A global analysis of green financial policies: Mapping policy output and evidence of effectiveness from a meta-analysis

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Abstract

Green financial policies (GFPs) have emerged as an option to align financial flows with the objectives of the Paris Agreement. While conceptual studies suggest that GFPs that target the financial sector can contribute to emissions reductions in real economy sectors, empirical evidence on their effectiveness remains unclear. To fill this gap, here we analyse GFP policy output in G20 countries and conduct the first meta-analysis and assessment of empirical evidence in this area. We present a matrix that maps evidence (gaps) concerning the adopted policies. We find that more direct intervention instruments, such as credit allocation policies or green investment by public banks, are more widely studied, and the evidence appears mostly positive. Information policies, including taxonomies and standards, have received some empirical attention, but evidence for emission reductions remains weak. Finally, novel policy approaches such as green monetary or prudential approaches remain significantly under-evaluated. Based on the available evidence, we discuss the key impact mechanisms and respective outcome variables. Overall, our analysis highlights that the empirical evidence is still limited and derives priorities for future GFP research.

Keywords

Climate policy, Green financial policy, Green finance, Policy evaluation, Policy adoption

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A global analysis of green financial policies: Mapping policy output and evidence of effectiveness from a meta-analysis

Introduction

Mitigating dangerous climate change is one of the most significant societal challenges of this century. Article 2.1c of the Paris Agreement (2015) recognises a role for the financial sector to play in aligning financial flows with the objectives of a low-carbon transition, which requires scaling up investments in low-carbon technologies and divesting from carbon-intense ones. As such, in recent years, "green" policies targeting the financial sector have gained traction in policymaking and academic policy analysis[1–4]. These policies, often referred to as 'climate-related' or 'green financial policies' (GFPs), are designed to align financial flows with the objectives set by the Paris Agreement. Over the past two decades, the number of GFPs adopted by parliaments, financial regulators, and central banks has grown substantially[5,6].

Despite the momentum in policy output, the analysis of available policy instruments in this area remains limited. While conceptual literature on specific policy instruments, such as green monetary policy or credit allocation policy, has been proliferating in recent years[3,7–11], comprehensive analyses that include the whole spectrum of GFPs are largely missing. Established climate policies' taxonomies, such as those from the IEA[12] and OECD frameworks[13], or those developed by climate policy scholars,[14] focus on polluting sectors and non-financial climate policies, so they do not include GFPs. Recent academic studies provided first classifications of GFP specifically, however covering only a part of the spectrum of existing policies (e.g., excluding the establishment of green financial institutions, or green prudential policies) [5,6,15].

Moreover, the effectiveness of green financial policies is poorly understood. Theoretical studies have proposed that financial policies could effectively channel capital into green projects and sectors[3,7], with various conceivable impact mechanisms[3,16]. However, the empirical literature on the evaluation of such policies has remained scattered as the existing evidence to validate these claims has not been comprehensively reviewed or analysed. As such, it remains unclear which GFP options can be most effective in achieving their intended goals. This gap is particularly problematic at a time when many countries are designing interventions and require evidence-based guidance.

In contrast, a well-developed body of literature focuses on assessing evidence from empirical evaluations of non-financial climate policies[17–22]. Systematic reviews and meta-analyses have consolidated the status of knowledge on the effectiveness of these policies, allowing to understand 'what works'. Particularly, studies have been interested in the effectiveness of instruments like carbon pricing[23–27], energy efficiency policies[28], renewable energy support policies[22,29], and climate mitigation policies more broadly[30,31]. These research developments have resulted in better understandings of the potential of specific policies or policy mixes for meeting the required climate targets.

Such analyses are missing from the GFP literature. To fill this gap, we provide a global analysis of green financial policies, mapping policy output and evidence of effectiveness. As a first step, we study policy output over time. To this end, we compile a database of 197 green financial policies in the Group of 20 (G20) from 2005-2022. Then, we develop a novel taxonomy of GFPs (see Table 1) and use it to structure our analysis of countries' policy mixes. Building on the enhanced understanding of the policy landscape and using the taxonomy to structure our analysis, in a second step, we conduct a systematic mapping of empirical studies that evaluate the effectiveness of green financial policies. We review abstracts of 4418 academic papers, employing the artificial intelligence-supported systematic review tool ASReview [27,32] and manual verification and obtain 342 relevant papers. Finally, we map existing evidence gaps in this policy domain by combining steps one and two and critically discuss effectiveness in the context of GFPs.

Our results show that evaluations of green financial policies remain scarce and concentrated on policies in a few jurisdictions, particularly China and the European Union (EU), and on only a few policy types, particularly credit allocation policies and green investment and lending actions by public financial institutions. Empirical studies are rare particularly for prudential regulations and monetary policies, limiting broader conclusions on effectiveness. A key challenge in evaluating GFPs is their indirect impact on CO_2 emissions. Unlike carbon pricing or subsidies, these policies primarily shape capital allocation and financing conditions. Existing studies highlight their influence on financial markets, particularly banks through credit regulations; investors through promoting disclosure requirements and standards for green financial products; and firm behaviour, through interaction with the financial market, but rarely establish a direct link to CO_2 reductions. This calls for a broader framework to assess effectiveness, incorporating intermediate financial sector outcomes alongside emissions metrics.

