with this second normative view include the introduction of green supporting factors or brown penalizing factors into prudential regulation ([High-Level Expert Group on Sustainable Finance, 2018](#)). A green supporting factor would decrease the risk weighting associated with environment-friendly assets; capital requirements associated with these assets for lending banks would be lowered. A brown penalizing factor would increase the risk weighting associated with environmentally harmful assets and thus increase capital requirements. Similarly, it would be possible to introduce differentiated reserve and liquidity requirements.

A third normative viewpoint goes beyond merely protecting the financial system from outside climate (physical or transition) risks and seeks to use the monetary regime in a “promotional” (Baer *et al.*, 2021) capacity so that monetary authorities might “do everything in their power to steer financial markets away from funding ecologically unsustainable activities” (Oman *et al.*, 2022)(p. 152). Here the focus is no longer merely on protecting the financial system from climate risks, but rather in using the financial system as a lever to induce an orderly and quick transition. Some of the same incentive-based policies that could fall under a prudential framework may therefore also be considered as promotional depending on the intention of the authorities implementing them. This includes incorporating environmental factors into asset eligibility criteria as counterparts into central banks’ purchasing programs and collateral frameworks (Campiglio *et al.*, 2018). Going further, it is possible to impose direct quantitative controls on financial flows targeting an ecological transition. In this line of thinking, monetary authorities could impose lending quotas on banks to lend defined proportions of their total volume of loans to specific sectors or restrict bank lending to certain damaging activities. Central banks could also directly finance sustainable activities or lend to public development banks that do so.

Finally, Oman *et al.* (2022, 2024) identify a last normative point of view, where monetary authorities consider their mandate from an evolutionary perspective acknowledging that they cannot substitute for insufficient actions across other domains of the state (industrial policy, fiscal policy, etc.). This view advocates closer coordination between central banks in particular and other state actors and therefore a broader institutional transformation which requires reconsidering central bank mandates and the extent of central bank independence. This may imply a stronger focus on keeping government borrowing costs low, even at the expense of price stability, or even direct central bank financing of government spending (Oman *et al.*, 2024).

Nonetheless, without waiting for such broader institutional evolutions, central banks around the world have already implemented an array of informational, incentive- and quantity-based policies with a prudential and promotional focus. In terms of micro- and macroprudential policies, central banks of Brazil, Netherlands, Switzerland and China have integrated some sustainability or ESG criteria. In terms of monetary policy, credit quotas and guidance are used by central banks of China, India and Bangladesh. Differentiated interest rates in the form of preferential refinancing or subsidized reserves are used by central banks of Japan and Bangladesh (Campiglio *et al.*, 2018). D’Orazio and Popoyan (2019b) sample of fifty-six countries found that 10 countries had implemented mandatory regulations, 13 had implemented voluntary regulations and 25 were discussing new regulations.

Yet things have been moving rapidly over just the past few years, and these early examples are no longer sufficient to give an overall picture. In the next section, we present a comprehensive dataset across 85 countries having implemented at least some type of green monetary or financial policy as of 2024.

3 Methodology: data, sample and empirical strategy

3.1 Data and sample

Our database of green monetary regime policies was constructed in three steps. First, we specified the criteria for including a policy. Second, we cross-checked existing databases manually in order to ensure comprehensiveness and filter for policies relevant to our criteria. Third, we categorized each policy according to multiple modalities concerning, where relevant, policy category, legal status (voluntary vs. mandatory), environmental type (climate or environment at large), and type of firms affected (banks, investment funds, listed firms, etc), among others. The result is a comprehensive global database of 145 policies and 15 policy categories across 85 countries grounded in an institutional theory of the monetary regime.¹

Concerning the first step, our selection criteria for including a policy includes several specificities. We follow the concrete definition of a monetary regime as the combination of credit and money creation regulations, financial regulation, lender of last resort, exchange rate regime and openness of the balance of payment's financial account (Guttman, 2002) as the basis for our policy selection. Following from this, all policies included must be state policies. Furthermore, we consider that a policy must be a national policy or a policy with significant national scope (*i.e.*, the regulation of a nationally-important stock exchange) in order to qualify for our database. Lastly, we only keep implemented policies or policies for which there is a formal commitment for implementation, rather than those that were merely proposed or under discussion.

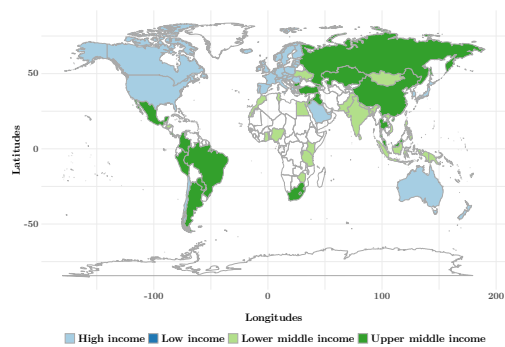
Concerning the second step, in order to ensure comprehensiveness, we cross-checked existing databases of green financial policies by examining every policy manually. The main databases we use include the Green Finance Measures Database from the Green Finance Platform²; the Green Monetary and Financial Policies (GMFP) Tracker from the E-axes Forum on Climate Change, Macroeconomics, and Finance³; and the Green Central Banking Scorecard (Eames and Barmes, 2022). We also use data from academic literature such as D'Orazio and Popoyan (2019a) and Dikau and Volz (2021). Finally, numerous reports and official decisions by national central banks and financial regulators are used to verify information and specify the modalities of the policies implemented whenever needed.

