NOVEMBER 2019 | NUMBER 017

THE CENTER FOR INTERNATIONAL ENVIRONMENT & RESOURCE POLICY

CLIMATE POLICY LAB
THE FLETCHER SCHOOL
TUFTS UNIVERSITY

Climate Finance Policy in Practice: A Review of the Evidence

Rishikesh Ram Bhandary, Kelly Sims Gallagher, Fang Zhang

Abstract

This paper evaluates how policy to mobilize climate finance works in practice. It examines the empirical performance of nine types of climate finance policies through a literature review and case studies. Both successful and unsuccessful cases are examined. Criteria are established to evaluate climate finance policy, factors which lead to effective climate finance policy in practice are identified, current knowledge gaps are clarified, and policy implications provided.

Acknowledgements
The authors wish to gratefully acknowledge the financial support provided by the following funders of the Climate Policy Lab: BP International, Ltd., the William and Flora Hewlett Foundation, the Rockefeller Brothers Fund, and ClimateWorks Foundation.

Table of Contents

A note to readers: This discussion paper is being published in order to solicit comment. Feedback and suggestions for improvement are welcome and should be sent to Fang Zhang in the Center for International Environment and Resource Policy at The Fletcher School at fang.zhang@tufts.edu

List of Acronyms

BNDES	Brazilian Development Bank
CBRC	China Banking and Regulatory Commission
CRGE	Climate Resilient Green Economy
CSRC	China Securities Regulatory Commission
DOE	U.S. Department of Energy
ETS	Emissions trading system
FiT	Feed-in tariff
GCF	Green Climate Fund
GEF	Global Environment Facility
IFC	International Finance Corporation
IMF	International Monetary Fund
ITC	Investment tax credit
JCT	Joint Committee on Taxation, U.S. Congress
KfW	Kreditanstalt für Wiederaufbau, German Development Bank
LDCF	Least Developed Country Fund
LGP	Loan guarantee program
LPO	Loan guarantee program office of the U.S. Department of Energy
MRV	Measurement, reporting, verification
NABARD	National Bank for Agriculture and Rural Development of India
NDB	National development bank
NDRC	National Development and Reform Commission of China
PBOC	People's Bank of China
PTC	Production tax credit
PV	Photovoltaic
RE	Renewable energy
SEC	Security and Exchange Commission
SEPA	State Environmental Protection Administration of China (former government agency, now the Ministry of Ecology and Environment)
SIDS	Small Island Developing States
SME	Small and medium-sized enterprise
WHO	World Health Organization

1. Introduction

Scholars and practitioners alike widely recognize the importance of finance in enabling a transition to a low-carbon, climate-resilient economy. The Paris Agreement itself commits to aligning all financial flows to be consistent with the goal of limiting temperature rise to well below 2 degrees Celsius (˚C), with further efforts to limit warming to 1.5˚C. Numerous studies have established that a substantial financial gap exists to meet these goals (CPI 2018; IPCC 2018; McKinsey & Company 2009; UNCTAD 2014). A recent estimate of adaptation needs, for example, identified $1.8 trillion in potential investments that would result in $7.1 trillion in benefits (Global Commission on Adaptation 2019), yet recent estimates only identify $22 billion in adaptation investments (CPI 2018). To fix these financial gaps in both mitigation and adaptation, public funding is necessary, but not likely to be sufficient. For instance, a different estimate of the total green finance need amounted to about $400 billion annually, of which no more than 15% was estimated as likely to be met from public sources (Zhang et al. 2015). More effectively mobilizing and steering private finance to climate-related purposes is therefore of critical importance.