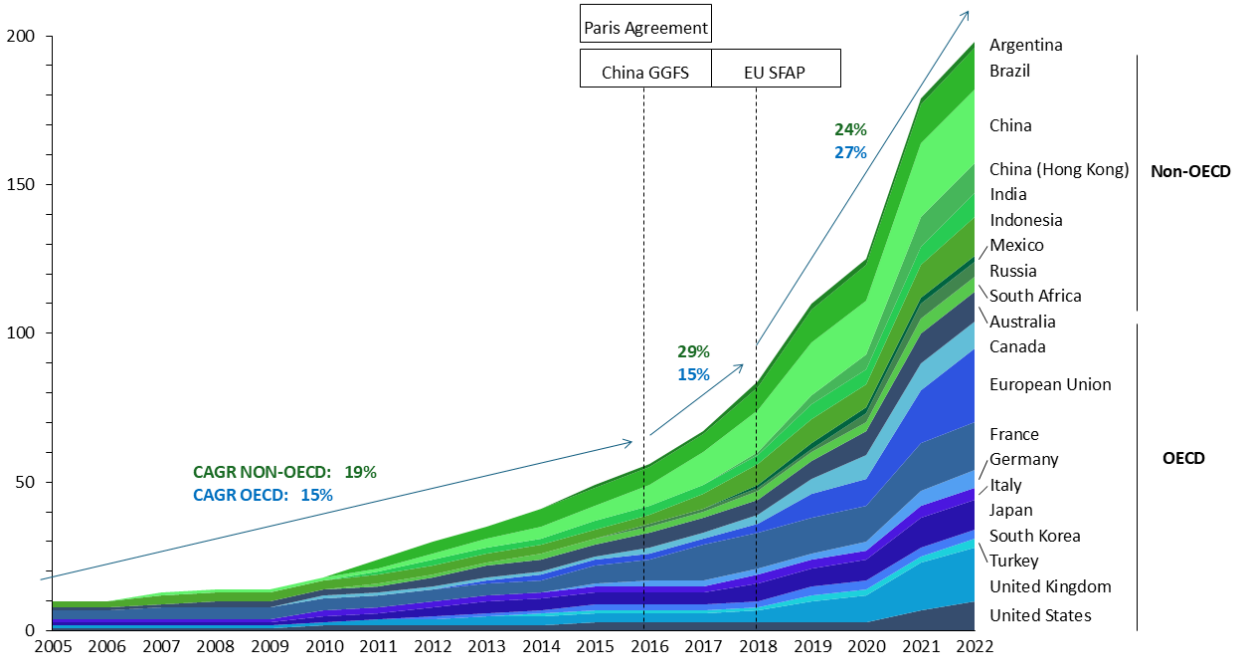
Results

Green financial policy output

As a starting point, we study green financial policies adopted over time across the G20, a group of 19 countries plus the EU that comprise 85% of global GDP and 80% of global emissions[33]. Following previous studies[6,34], we consider policy density, a measure of the number of policies in a specific domain over time, as the variable alongside which we structure our study. Figure 1 depicts the cumulative number of policies, distinguishing between OECD and non-OECD countries. The data shows a consistent upward trend, with a marked increase in the adoption of in the latest years of the dataset, particularly during 2018–2022. The starting year of our analysis represents the entry into force of the Kyoto Protocol (2005), the landmark climate protocol that required significant CO_2 emission reductions from its members and sparked climate policymaking in many countries. We look at the cumulative annual growth rate (CAGR) in three periods delimited by two key dates: 2016, the year the Paris Agreement entered into force and China published its ‘Guidelines for Greening the Financial System’ as part of its 13th 5-Year Plan; and 2018, the year the European Union published its ‘Sustainable Finance

Action Plan', a major GFP program. Our results shows that GFP adoption has been on the rise, especially since the entry into force of the Paris Agreement. While previous literature [5,6] only included policies up to 2020, we see that, the rate of policy adoption is not only maintained, but strongly increases for the years following the COVID pandemic; in fact, the number of GFPs in G20 countries increased by 60% from 2020 to 2022.

Figure 1 : Green Financial policies adopted by G20 countries (cumulative). We calculate the cumulative annual growth rate (CAGR) for three periods: pre-Paris Agreement, post-Paris Agreement and the Chinese Guidelines for Greening the Financial System (GGFS), and post EU Sustainable Finance Action Plan (EU SFAP).



Both country groups show solid growth —15% CAGR for OECD and 19% for non-OECD — in the first period, primarily driven by early adopters such as Australia and France (OECD) and Brazil and China (non-OECD). During the second period (2016-2018), non-OECD countries outpace the rest, with countries like Indonesia catching up —5 policies adopted— and Brazil and China maintaining steady growth —2 and 4 policies adopted, respectively —. In the OECD group we do not observe an increased momentum compared to the previous period, with only France adopting 3 additional GFPs in this period and others in the group adopting at most 2 policies. Finally, the last period (2018-2022) is characterised

by significant adoption by the European Union and China—25 policies (out of which 10 in Hong Kong) adopted, each—, these two become the leading jurisdictions in this policy area. In total, the EU contributed to 23% of policies adopted within the OECD group for the 2000-2022 period, with China contributing 39% for the non-OECD group.

GFPs encompass a wide range of policy instruments, only partly covered in existing taxonomies. We thus build a comprehensive taxonomy of GFPs by systematically reviewing the academic literature on green financial policies and grouping policies into types through an iterative process, using broader policy taxonomies for theoretical grounding[35–37].

Table 1 shows the taxonomy, including a high-level description of underlying policy mechanisms as derived from conceptual literature on GFPs[1,16]. The four policy types include policies that operate through regulation (REG) or targeted actions (TACT) to redirect capital to green sectors; those that are transparency-based (TRANS); and, finally, policies that seek to manage or reduce climate-related financial risk, often referred to as 'green prudential policies' (PRUD).

Table 1. Taxonomy of green financial policies.

Policy type	Policy instrument	Description	Policy mechanism
Regulation-based instruments to directly redirect financial flows to green sectors (REG)	REG.1. Green Monetary Policy	Integration of climate considerations in monetary policy operations by central banks, such as green asset purchases, preferential refinancing rates for green investments, or climate-adjusted collateral frameworks.	Increased bank liquidity for green activities → Increased bank green lending → Redirection of financial flows Preferred eligibility of green assets as collateral → Portfolio composition tilting green → Redirection of financial flows
	REG.2. Green Credit Allocation Policy	Regulation requiring financial institutions to take into consideration climate-related aspects or risks when conducting credit operations.	Preferred eligibility of green projects in Capital Adequacy Ratio (CAR) → Cost of capital for green projects → Increased bank lending → Redirection of financial flows
	REG.3. Green Investment Policy of Public Funds	Regulation requiring public funds to direct investments towards green projects through the establishment of criteria or guidelines.	Preferred eligibility for green projects → Redirection of financial flows
Targeted actions on the financial markets to directly redirect financial flows to green sectors (TACT)	TACT.1. Targeted green borrowing on financial markets by public actors	Direct borrowing action by public actors on the financial market designed to steer capital to green projects, such as issuing green bonds.	Preferred eligibility for green assets (bonds) → Increased proportion of green financial products → Redirection of financial flows
	TACT.2. Targeted green investment or lending by public actors	Direct investment or lending action on the financial market designed to steer capital to green projects.	Preferred eligibility for green projects → Redirection of financial flows
	TACT.3. Subsidies for green financial products	Financial support action, such as grants or tax incentives, to reduce the transaction cost of green financial products.	Lower price of green financial products → Redirection of financial flows
Transparency-based instruments (including regulation) to indirectly redirect financial flows to green sectors (TRANS)	TRANS.1. Disclosure requirements	Regulation mandating companies or financial institutions to publicly report their climate-related impact, to promote transparency and informed decision-making.	Enhanced transparency ⇢ Increased green investing → Redirection of financial flows
	TRANS.2. Taxonomy or Standards	Provision of a classification system or guidelines to financial actors for defining green or climate-related activities, ensuring consistency and clarity in identifying investments that align with green goals.	Enhanced transparency ⇢ Increased green investing → Redirection of financial flows
	TRANS.3. Strategy or Roadmap	Strategy/roadmap paper that outlines policies, incentives, and frameworks to redirect financial flows.	Enhanced transparency ⇢ Increased green investing → Redirection of financial flows
Prudential policies to reduce climate-related systemic risk to the financial sector (PRUD)	PRUD.1. Green prudential assessments	Evaluation conducted by regulator to assess the exposure of financial institutions to climate-related risks.	Improved risk pricing → Improved resilience of the financial system
	PRUD.2. Green prudential regulation	Regulatory measure adopted by financial authorities to mandate financial actors to apply climate-related risk management systems and assess their exposure to climate-related risks.	Improved risk pricing → Improved resilience of the financial system

Legend: "→" denotes a direct causal mechanism. "⇢" denotes an indirect causal mechanism through changes in expectations of financial actors.