The first two steps produce our global sample of 85 countries and 145 policies. Figure 1 shows the composition of our sample in terms of geographical location (1a) and income groups (1a and 1b). Our sample is dominated by high income countries but close to half of the countries are middle income. Two countries are low income.

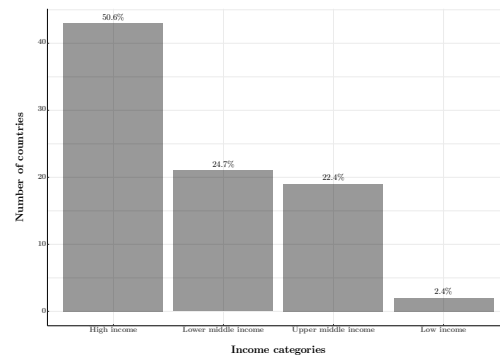
¹To our knowledge, in the academic literature, only D'Orazio (2023) has built a similarly comprehensive global database. Our database nonetheless goes further. It includes 15 policy categories rather than 5 and clearly distinguishes climate policies from other environmental policies. Our database also distinguishes additional modalities of each policy, permitting a more multidimensional clustering analysis. Finally, we exclude banking association policies and other purely private initiatives. Our database is therefore built to be closely connected to the theoretical literature on monetary regimes.

²<https://www.greenfinanceplatform.org/financial-measures/browse/>; last access 27/09/2024

³https://e-axes.org/tableau_iframe/policy-visualization/; last access 27/09/2024



(a) Geographical distribution of the sample



(b) Distribution of the sample across income groups.

Figure 1: Geographical and income distribution of the sample. Note: income groups according to World Bank classification.

In the final step, we identify 15 policy categories from the sample of 145 policies. Policies can be understood as modalities of each policy category. For instance, two central banks may include environmental criteria in their collateral framework but one may limit these criteria to climate while the other may consider other environmental dimensions. In that case, we consider these as two different policies, or two different modalities of the collateral framework policy category. Table 1 details these policy categories, their label and the type of policies belonging to each.

Policy category	Label	Definition
Asset purchasing programs	<i>APP</i>	Climate and environmental criteria in assets eligibility to asset purchasing programs; eligibility of green bonds
Collateral framework	<i>collateral</i>	Climate or environmental criteria in collateral framework; green bonds eligible as collateral
Credit policy	<i>credit policy</i>	Differentiated interest rates for banks refinancing when lending to sustainable activities; credit control
Disclosure	<i>disclosure</i>	Disclosure on environmental risks; double materiality
Environmental, Social and Governance	<i>ESG investment</i>	Integration of ESG criteria in investments by financial institutions
Foreign reserves	<i>FX</i>	Climate and environmental criteria in foreign reserves management, eligibility of green bonds
Green bonds standards and guidelines	<i>green bonds</i>	Guidelines and standards on how to issue and use green bonds
Guidelines on risk management	<i>guidelines environmental risk</i>	Guidelines on environmental risk management for financial institutions
Central banks' mandate	<i>mandate</i>	Integration of sustainability in central banks' mandates
Management of non-monetary policy portfolios	<i>nonmonetary portfolio</i>	Greening of CB's non-monetary policy portfolios (own funds, own pension fund)
Prudential regulation	<i>prudential regulation</i>	Integration of environmental risks in prudential regulation
Reserves	<i>reserves</i>	Differentiated mandatory reserves rate and differentiated interest rates on reserves for financing of sustainable activities
Stress tests	<i>stress tests</i>	Climate and environmental stress tests
Supervision	<i>supervision</i>	Integration of environmental risks in supervision by central banks
Taxonomy	<i>taxonomy</i>	Taxonomy of sustainable activities

Table 1: Policy categories identified from the sample of 145 policies, labels used in the statistical analysis and policies included.

The result is a dataset of 85 rows and 88 columns. Table 2 gives an illustration of our dataset for the first ten countries and the policy category *APP*.