Both financial and non-financial barriers have impeded the mobilization of private finance to address climate change. Financial barriers include the lack of quantifiable incentives, unwillingness of most for-profit firms to internalize environmental externalities, low or intangible returns to corporate social responsibility practices (Pillay, Aakre, and Torvanger 2017), perceptions of high risks of low-carbon technologies on the part of commercial banks and other mainstream financiers, a mismatch between long-term payback periods and the short-term horizons of most private investors, lack of information to evaluate particular projects, a shortage of bankable and investable low carbon, adaptation, and resilience projects, and poor awareness of environmental and climate change consequences of certain types of investments (Chawla and Ghosh 2019; Leete, Xu, and Wheeler 2013; Jaffe, Newell, and Stavins 2005; Polzin 2017; Wilson et al. 2012). Non-financial barriers to private investments, including political, institutional, and legal barriers, may be even more profound. Lack of stable policy clarity coupled with a lack of policy coordination disincentivizes the mobilization of climate finance in many countries.

Given these barriers and market failures, some governments have begun to implement new policies to mobilize climate finance to reduce air pollution, support low-carbon manufacturing and job creation, accelerate decarbonization, and improve adaptation and resilience to climate change impacts. Although there are numerous conceptual models for how climate finance could work and what kinds of climate finance can be useful, no empirical assessment has yet been conducted about how climate finance policies work in practice. To address this gap, this paper reviews the evidence regarding climate finance policies that have already been implemented around the world, with the objective of harvesting early lessons about how climate finance policies have actually

worked in practice. Specifically, the paper explores which climate finance policies work, which do not, and under what conditions certain climate finance policies appear to work better. This paper also considers the policy implications of the findings in order to inform the effective design or reform of climate finance policies that would catalyze even more private finance. We also seek to clarify knowledge gaps in the existing literature on climate finance policy and therefore propose a research agenda going forward.

This paper contributes to the extant scholarly literature in two ways. First, it investigates the efficacy of climate finance policies that countries have adopted domestically. It therefore contributes to the incipient policy analysis literature on climate policy implementation. Second, the paper analyzes climate finance policies at the national level. There is substantial existing scholarly work on climate finance at the level of individual entities (i.e., the firm level). Much of the climate finance literature has focused on estimating financing needs for mitigation, adaptation, and resilience (Flåm and Skjaerseth 2009; IPCC 2018; McKinsey & Company 2009; UNCTAD 2014). The literature on climate finance has also tracked progress on addressing this issue in international climate negotiations (Persson et al. 2009; Roberts, Stadelmann, and Huq 2010; Roberts and Weikmans 2017). It is not surprising that the sources and recipients of climate finance and the organization of global climate finance architecture have received the majority of scholarly attention to date. But, there is a dearth of academic literature evaluating the policies that governments have formulated to mobilize and catalyze climate finance. Therefore, by casting the frame of analysis at the country level, this paper aims to provide an assessment of the tools that policymakers have at their disposal to mobilize climate finance.

2. Methodology and Road Map

To analyze what works, what doesn't, and why in climate finance policy, we first develop a taxonomy of climate finance policies. The taxonomy in Section 3 classifies climate finance policies by type and also by whether or not they stimulate the demand for climate finance, increase the supply for finance, or link both ends of the market. We select nine types of climate finance policies to evaluate in more detail: targeted lending, green bonds, loan guarantees, weather insurance, feed-in tariffs, tax incentives, national development banks, national climate funds, and disclosure. These policies were selected to illustrate demand-side and supply-side policies. The extent of available evidence also influenced which countries we could include. Country experience with designing and implementing these policies is presented in Section 4 based on existing literature and interviews conducted with stakeholders (i.e., government officials, banks, experts, stakeholders, and firm representatives). In Section 5, we establish a set of criteria for analyzing the relative effectiveness of the climate finance policies and then use these criteria to analyze the evidence about the nine climate finance policies.

Section 6 identifies key design features for effective climate finance policy. Section 7 presents findings, conclusions, knowledge gaps, and policy implications.