Regulation (REG) policies comprise regulation-based instruments designed to redirect financial flows toward green sectors. By establishing regulatory mandates and incentives, these policies influence financial actors' decisions with the aim of more capital being channelled toward green activities. These policies encompass green monetary policies, credit allocation schemes, and green investment strategies implemented through existing public funds. Examples include the Chinese 'Green Credit Guidelines' (2012) or the Central Bank of Brazil's 'launch of its sustainability dimension' (2020).

Targeted action (TACT) policies are designed to mobilise capital into green sectors, mitigate investment risks, and foster the development of new markets by means of direct investment and lending actions by government, including subsidy schemes for green financial products. Examples of adopted policies include the issuance of green sovereign bonds by countries like Indonesia, France or Italy; green investing or lending actions by public banks like the German KfW (2022) or the Canada Infrastructure Bank (2020); or the Chinese Pilot Green Bond Grant Scheme (2019).

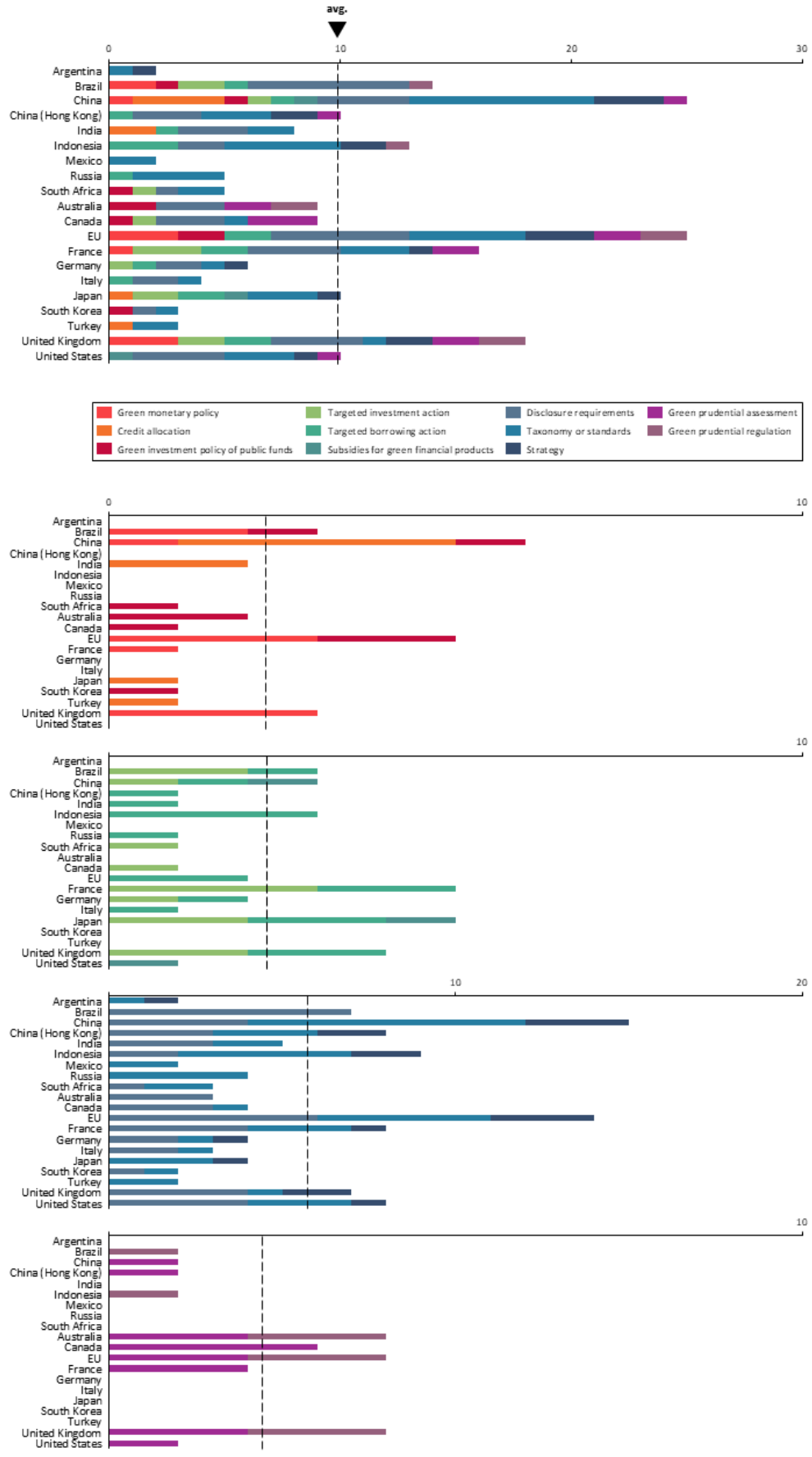
Transparency-based instruments (TRANS) aim to reduce information asymmetries for financial actors by enhancing transparency and increasing awareness of the climate impact of financial decisions. While TRANS policies concern the regulation of financial markets, similar to REG policies, their policy mechanism is fundamentally different as they do not affect financial flows directly but rather indirectly influence the behaviour of financial actors through changes in their expectations. This logic is based on the assumption that investors exhibit 'green preferences' and, when provided with accurate and standardized information, will adjust their investment choices accordingly[38]. Transparency policies include standards for green financial products, taxonomies, and disclosure requirements, which serve to improve the consistency and comparability of sustainability-related financial information. Examples include the EU Taxonomy (2020) or Japan's Green Bond Guidelines (2020),

Green prudential policies (PRUD), finally, also aim to enhance transparency with the objective of managing climate-related risk. Traditional prudential policymaking focuses on managing systemic financial risks by strengthening the resilience of financial institutions to economic shocks and preventing excessive risk accumulation within the financial system[39,40]. In the context of climate change,

prudential policies extend these principles to address physical and transition risks that could significantly impact financial stability[41]. Accordingly, such policies encourage financial institutions to adopt climate-related risk management frameworks and climate risks into regulatory stress tests or other risk assessments. These policies encompass green prudential assessments and green prudential regulations. Moreover, examples include Australia's Prudential Practice Guide on Climate Change Financial Risks (CPG 229) (2021) or UK's Supervisory Statement (SS3/19) on Enhancing Banks' and Insurers' Approaches to Managing the Financial Risks from Climate Change (2022).

This taxonomy facilitates a systematic comparative analysis of GFP mixes across countries, shedding light on patterns of policy adoption and divergences across countries. Figure 2 illustrates these dynamics for G20 countries. Transparency-based policies, particularly taxonomies and disclosure standards, have been widely adopted, with most countries adopting at least some form of transparency-based policy instrument. This widespread adoption reflects the growing emphasis on financial transparency as a foundational enabler of green investment, aligning with global efforts to standardize sustainability reporting frameworks. In contrast, green monetary and prudential policies remain disproportionately concentrated in high-income countries.

Figure 2: Green financial policies adopted by G20 countries by policy type. Note scales differ for the charts shown.