Policy category: asset purchasing programs			
Country/Modality	APP_discl_requirement	APP_environment_type	APP_paris_aligned
ARE	no_disclosure_requirement	no_environment_type	no_paris_aligned
ARG	no_disclosure_requirement	no_environment_type	no_paris_aligned
AUS	no_disclosure_requirement	no_environment_type	no_paris_aligned
AUT	double_materiality	climate	paris_aligned
BEL	double_materiality	environment	paris_aligned
BGD	no_disclosure_requirement	no_environment_type	no_paris_aligned
BGR	double_materiality	climate	paris_aligned
BHR	no_disclosure_requirement	no_environment_type	no_paris_aligned
BRA	no_disclosure_requirement	no_environment_type	no_paris_aligned
CAN	no_disclosure_requirement	no_environment_type	no_paris_aligned
...			

Table 2: Snapshot of the final dataset of 85 rows and 88 columns. Note: Each column is one modality of a policy category. The corresponding policy category is indicated by the prefix in the name of each modality, here *APP_*.

3.2 Empirical strategy

The goal for the empirical analysis is twofold: 1) to analyze the variation in green monetary and financial policy mixes; and 2) to help understand why countries group around different policy mixes. In order to do so, we use multifactor analysis followed by hierarchical clustering to identify 6 main clusters of green monetary and financial policy mixes. We then utilize multinomial probit/logit regression to predict cluster group as the outcome variable through the use of independent variables representing different institutional forms in a country’s mode of regulation. We briefly discuss each of the two steps in further detail before proceeding to the results.

Multifactor analysis (MFA) is well suited to exploit the richness of the dataset assembled, which features variation across 88 columns grouped into 15 policy categories. The method is similar to multi-correspondence analysis which allows a reduction of dimensionality while retaining the principal variation of a dataset, except it allows for the definition of particular subgroups of variables (our 15 policy categories) that permits us to balance the influence of each of these subgroups. Otherwise, a policy category with more modalities would weigh heavier in the reduction of dimensionality (Pagès, 2014).

Reducing the dimensionality through the multifactor analysis also permits us to obtain a more meaningful cluster analysis by eliminating noise in the raw data and retaining the statistically significant information. We thus perform hierarchical clustering on the retained principal components from the MFA, which improves the stability of the clusters (Husson *et al.*, 2010).

For the second step of the empirical analysis, we feed the seven clusters obtained from the previous step as outcome variables into a multinomial probit regression. We gather a corresponding dataset of indicators reflecting the institutional forms of national formations to see whether they serve as predictors for the specific type of greening of a monetary regime undertaken. Based on

the literature and on the insights from our clustering, independent variables include environmental state variables (carbon pricing, stringency and level of enforcement of environmental policies, etc), non-green monetary regime variables (exchange rate regime, level of independence of the central bank, etc), variables characterizing the productive structure and its intensity in environmental inputs and outputs (carbon intensity of GDP, etc) and general economic variable such as GDP per capita. The results indicate the likelihood that a country belongs to a particular cluster of green monetary and financial policies based on its specific mode of regulation.

4 How and why do monetary regimes go green?

4.1 Some descriptive statistics: greening monetary regime goes predominantly through incentive measures

Many countries have started greening their monetary regime, although quite differently both in terms of number of policies implemented and of the nature of policies implemented. Table 3 ranks countries in our sample by the number of policies implemented. In terms of number of policies, when excluding European Union-level policies and focusing on strictly national policies, the United Kingdom stands out with 20 policies, followed by China, Hungary, Australia, Brazil, France, Russia, Singapore, Italy and the Netherlands. We counted 27 EU-level policies in our sample, not of all these 27 policies being implemented by all EU countries. Therefore, if we account for those, the top 10 changes and is occupied solely by EU countries with Hungary on top. The UK and China follow after all EU countries.