Methodologically, we review existing peer-reviewed publications about the impact of different climate finance policies in practice. Our review of the available literature is complemented by primary research in some countries on certain policy instruments included in this paper. Field research was conducted in Bangladesh, Brazil, China, Indonesia, Ethiopia, Germany, India, and the United States. Based on these primary and secondary sources, we evaluate the efficacy of the nine climate finance policies using an explicit set of criteria for assessment that are stated in the paper. We rate the individual climate policies as implemented in practice against the criteria to develop our findings about which climate policies work, which don't, and why.

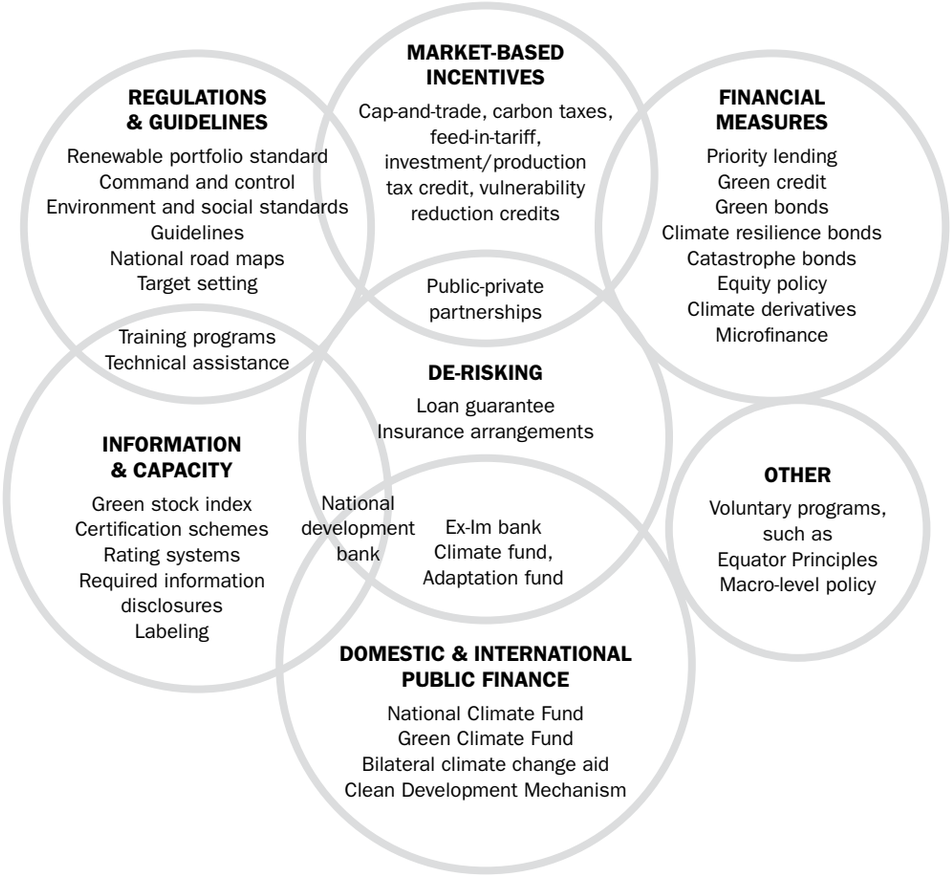
3. Taxonomies of Climate Finance Policies

We define climate finance policies as those policies that aim to mobilize finance for climate-related objectives including mitigation of greenhouse gases, adaptation to climate change impacts, and creation of longer-term resiliency to climate disruption. Climate finance can be considered a subset of "green" finance, which might include finance for environmental technologies that are not necessarily aimed at climate mitigation or adaptation such as remediation of hazardous waste. Nonetheless, climate finance and green finance are overlapping concepts.

Climate finance policies can be broadly grouped into demand-side policies, supply-side policies, and policies that link the two sides. Demand-side policies are those that create or increase effective demand for climate finance by translating a need for green investment into well-prepared, bankable projects. These polices can include tax incentives, feed-in-tariffs, and carbon prices, which internalize negative externalities. Supply-side policies are those that increase the supply of affordable finance for green projects or sectors by creating incentives or penalties. Examples of incentive policies are targeted lending, green bonds, green insurance, and loan guarantees. Linkage policies arise when governments facilitate matchmaking between demand and supply by establishing new institutions dedicated to green finance or by providing information that reduces knowledge asymmetries between buyers and sellers.