Notably, green prudential regulations—aimed at incorporating climate-related financial risks into regulatory frameworks—have been adopted in only a limited number of jurisdictions, including the United Kingdom, Australia, Brazil, and the European Union. Furthermore, green credit allocation policies exhibit a distinct geographical concentration, with countries such as China, Japan, India, and Turkey leading their adoption. This regional clustering suggests that these policy instruments are more prevalent in economies where state-directed financial mechanisms play a central role in steering credit flows toward priority sectors. The uneven adoption of these diverse policy types underscores significant cross-country differences in regulatory approaches, financial market structures, and institutional capacities.

Overview of empirical evidence

Scientific ex-post evaluations of green financial instruments have been growing rapidly in the past decade, particularly in the last five years. Following a review of abstracts of 4,418 peer-reviewed papers (and the full text where needed), we identify 342 academic studies that conduct ex-post evaluations of GFPs. Out of the identified studies, the vast majority (308) focusses on Chinese policies. The remaining 35 papers include studies conducting large-n analysis (15) and those studying specific geographies, either through small-n comparative or single-country analysis (19).

Figure 3 presents a breakdown of the identified literature. We distinguish between studies focusing only on Chinese policies and other studies. In terms of differences between these two groups, studies on Chinese policies present a much higher share of quantitative methods, with approximately 78% employing quasi-experimental methods (QEM) such as difference-in-differences (DiD) or synthetic controls. The prevalence of QEM likely stems from the availability of data as well as the suitable conditions for causal inference, given the fact that many policies in China are implemented through a ‘piloting’ design approach with staggered introduction across provinces, facilitating causal

identification. Other notable examples of similar research cases of policies with ample coverage include the pilot low-carbon city initiative[42] or the Chinese ETS[43].

Moreover, studies on Chinese GFPs are highly concentrated on two policies, the Green Credit Guidelines (GCG, 220 papers) and the Green Finance Reform and Innovation Pilot Zones policy (GFPZ, 74 papers). The GCG was implemented by the China Banking Regulatory Commission in 2012 [44]. Green credit policies require banks to evaluate climate-related considerations of firms in their credit operations, expecting an alignment or coordination between bank lending and climate objectives. The GFPZ was put in place in June 2017 by the State Council of China and implemented priorities for green financial development in eight zones across five provinces. This policy's main purpose is to accelerate innovation in green financial systems and increase financial support for green projects[45].

In comparison, the empirical studies that evaluate policies outside of China are more diverse. They use quantitative (53%), qualitative (36%), as well as mixed methods (12%). They cover various policy instruments, including green public investment banks, environmental, social and governance (ESG) policies, green capital requirements or green credit allocation. In terms of regional focus, the most frequently studied jurisdictions include India (9), Germany (13), and policies at the European Union (EU) level (10). Notably, approximately one-third of studies (10) in this group utilize composite indices of green financial policies to assess the overall impact of GFP policy density on financial markets and economic outcomes across multiple jurisdictions. In this sense, these studies evaluate GFPs, but only in an aggregated manner, and not allowing for isolating effectiveness of specific policies or policy mixes.

Figure 3: Overview of the identified studies. Note: DiD: difference-in-differences method, Reg: regression analysis, GCG: Green credit guidelines, GFPZ: Green Finance Reform and Innovation Pilot Zones.