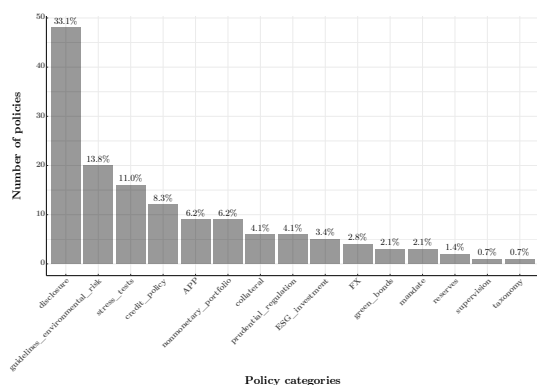
Countries	Without EU policies	EU	With EU policies	Countries
United Kingdom	20		36	Hungary
China	14		34	France, Italy
Hungary	12		32	Netherlands
Australia, Brazil	11		30	Sweden
France, Russia, Singapore	10		29	Austria, Belgium, Germany, Spain
Italy, Netherlands	9		28	Denmark, Finland, Portugal, Slovenia
Canada, Mexico	8		27	Czechia, Malta, Poland
Indonesia, India, South Korea, Philippines, South Africa	7		26	Bulgaria, Cyprus, Estonia, Greece, Croatia, Ireland, Lithuania, Luxembourg, Latvia, Romania, Slovakia
Fiji, Japan, Malaysia, Sweden, Turkey	6		20	United Kingdom
Bangladesh, Switzerland, United States	5		14	China
Georgia, Kenya, Mongolia, Nigeria, New Zealand, Peru, Vietnam	4		11	Australia, Brazil
United Arab Emirates, Argentina, Austria, Belgium, Chile, Colombia, Germany, Egypt, Spain, Morocco, Thailand	3		10	Russia, Singapore
Bahrain, Costa Rica, Denmark, Finland, Gambia, Iraq, Kazakhstan, Lebanon, Nepal, Pakistan, Portugal, Paraguay, Saudi Arabia, Slovenia	2		8	Canada, Mexico
Czechia, Ghana, Greece, Honduras, Iceland, Jordan, Kuwait, Sri Lanka, Luxembourg, Malta, Norway, Papua New Guinea, Poland, Qatar, Rwanda, Tunisia, Tanzania, Ukraine, Zimbabwe	1		7	Indonesia, India, South Korea, Philippines, South Africa
			6	Fiji, Japan, Malaysia, Turkey
			5	Bangladesh, Switzerland, United States
			4	Georgia, Kenya, Mongolia, Nigeria, New Zealand, Peru, Vietnam
			3	United Arab Emirates, Argentina, Chile, Colombia, Egypt, Morocco, Thailand
			2	Bahrain, Costa Rica, Gambia, Iraq, Kazakhstan, Lebanon, Nepal, Pakistan, Paraguay, Saudi Arabia
			1	Ghana, Honduras, Iceland, Jordan, Kuwait, Sri Lanka, Norway, Papua New Guinea, Qatar, Rwanda, Tunisia, Tanzania, Ukraine, Zimbabwe
Total policy implementations without EU policies	320		1010	Total policy implementations with EU policies

Table 3: Number of policies implemented by country, including and excluding European Union-level policies. Note: at the country level, the counts represent single policies. At sample level, totals are policy implementations and not single policies, as the same policy can be implemented by several countries.

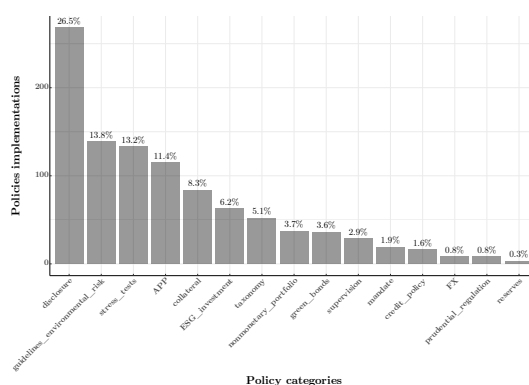
The number of policies may say something about the voluntarism of central banks and financial regulators to address the ecological crisis and green the monetary regime. However, such numbers do not say anything about the nature of the policies implemented. [Baer et al. \(2021\)](#) differentiate between three broad kinds of policies: informational, incentive and control-based. Informational policies aim at uniformizing the information available to market participants through

clarifying concepts and standards, develop environmental risk assessment methodologies and mainstream disclosure of such risk assessments. Incentive-based policies aims at improving the risk-return profile of low-carbon strategies for financial investors. Control-based policies aims at directing the allocation of capital through implementing quantitative controls on financial flows, *e.g.*, credit. These three types of measures describe three levels of control exerted by monetary and financial authorities on private actors.

Figures 2 and 3 give more indications. Figure 2a shows the number of policies per policy categories, which gives a first indication on the kind of measures favoured to green monetary regimes. We see that disclosure policies largely dominate the policy universe, followed by guidelines on environmental risk management for financial institution and stress tests. Following [Baer *et al.* \(2021\)](#), these three policy categories can be characterized as informational. Credit policy comes after: this category includes both incentive policies such as differentiated interest rates and control-based policies such as credit controls. Most of the other policy categories are either informational (*green bonds, supervision*) or incentive (*APP, nonmonetary portfolio, collateral, prudential regulation, ESG investment, FX, reserves, taxonomy*). Only *mandate* could be considered to be control-based as it refers to whether sustainability is an explicit objective in central banks' mandates and thus forces central banks to tackle such issues. However, classifying *mandate* as control-based can be questioned: indeed, sustainability as an explicit objective of central banks do not say anything about the kind of measures central banks take to comply with such objective. We discuss the relation between mandates and measures taken later. The greening of non-monetary policy portfolio and foreign reserves management are specific because they are policies central banks impose to themselves. We classify them as incentive in so far as they can be interpreted as measures taken by central banks to both reduce their own exposure to climate and other environmental risks and to steer markets in a greener direction: through reallocating capital of their own funds and pension fund towards financial assets labelled as green, central banks create a demand for such assets that may incentivize financial and non-financial actors to issue more of them through financing more projects qualifying as green. There can also be a leading by example effect, where central banks contribute to shifting norms in capital allocation choices across financial actors by mainstreaming investments in green financial assets in their own portfolios. Finally, some of these numbers are the result of how we constructed our database: for the *taxonomy* category, we only indicate whether countries have or do not have a taxonomy, without differentiating between the different taxonomies. Had we done so, this category would include more than one policy ([Ehlers *et al.*, 2021](#)). Similarly, for *mandate* categories, we consider whether they have or do not have sustainability as an explicit objective, but we do not differentiate between different ways to do so. Figure 2b confirms the dominance of informational policies in greening monetary regimes. However, it also shows that when it comes to the number of times each policy is implemented, control-based policies like credit policy are relegated at the fringe of the policy universe. This also true of incentive policies such as integrating climate or environmental risks in prudential regulation.