To determine which policies to include in the analysis, we further categorize climate finance policies based on the functions of climate finance policies and the incentive mechanisms embedded in these policies as depicted in Figure 1. The main types of climate finance policies are de-risking, regulations and guidelines, market-based incentives, financial measures, information & capacity, domestic and international public finance, and other. Some policies fit into more than one of these categories, and these are depicted in the overlapping circles in the Venn diagram in Figure 1.

Figure 1: Classification of climate finance policies based on function



Source: Adapted from Gallagher and Xuan (2018)

Notably, beyond climate policy instruments, broader macro policies, which create enabling conditions for financing, also play a key role in facilitating or hindering private investment. These factors include the domestic policy environment (e.g., legal framework, investment promotion and facilitation, public governance aspects), as well as country-risk and opportunity factors (e.g., political stability and currency exchange risks).

Table 1. Market intervention points of climate finance policies

Demand side	Supply side	Linkage of demand and supply
Feed-in tariffs	Targeted lending	Guidelines
Regulations	National development banks	
Weather insurance	National climate funds	Short, medium, and long-term targets
Carbon tax or emission and trading system (ETS)	Tax credits (e.g. for renewables or vulnerability reduction)	Roadmaps
Performance standards	Green bonds	Third-party monitoring reporting and verification (MRV)
Rating systems	Catastrophe bonds	Data/information platforms
Tax credits	Ex-Im banks	Training programs and technical assistance
	Microfinance platforms	Disclosure
	Loan guarantees	
	Green Climate Fund, Adaptation Fund, Least Developed Countries Fund (LDCF)	
	Public-private-partnership	

Source: Authors

4. Climate Finance Policy Instruments in Practice

This section examines nine selected policy instruments and their application in individual countries to assess how they influence the behavior of financiers or investors, what barriers the policies are addressing, and whether they affect finance flows towards deployment of climate-friendly technologies. The cases are selected based on our taxonomy of climate finance policies with five supply-side policies, two demand-side policies, and one policy aimed at linkage. For each type of climate finance policy, we examine multiple empirical cases of the use of the policy in a national context (as shown in Table 2). The analysis of country cases will elucidate how these typical

climate finance policies have operated empirically in concrete national contexts. The research in this section draws on both primary sources (interviews in relevant countries) and secondary data sources including published scholarly articles, think tank reports, government agencies, the Climate Policy Initiative (CPI), and Bloomberg New Energy Finance (BNEF).

Table 2. Selected policies and country experience

Policy Instrument	Country experience	Target	Objective
Targeted lending	India, China	Cross-cutting	To promote access to finance among certain stakeholders
Green bonds	China, Indonesia, India, Europe, United States	Cross-cutting	To promote access to finance, provide long-term finance, and reduce cost of capital
Loan guarantees	United States World Bank	Clean energy	To mitigate high or perceived risks, and to reduce cost of capital.
Weather index-based insurance	Asia, Africa	Adaptation	To de-risk adaptation and resilience projects
Tax credits	United States, Netherlands, Japan	Cross-cutting	To promote the production or purchase of certain products or services
Feed-in-tariff	Spain, Germany, Italy, China	Clean energy	To mitigate risk, increase economic competitiveness, and provide clear returns to investments
National development bank	Germany, China, India	Clean energy, energy efficiency	To promote access to long-term finance, de-risk projects, provide demonstration and enable learning, create trust for projects; take a first or early mover role to help projects gain a track record
National climate fund	Amazon Fund (Brazil), CRGE Facility (Ethiopia), Climate Change Resilience Fund (Bangladesh), Climate Change Trust Fund (Indonesia)	Clean energy, adaptation, forestry	To facilitate the adoption of cleaner or more resilient technologies in developing countries through the establishment of a dedicated national climate fund
Disclosure	United States	Cross-cutting	To provide information and reduce information asymmetry