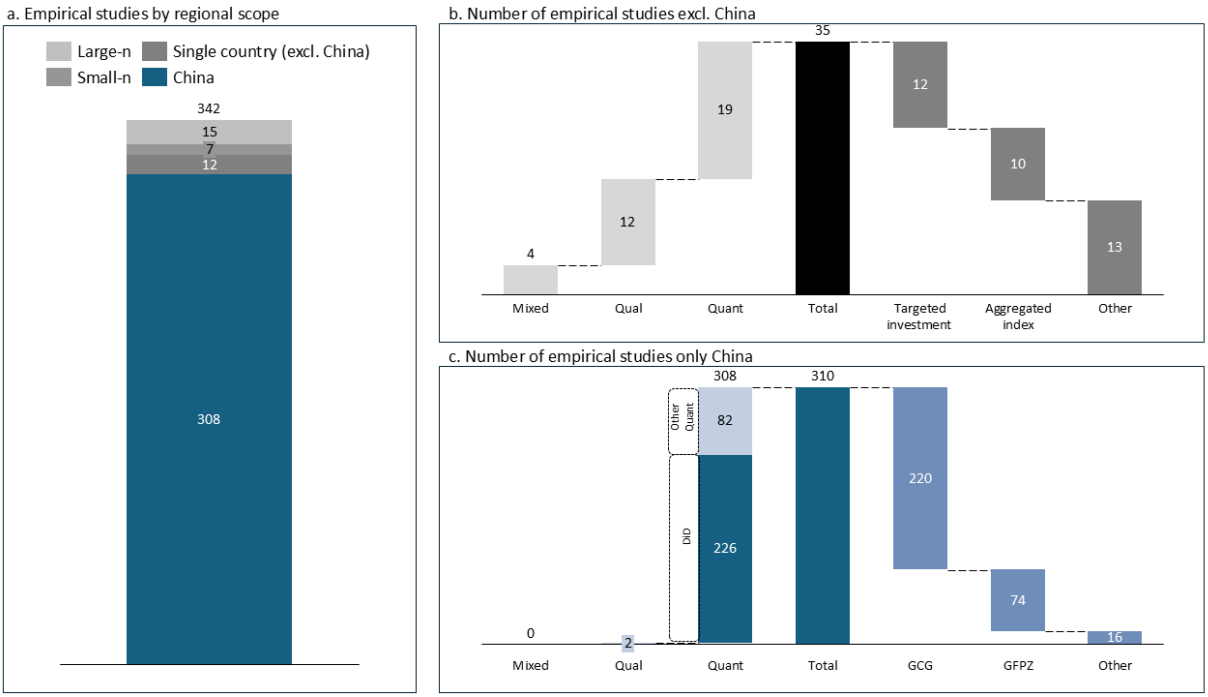


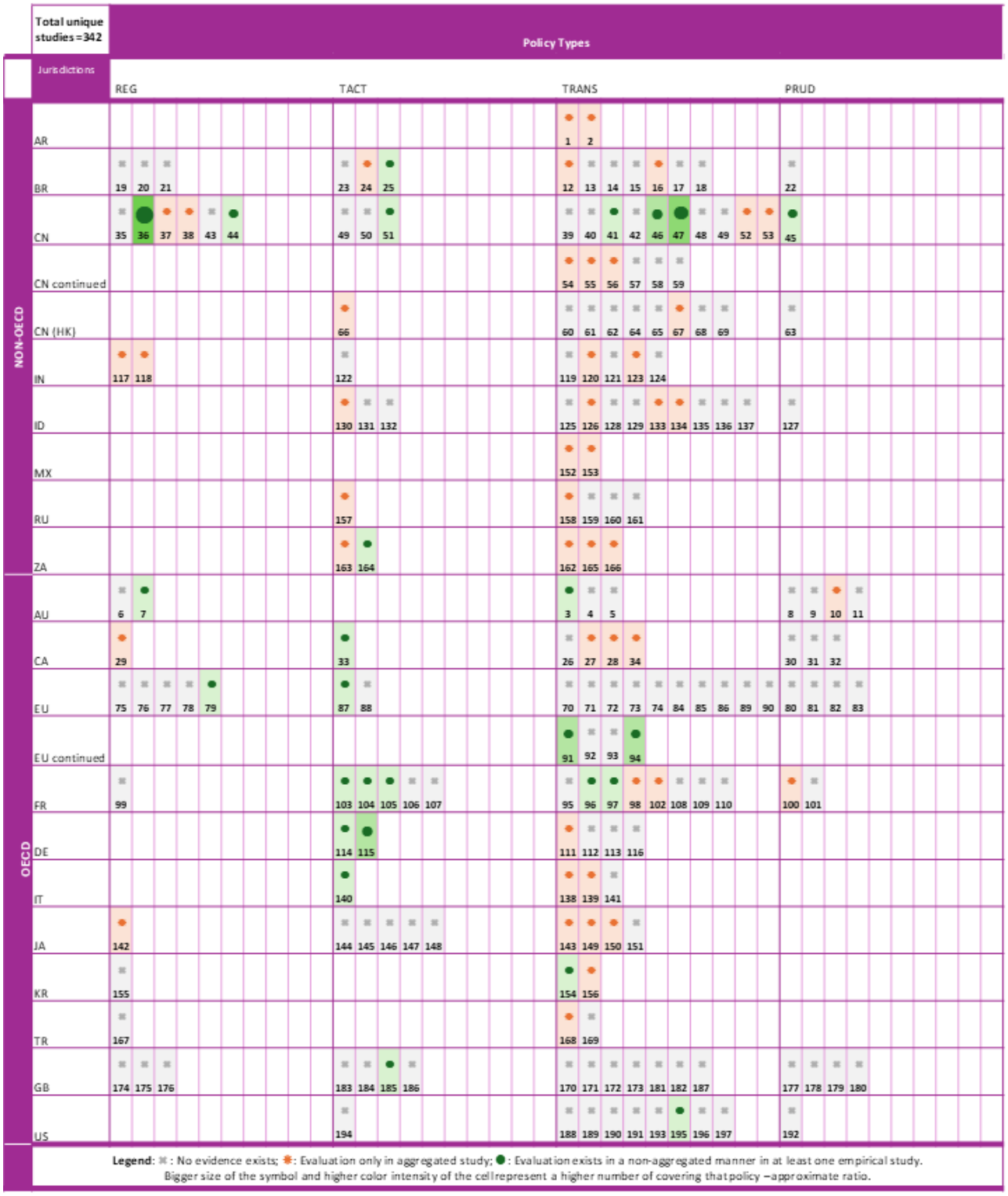
Figure 4 presents a matrix that matches the adopted green financial policies across all G20 countries and existing empirical evidence that evaluates their effectiveness. By doing so, the matrix also functions as an 'evidence gap map' for GFPs, revealing areas where empirical evidence of a policy's effectiveness remains limited. In the matrix, each cell represents a GFP with numbers indicating the policy's position in our database. We distinguish five states of the evidence base for each policy, represented by the different cell colours: no evidence of effectiveness, just one study with evidence of effectiveness, more than one study, only a large n study (such as regression analyses) and only a study/studies that use an aggregation of GFPs including that policy. The GFP taxonomy presented in Table 1 is used to structure the analysis.

The matrix reveals evidence gaps for some regulation (REG) and targeted action (TACT) policies across many countries. While credit allocation policies have been studied in China and Indonesia, other key instruments—such as green monetary policies, green bond issuance, and subsidies for green financial products—remain underexplored in the empirical literature. This limited coverage suggests that certain green financial instruments, despite their growing adoption, have not yet been systematically analysed

for their effectiveness in mobilizing green investments or driving sustainable transitions. In contrast, studies on green finance institutions (GFIs) exhibit broader geographical coverage and methodological diversity, with a particular focus on quantitative methods. In the case of TRANS policies, we observe that they are mostly covered by studies that use aggregated GFP measures, nonetheless, some prominent policies like the EU Taxonomy (2020) have garnered more attention and are studied also in isolation.

Finally, significant gaps exist in the evaluation of prudential policies (PRUD). While some are examined within aggregated studies—which assess the effectiveness of policy combinations without isolating individual impacts—their effectiveness as standalone measures remains largely unexplored. The only exception is Brazil's capital requirements policy (2017) that has been evaluated in isolation. This gap likely reflects the primary objective of prudential policies: enhancing financial system resilience rather than directly redirecting financial flows or reducing carbon emissions. Unlike other GFPs, which primarily influence investment decisions, prudential policies focus on risk mitigation and financial stability, making their impacts on financial markets and climate-related outcomes more challenging to quantify using conventional empirical methods.

Figure 4: Evidence summary for green financial policies in G20 countries.



Impact mechanisms and policy effectiveness

The evaluation of policy instruments has been a central focus of the public policy literature since the field's inception. Here we use the concept of policy effectiveness to guide our evidence synthesis and comparison of results from evaluation studies. This concept refers to the extent to which a given policy achieves its intended objectives, considering both its implementation process and measurable outcomes[46]. Other dimensions that policy evaluation studies consider include equity or efficiency considerations[46], however, these are outside our scope of analysis, as the GFP evaluation literature remains mostly focused on effectiveness.

In the context of non-financial climate policies, scholars typically evaluate the success of a given policy in reducing carbon or greenhouse gas (GHG) emissions, allowing for direct comparisons of policy performance across instruments[17,24,27,32]. However, in the case of GFPs, evaluation presents unique challenges as the causal mechanisms or transmission channels between green financial policy instruments and real-economy emissions' reductions remain weakly established. To overcome this hurdle, empirical studies on GFPs adopt varying definitions of 'effectiveness' and evaluation criteria, depending on the policy instrument and research context. Some studies assess effectiveness in terms of shifts in financial flows, changes in investment patterns, credit allocation or capital market behaviour, while others attempt to trace indirect effects on carbon emissions. This conceptual variability poses challenges for cross-study comparability and limits the ability to systematically assess the relative performance of different policy options.

To address this challenge, we categorize the dependent variables employed in these studies (policy outcome) into four effect groups: (1) financial sector effects, (2) financing cost effects, (3) real economy effects, and (4) macro level effects (See Figure 5). This classification allows for a structured assessment of how evaluations of GFPs conceptualize effectiveness and shed light into policy effect mechanisms and intended and unintended impacts. Figure 5 presents the policy outcomes studied by the identified empirical studies, grouped into 24 themes. We additionally distinguish those outcomes that are relevant

for green or low-carbon investments, such as firm-level emissions and environmental impacts or investment flows towards green projects; those that are independent of green or low-carbon objectives, such as bank profitability, and those that are studied for both, such as firm (green) innovation.

Figure 5: Policy outcomes of green financial policies (GFP) as studied by the literature.