(a) Number of policies by policy categories. Reading: *there are nine policies in the green asset purchasing programs (APP) policy category, which represents 6.2% of the policy universe in our sample.*



(b) Share of policy categories in policy implementations. Reading: *green asset purchasing programs (APP) policies have been implemented 115 times, which represents 11.4% of all policy implementations in our sample.*

Figure 2: Distribution of policy categories by number of policies and by share in policies implementations. Note: *policy implementations* refers to the number of times all policies from one policy category are implemented. One country can implement one or more policies from one policy category, so the number of policy implementations per policy category may exceed the number of countries.

Finally, such observation appears strikingly when we examine the number of countries implementing at least one policy belonging to a given policy category (figure 3). The main policy categories are all the main informational measures: disclosure rules, guidelines on environmental risk management, taxonomy of sustainable activities, and climate or environmental stress tests. Green bonds standards and guidelines are also in the top 5 in terms of country implementations. In contrast, control-based or incentive policies such as credit policy, prudential regulation and reserves policies are all at the fringe of the green monetary regime policies universe.

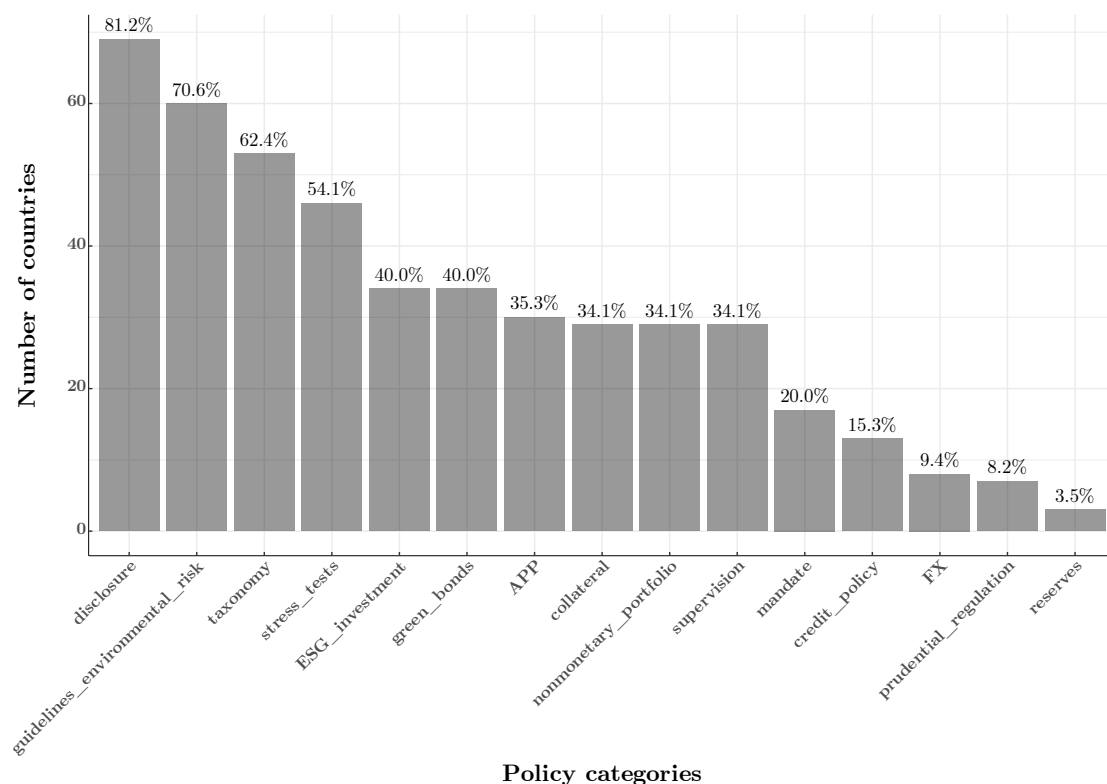


Figure 3: Share of policy categories in country implementations. Reading: *Thirty countries in our sample (35.3% of the countries) have implemented at least one policy to green asset purchasing programs.* Note: *country implementations* refers to the number of countries implementing at least one policy pertaining to a given policy category. The maximum number of country implementations is therefore the number of countries in the sample (85).