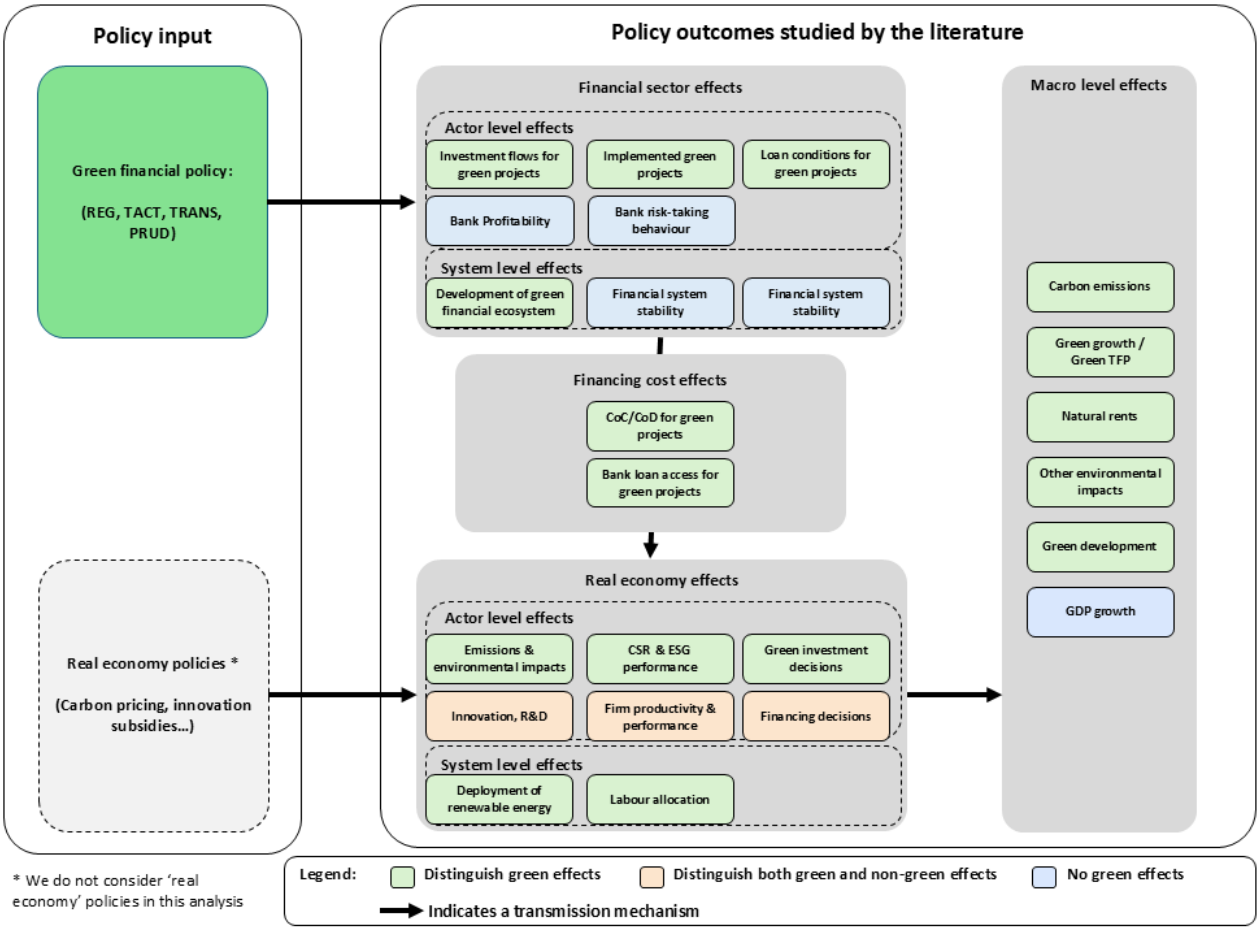


Table 2 summarises the evaluation results from the empirical literature, showcasing the policies they cover, methodology employed, and the policy outcomes assessed. The most widely covered policies by the literature are the Chinese GCG (220 studies) and GFPZ (74), leading by a significant margin, and followed by the green targeted actions of the German public bank KfW (6) and the EU taxonomy (3). The literature covering Chinese green financial policies exploits the availability of data and suitable conditions for econometric research to conduct evaluations employing various dependent variables,

from CO_2 emissions to firm digitalisation or bank profitability. Notably, this literature assesses the impact of GFPs on (green) innovation and green performance of firms (26% of studies on Chinese GFPs). Studies find a strong effect for both indicators.

Studies on green targeted actions most commonly focus on green financial institutions (GFIs) such as green state investment banks and primarily focus on their ability to mobilize investment and de-risk low-carbon projects[47–51]. These studies emphasize financial mobilization effects, highlighting the role of GFIs in increasing investor confidence, facilitating learning effects, and promoting policy coordination. However, they also reveal substantial heterogeneity in GFIs' capacity to redirect investments and their institutional readiness for green finance.

Other GFP instruments analysed in empirical studies include green bond issuance, capital requirements, and green central banking. These policies are typically assessed using financial-sector indicators such as stock market reactions, bank lending behaviour, and risk perceptions. The findings suggest that these instruments are effective in signalling value-enhancing and risk-reducing benefits to financial actors, as demonstrated by the response of financial markets to green bond issuances, particularly in Europe. However, as with GFIs, most studies refrain from analysing their overall effectiveness in reducing emissions, instead focusing on their intermediate financial effects. Finally, ten identified studies evaluate GFP adoption using policy indices, examining a broader set of economic and climate-related outcomes. These studies explore effects on green innovation, participation in global value chains, and macro-level indicators such as CO_2 emissions and ecological footprints. The findings suggest that climate-related financial policies yield stronger long-term effects in well-developed financial systems, where institutional capacity and regulatory coherence enhance policy adoption[52–58].

Before deriving general conclusions and compare policy instruments, it is important to assess the strength of the evidence base. Overall, the evidence base on the effectiveness of GFPs remains very limited. While the included papers address various GFP types, substantial gaps persist in the scope and depth of coverage, particularly in jurisdictions outside of China. Out of 201 identified policies, 40% are studied by the literature; however, out of this 40%, 69% are covered only as part of an aggregated GFP

index and just 9% have been covered by more than one study. This translates into just 7 policies, or 3% of the total GFP database. As such, while the evidence supporting the deployment of GFPs appears mostly positive, the strength of evidence is arguably not solid enough to draw clear conclusions and prospective recommendations that apply beyond the few specific policies that are covered. Methodological and research design heterogeneity further complicate drawing direct comparisons across studies and limits our ability to draw broad generalizations about policy effectiveness. Finally, the identified literature largely neglects other dimensions of policy outcome, including equity or distributional outcomes, and economic efficiency or cost-effectiveness.

Table 2. Results from the identified empirical studies with regards to policy effectiveness in G20 countries. Numbers represent a policy study; identified papers can cover more than one policy. We distinguish between policies that are studied in a single jurisdiction and those that are studied across countries, either through indexes or comparative case studies. ↑ indicates an overall positive effect, ↗ indicates a positive effect in the short run only or only under certain conditions, ↓ indicates an overall negative effect, ↘ indicates a negative effect in the short run only or only under certain conditions, and ↕ indicates no overall effect or mixed effects. QEM: quasi experimental methods.

Policy instrument	Region	Policy type (Regulation, Direct action, Transparency, Prudential)	N. of studies	Methodology	Overall instrument effectiveness
Green credit guidelines (GCG) (2012)	China	REG: Credit Allocation Policy	234	Mostly quantitative (regression: QEM)	**Real economy:** ↑ firm (green) innovation, ↕ firm green transformation, ↑ digitalisation by firms, ↑ sustainable development, ↑ green investment by firms, ↑ CSR, ↑ renewable energy deployment, **Financial sector:** ↑ bank performance, ↑ bank profitability, ↑ Number of bank loans (green projects), ↓ cost of capital (for green firms), ↑ green loan terms **Financial sector-real economy interaction:** ↓ cost of debt (for green firms) **Macro:** ↑ air quality, ↑ green growth, ↑ regional development, ↑ SDG progress
Green Finance Reform and Innovation Pilot Zones policy (GFPZ) (2018)	China	TRANS: Strategy or Roadmap	52	Mostly quantitative (regression: QEM)	**Financial sector:** ↑ energy efficiency of firms, ↑ green performance of firms, ↑ financial performance, ↑ firm productivity, ↑ green innovation, **Macro:** ↑ air quality
Capital requirements (2017)	Brazil	PRUD: Green prudential regulation	1	Quantitative (regression: QEM)	**Real economy:** ↕ real activity and GHG emissions of brown sectors, ↑ labour reallocation to large firms.
Clean Energy Finance Corporation	Australia	REG: Green investment policy of public funds	2	Qualitative (comparative case study), Quantitative (regression: QEM)	**Financial sector:** ↑ redirection of financial flows, ↑(green) projects implemented.
BNDES	Brazil	TACT: Targeted investment action on financial markets	2	Qualitative (comparative analysis)	**Financial sector:** ↑ redirection of financial flows, ↑ (green) projects implemented
BPI France	France	TACT: Targeted investment action on financial markets	2	Qualitative (comparative analysis), Quantitative (regression other)	**Financial sector:** ↑ redirection of financial flows, ↑ (green) projects implemented
KfW	Germany	TACT: Targeted investment action on financial markets	6	Qualitative (comparative case study) Mixed methods, Quantitative (regression other)	**Financial sector:** ↑ redirection of financial flows, ↑ (green) projects implemented, ↑ crowd-in effect
IREDA	India	TACT: Targeted investment action on financial markets	1	Qualitative (comparative case study)	**Financial sector:** ↑ redirection of financial flows, ↑ (green) projects implemented, ↑ crowd-in effect
Nacional Financiera (NAFIN)	Mexico	TACT: Targeted investment action on financial markets	2	Qualitative (comparative analysis), Quantitative (regression other)	**Financial sector:** ↑ redirection of financial flows, ↑ (green) projects implemented, ↑ crowd-in effect
Green Investment Bank (GIB)	United Kingdom	TACT: Targeted investment action on financial markets	2	Qualitative (comparative case study), Quantitative (regression other)	**Financial sector:** ↑ redirection of financial flows, ↑ (green) projects implemented, ↑ crowd-in effect
Sustainable Finance disclosure Regulation (SFDR) (2021)	EU	TRANS: Disclosure requirements	1	Quantitative (regression other)	**Financial sector:** ↕ redirection of financial flows.
EU Taxonomy (2020)	EU	TRANS: Taxonomy or standards	3	Quantitative (regression other)	**Financial sector:** ↕ redirection of financial flows. **Firm level:** ↑Firm green behaviour, ↗Corporate investments.
Green bond issuance (2017, 2021)	France	TACT: Targeted borrowing action on financial markets	1	Quantitative (regression other)	**Financial sector:** ↗ green premium effect
Green bond issuance (2020)	Germany	TACT: Targeted borrowing action on financial markets	1	Quantitative (regression other)	**Financial sector:** ↗ green premium effect
Green bond issuance (2021)	Italy	TACT: Targeted borrowing action on financial markets	1	Quantitative (regression other)	**Financial sector:** ↗ green premium effect
Green credit policy	Indonesia	REG: Credit Allocation Policy	1	Quantitative (regression other)	**Financial sector:** ↑ bank profitability (ROE, NIM, and PBT)
Aggregated studies					
Green central banking	EU, China, US	REG: Green monetary policy	1	Qualitative (comparative case study)	**Financial sector:** ↗ promotion of green finance.
GFP index -ref[59]	G20 countries	All Types	9	Quantitative (regression other)	**Macro:** ↗ natural rents, ↗ ecological footprint, ↘ carbon emissions, **Firm:** ↑ participation in global value chains, ↑ green innovation, ↗ green behaviour

Discussion

As global momentum builds around aligning financial flows with the objectives of a low-carbon transition, this study provides the first systematic synthesis of empirical evidence on the effectiveness of green financial policies. We find that empirical research is still in its infancy, particularly when compared to evaluation of other climate policies, such as carbon pricing. As GFP adoption rises globally, understanding how these policies affect the redirection of financial flows and eventually drive down emissions should be at the forefront of future research. This will aid policymakers in designing more effective interventions in the context of urgent climate action. Our research assesses the effectiveness of adopted policies so far across four policy types and provides key insights for future research avenues.

Among G20 countries, transparency policies represent the most adopted policy type. These are seen as important signals and incentives for mobilising investors with green preferences[38]. However, the evidence suggests they are only marginally effective when implemented in isolation. This underscores the need to view them not as standalone levers, but as part of a broader policy mix[60]. With regards to regulation and targeted action policies, we see some evidence of effectiveness for instruments like credit policies and targeted lending and investment actions. Particularly, targeted lending and investment policies by SIBs appear effective in redirecting financial flows, yet further research is needed to assess whether they simply substitute existing investments or mobilize additional private capital. Green monetary and prudential policies stand out as emerging policy areas, while empirical evidence on the effectiveness of these policies remains scarce and inconclusive.

A fundamental challenge in assessing GFPs lies in their indirect impact on emissions reductions. Existing studies highlight the influence of GFPs on financial markets, particularly through credit regulations affecting banks and disclosure requirements shaping investor behaviour. However, the causal link between financial policy interventions and real-economy emissions reductions remains weakly established. Few studies trace how GFPs affect firm-level investment decisions, technology

adoption, or sectoral decarbonization pathways, making it difficult to determine which policies most effectively contribute to climate objectives. There have been some theoretical efforts, particularly by economists[1–4,16], that shed light into the causal mechanisms and potential effects of these policies, but this area remains nascent, and the empirical literature is still disconnected from it.

For policymakers, the findings of this study provide important insights into the design and implementation of green financial sector interventions. Targeted lending and investment policies appear effective in redirecting financial flows, but empirical studies highlight the moderating role of institutional quality. Transparency policies alone have been found to have limited effectiveness but can potentially enable or complement other instruments. Nonetheless, such policies impose regulatory and compliance costs on the actors they target. In the context of current major policy shifts such as the EU's Omnibus proposal[61], cost effectiveness becomes an important the focus for policymakers that remains largely absent from the GFP literature. Future studies should examine the burdens imposed by GFPs, such as how credit regulations affect bank profitability or how disclosure requirements influence firms' reporting costs and investment strategies. Green credit allocation policies, which have so far been adopted only in a few countries such as China and Indonesia, have shown high effectiveness across studies and outcome metrics, including financial flows and, in some cases, emissions reductions. While their transferability to other financial systems remains uncertain, some scholars have argued that they could be effective in redirecting financial flows in high-income countries[11].