Adopting an income groups perspective nuances the general observation. As figure 4, informational measures largely dominate in high income countries, and incentive measures are also implemented widely. Greening of foreign reserves management, mandate, credit policy and reserves is clearly at the bottom of the agenda. Middle income countries offer a more balance picture: the informational approach is clearly the favoured one as well but greening mandates and credit policy and prudential regulation is used as much as or even more than some informational and other incentive measures. As for low income countries, they equally favour informational measures and greening mandates, but it is hardly possible to draw any valid observation in their case as our sample only features two of them. Nevertheless, we see delineating a different general approach to green monetary regimes by high income countries on the one hand and middle and low income countries on the other hand: clearly informational and incentive-based in high income countries, informational flavoured with incentive-control based in the case of middle and low income countries. This is consistent with the general diverging views on central banking observed between high, middle and low income countries when it comes to central bank independence and using monetary and financial authorities to shape markets and productive structure of the

economy. Middle and low income countries tend to be more interventionists than high income countries.

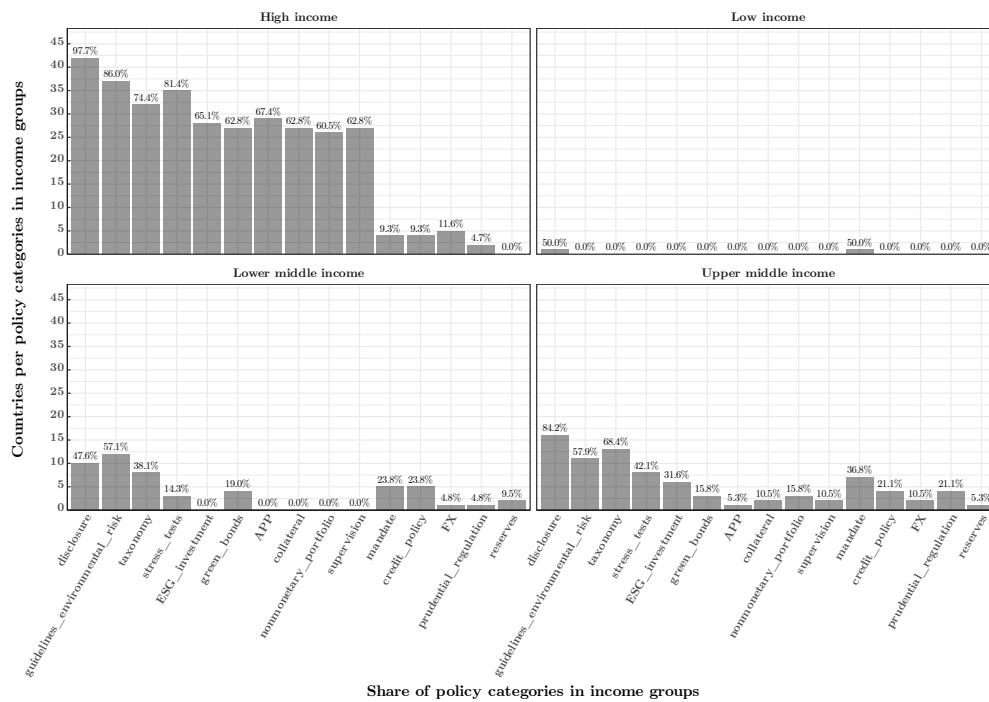


Figure 4

Examining the share of income groups in each policy categories (figure 5) confirm the more balanced approach to the greening of monetary regime across the information-incentive-control spectrum in middle and low income countries than in high income countries: high income countries represent most of the countries implementing informational and incentive measures but middle and low income countries are equally represented or dominate in categories such as credit policy, greening mandates, greening prudential regulation or greening reserves policy (only three countries implemented reserves policies, including one upper middle income and two lower middle income).