Future research is urgently needed to inform policy decisions. Given the relatively recent implementation of many GFPs, the impacts of these instruments are still largely unknown. As the field matures, robust and policy-relevant evaluations will be critical. Our evidence gap map (Figure 4) and systematic assessment of the evidence serves to highlight key areas where empirical research is lacking. First, comparative cross-country studies examining how different regulatory frameworks and policy mixes influence effectiveness could provide insights into the conditions under which these policies are most impactful. Second, given that GFPs operate through distinct financial mechanisms, their evaluation should extend beyond emission-based metrics to include indicators such as capital

reallocation patterns, financial risk mitigation, and green technology financing. Third, methodological advancements are needed to assess the mobilisation effects of financial interventions. Additionally, analysing the characteristics of funded projects, can serve to improve our understanding of policy impact.

As GFPs continue to evolve, building a stronger empirical foundation will be essential for ensuring that financial sector interventions contribute meaningfully to global decarbonization efforts. By addressing current evidence gaps, future research can provide more concrete guidance for policymakers seeking to align financial flows with climate objectives.

Methods

Our analysis comprises three parts: (1) a structured assessment of policy output building on a taxonomy of green financial policies, (2) a systematic review and evidence synthesis on the effectiveness of green financial policies, and (3) the development of an evidence gap map to showcase the evidence base for adopted policies and highlight research priorities. Each component builds upon the previous to offer a comprehensive understanding of the effectiveness of green financial policies (GFPs) in G20 countries.

Assessment of policy output

Green financial policy taxonomy

We use the taxonomy as a framework for the systematic evaluation of different types of green financial policy instruments. To build the taxonomy of green financial policies, we conduct a review of the green financial policy literature. First, we search Scopus applying a narrow search string to identify theoretical and empirical policy instruments. The Scopus database includes peer-reviewed publications and conference papers. The search was conducted in April 2024 and yielded 421 studies. We applied a machine learning algorithm using the review software ASReview to rank the studies in the order of relevance of their abstracts, which also facilitated the screening process[62]. ASReview is an open-source machine learning tool designed to assist researchers in reviewing large volumes of papers, commonly applied in systematic review and meta-analysis studies[63]. It incorporates an active learning approach to label and suggest potentially relevant records, which allows the reviewer to direct attention more efficiently. For the active learning model, we select ASReview's default parameters, namely Naive Bayes as classifier, Max as query strategy, and tf-idf for feature extraction. We apply inclusion and exclusion criteria and obtain 141 studies. Second, we manually scan obtained studies and code a large number of policy terms referring to GFPs or GFP types at different abstraction levels. We obtain a longlist of GFP policy terms. Third, through an iterative process, we use this longlist of terms to

analytically group them into categories to derive a robust taxonomy of green financial policies, providing a structured framework for further analysis.

Traditionally, policy analysis scholars distinguish between two common methods for classifying policy instruments [37]. The first is the "resource-based" approach, which categorizes instruments according to the governing resource they employ, such as organisational or fiscal mechanisms. The second is the "continuum" approach, which classifies instruments along a specific dimension, such as their degree of bindingness. In this study, we integrate these two approaches, considering four policy areas that reflect the governing resource and the intended policy mechanism.

We classify policies in four categories (Table 1). The four categories include: 'Regulation-based instruments to directly redirect capital allocation to green sectors' (REG); 'Targeted actions on the financial sector to directly redirect capital allocation to green sectors' (TACT); 'Transparency-based instruments to indirectly redirect capital allocation to green sectors' (TRANS) and 'Prudential policies to reduce climate-related systemic risk to the financial sector' (PRUD). The resulting taxonomy provides a structured lens for organizing both policy output and effectiveness evidence.

Data collection and policy scope for the policy database

We constructed a database of GFPs implemented in G20 countries from 2005 to 2022. This expanded dataset builds on methodology outlined in ref[6]. We compile relevant policy entries from four policy databases: the Green Finance Measures Database[64], the International Energy Agency's Policies Database[12], and the Green Bond Policy Data Set[65] and ref[66].

We consider green financial policies to be, first, financial policies[67], that is, policies targeting exclusively financial sector actors, and second, having the goal of aligning financial flows with the objectives of Article 2.1c of the Paris Agreement. As such, we only include policies concerned with aligning financial flows with a low-carbon transition, excluding those primarily related to biodiversity

or climate adaptation projects. Furthermore, we do not consider policies that primarily target real-economy actors, such as carbon pricing mechanisms, direct subsidies, or portfolio standards, as these fall outside the scope of financial sector regulation. Finally, we exclude low-binding information policies, such as published reports and broad ESG policies.

The final dataset comprises 197 green financial policies. Out of these, 170 come from the UNEP Green Database, and on top of those another 11 from the Climate Bonds Dataset, 6 from the IEA and 5 from ref[5]. Finally, we complete with 4 more policies that are identified and evaluated in the empirical literature that do not appear in any of the four datasets.

Systematic review approach

We conduct systematic review of studies that carry out empirical evaluations of green financial policies. First, we apply a broad search string of keywords on Scopus, including policy terms derived from our taxonomy (Table 1). The search was conducted in June 2024 and yielded 4,418 studies. To manage this large volume of literature, we applied a machine learning algorithm using the review software ASReview to rank the studies in the order of relevance of their abstracts. Two researchers and one research assistant worked independently in the review process and the 4,418 papers were reviewed by at least two, either through a title and abstract or a full paper scan. We apply inclusion and exclusion criteria and obtain 342 studies that met our criteria. Additionally, we completed PRISMA checklist for transparent reporting of systematic reviews and meta-analyses.

We understand empirical evaluations as ex-post quantitative or qualitative appraisals of a given policy or policy combination's effectiveness. We take 'effectiveness' in a broad sense and do not exclude papers based on the outcome that study, that is, if studies focus on emissions reductions or in changes in financial flows as the outcome variable. In terms of methodology, this excludes ex-ante modelling or theoretical analyses, but includes experimental or quasi-experimental methods, case studies, or other impact or outcome evaluation methods.

Second, we proceeded by coding these 342 studies according to our coding protocol outlined in the Supplementary Information. This systematic coding allowed us to categorise and analyse the empirical evidence in a structured and detailed manner. Additionally, we present the year of publication, title, authors, DOI and other descriptive information found in the primary studies.

Evidence gap map

We hand coded each study to indicate whether the specific GFP instrument(s) analysed were found to have a positive, null or negative impact on the specific outcomes. The same researchers matched the specific GFP instruments to a policy entry in our data base.

The evaluation results were mapped into an evidence gap map using standard methods[68]. This framework consists of four columns representing the four GFP types in our taxonomy, and rows indicating the country where the policy was adopted. The cells represent existing policies and can be segmented into five groups indicated by different colours. These colours represent the type of evidence that exists evaluating the effectiveness of such policy.

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