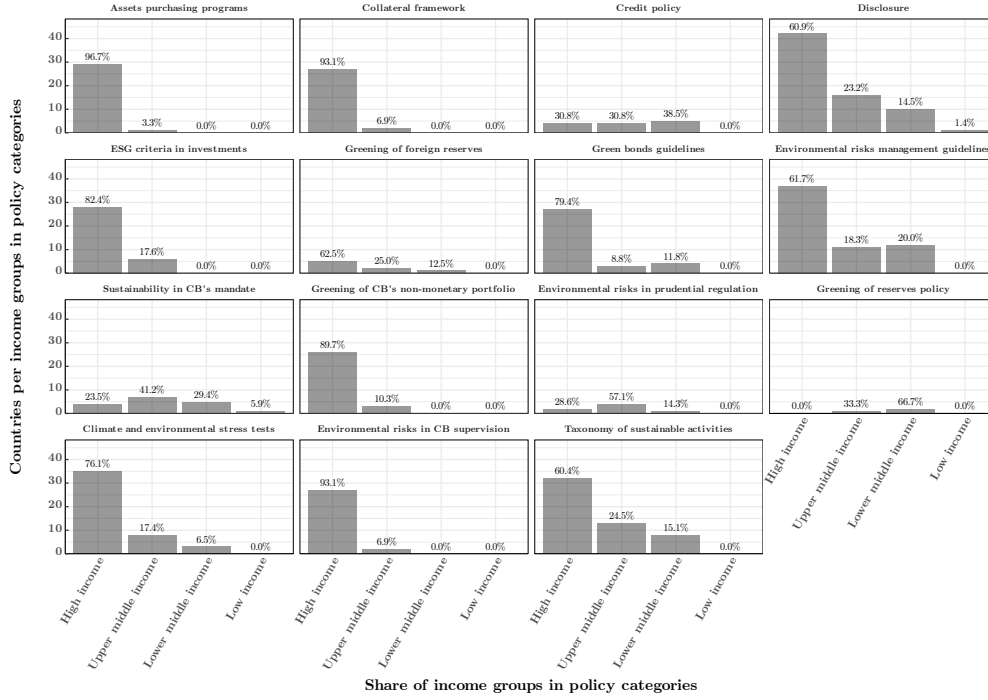


Figure 5: Enter Caption

The greening of monetary regime does not appear as a new era in the art of monetary policy and financial regulation. If tackling climate and other environmental issues remains relatively new — especially in high income countries — they are mostly included into the existing hierarchy of instruments dominated by informational and incentive ones, in accordance with mainstream approaches to central banking and financial regulation. The dominance of the informational and incentive approaches in the greening of monetary regimes signals that monetary and financial authorities favour softer ways to tackle environmental issues and are reluctant to exert stronger control over financial markets or to steer economies in any given direction. Indeed, these preliminary observations fit with the first and second normative approach identified by [Oman *et al.* \(2022, 2024\)](#), which prioritizes carbon pricing mechanisms and a risk management approach to environmental issues: informational measures typically aims at ensuring that climate and environmental risks are adequately priced in by financial institutions, in the hope that this will suffice reallocating capital where it is needed the ecological crisis. Incentive measures typically aim at reducing financial institutions' exposure to climate and other environmental risks to prevent potential financial instability to arise from the low-carbon transition, or climate or other natural events.

4.2 Seven shades of green: a typology of greening monetary regimes

To refine our descriptive analysis, we proceed to a mixed hierarchical k-means clustering performed on the relevant principal components obtained through a multiple factor analysis (MFA)

of our $85 \text{ rows} \times 88 \text{ columns}$ dataset. Proceeding to an MFA instead of clustering directly from the raw variables reduces the dimensionality of the dataset used for the clustering. In doing so, it improves the quality of the clustering as only the statistically significant information is retained (Husson *et al.*, 2010, 2017). We keep nine principal components from the MFA. The clustering combines hierarchical clustering with k-means partitioning. A hierarchical clustering is first performed. The gravity centres of the clusters are then used as the initial number of partitions for the k-means algorithm, which then further homogenizes the clusters. In the final selection of the number of clusters, we combine statistical considerations — the suggestion of the algorithm and the inertia gain of one more cluster — with economics reasoning — what appears to make sense from an economic analysis perspective. We end up with seven clusters.

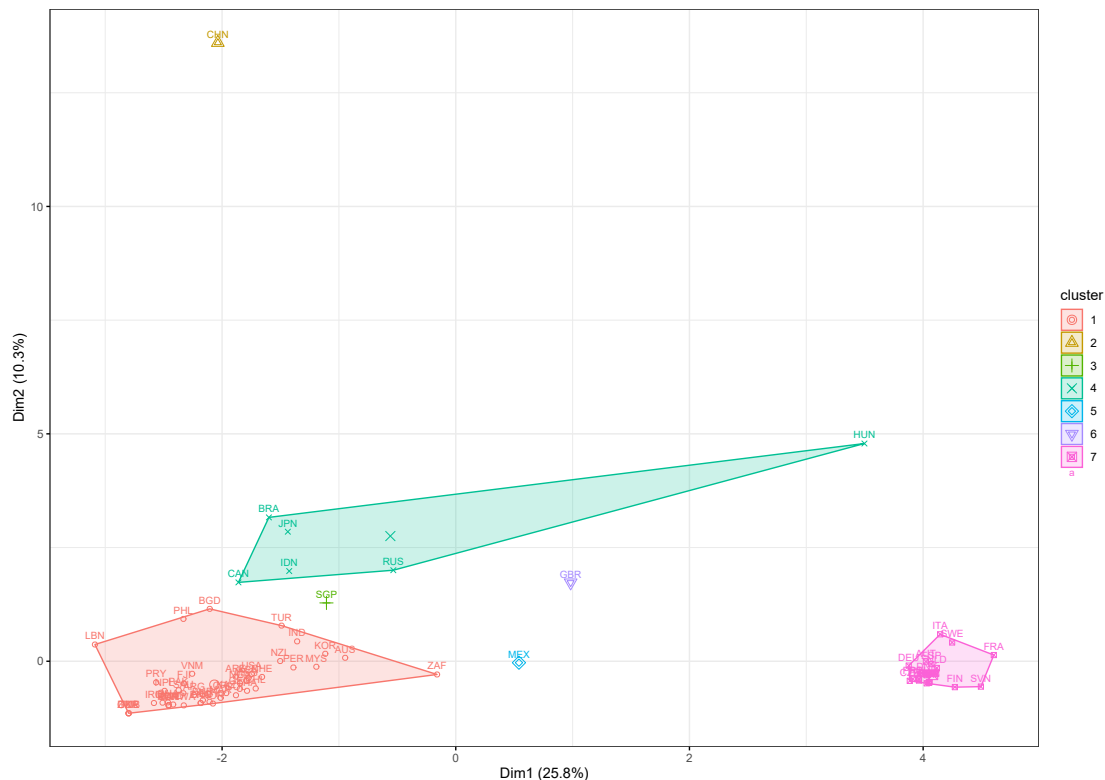


Figure 6: Clustering of green monetary regimes. Note: the clustering is shown using the first two principal components obtained with the multiple factor analysis applied to our dataset, but nine components are retained to proceed to the clustering. Some countries appearing as far away from each other on the plan of principal components 1 and 2 may thus be close to each other on the plans of the other principal components.

The clustering is illustrated on figure 6. To some extent, it confirms the divide between high income countries and middle and low income countries but this divide is not so clear cut in the composition of the clusters. Other factors play a role: EU countries are clustered together, which is easily explained as EU policies make for the bulk of green monetary regime policies in

these countries. If there are some national differences among EU countries they are nonetheless very close in terms of green monetary regime. Thus, the cluster of EU countries is by far the most homogenous one along the first two principal components, standalone countries aside. Table 4 indicates the composition of each cluster.

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
United Arab Emirates, Argentina, Australia, Bangladesh, Bahrain, Switzerland, Chile, Colombia, Costa Rica, Egypt, Fiji, Georgia, Ghana, Gambia, Honduras, India, Iraq, Iceland, Jordan, Kazakhstan, Kenya, South Korea, Kuwait, Lebanon, Sri Lanka, Morocco, Mongolia, Malaysia, Nigeria, Norway, Nepal, New Zealand, Pakistan, Peru, Philippines, Papua New Guinea, Paraguay, Qatar, Rwanda, Saudi Arabia, Thailand, Tunisia, Turkey, Tanzania, Ukraine, United States, Vietnam, South Africa, Zimbabwe	China	Singapore	Brazil, Canada, Hungary, Indonesia, Japan, Russia	Mexico	United Kingdom	Austria, Belgium, Bulgaria, Cyprus, Czechia, Germany, Denmark, Spain, Estonia, Finland, France, Greece, Croatia, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden

Table 4: Clusters composition. Note: first, the interpretation of a cluster’s characteristics is only valid at the cluster level and not at the country level. Second, the composition of a cluster is robust if most countries are similar in terms of the variables used. Of course, countries of a given cluster may be different if other variables are considered. Third, more clusters reduces intra-cluster heterogeneity but decreases the meaningfulness of the clustering exercise: eventually, each country is itself its best cluster.

Each cluster can be characterized in terms of what variables differentiate it most from the sample average. Cluster 1 is the cluster comprising most countries. This cluster is mainly characterized by little greening of the monetary regime. Relatively to the rest of the sample, its most characterizing variables are the absence of guidelines for banks to consider ESG criteria in investments, no green bonds eligibility in asset purchasing programs or no screening performed in APPs. Cluster 2 is characterized by the greening of prudential regulation and of foreign exchange reserves. Cluster 3 is characterized in particular by the greening of asset purchasing programs and positive screening in foreign reserves management. Cluster 4 is characterized by the greening of prudential regulation, of foreign reserves management and of stress tests. Cluster 5 is not characterized by any significant variables: this does not mean that Mexico takes no green monetary regime measures but simply that no variables characterize it significantly differently than the sample average. Cluster 6 distinguishes itself by the absence of preferential treatment given to green assets in the collateral framework. Cluster 7 features greening of non-monetary policy portfolios, environmental stress tests, disclosure requirements for assets eligibility in APPs, consideration of ESG criteria in APPs, and the greening of the collateral framework.

Clusters 2, 3, 4 and 7 are those that distinguish themselves the most in terms of greening their monetary regimes relatively to the rest of the sample. From the typologies of approaches suggested by [Baer et al. \(2021\)](#) and [Oman et al. \(2022, 2024\)](#), we can label them as incentive-

prudential (cluster 2, China, cluster 3, Singapore, and cluster 4, Brazil, Russia, Indonesia, Hungary, Canada and Japan). Cluster 7 appears to be informational-prudential.

4.3 Explaining the clustering: why do countries green their monetary regimes, and why do they in these specific ways?

5 Synergies and contradictions between green monetary regimes and other areas of regulations

6 Conclusion

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