4.1 TARGETED LENDING

Targeted lending policies, also referred to as priority sector lending practices, are those that require banks to lend a certain portion of their credit or deposits towards certain policy priorities, such as agriculture or clean energy. The primary rationale for a targeted lending approach is the undersupply of credit to certain sectors due to high risk, information asymmetries, or the environmental externalities of green projects (Vittas and Cho 1996). But one of the key concerns expressed by critics of targeted lending programs is that it forces banks that do not have expertise in a sector to lend in it, thereby undermining performance.

In India, the Reserve Bank of India has a priority sector lending policy that requires 40% of adjusted net bank credit (or credit equivalent amount of off-balance sheet exposure) to fall in priority sectors, including agriculture (18%), micro-enterprises (7.5%), weaker sections (10%), and other priority sectors (4.5%) (Reserve Bank of India 2018). Renewable energy products are included in the "other" priority sectors. The penalty for missing the targets is that the banks are required to contribute to public funds such as the Rural Infrastructure Development Fund, which is operated by the National Bank for Agriculture and Rural Development (NABARD). The interest rates on priority sector loans do not differ from non-priority sector loans. Indian banks have had trouble meeting the priority sector lending targets. State-owned banks (public sector banks) have had more success in meeting targets than commercial ones. To facilitate compliance, the Reserve Bank of India (RBI) has allowed banks to meet their obligations by purchasing 'priority sector lending certificates' from those banks that exceed the lending requirements. Particularly noteworthy from a climate resilience standpoint is that the gross non-performing assets, in the agriculture sector, are substantial.

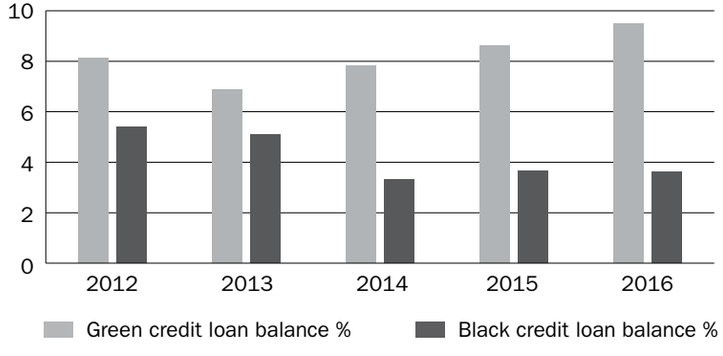
In China, the targeted lending policy is called the green credit policy which was jointly issued by the China Banking Regulatory Commission (CBRC), People's Bank of China (PBOC), and the former State Environment Protection Administration (SEPA, the predecessor to the Ministry of Environment and Ecology) in 2007. The policy calls on banks to provide credit support to strategically chosen industries and withdraw loans or credit from projects in high energy-intensive and pollution-intensive industries. The policy does not set up a mandatory percentage of credit to fall in the green credit. The policy is currently more voluntary than mandatory, and data are not publicly reported so it is impossible to determine compliance.

The relationship between targeted lending policies and climate finance policy outcomes is not well established. There is emerging evidence that banks face difficulties in lending to clean energy projects in India (Jain, Parida, and Ghosh 2015). Currently, banks prefer to avoid lending money to renewable energy producers due to the risk of losing money.[1]

1 Interview by Fang Zhang in India (Expert, Shakti Sustainable Energy Foundation, India, Nov. 19th, 2018.)

For China, data suggests that the green credit policy in China is financially effective. The total green credit lending for China's 21 main banks increased and has hovered at nearly 10% of their commercial lending volume as of 2016, whereas black credit loan volumes as a percentage of corporate lending declined since 2012 (Ho 2018). There are, however, doubts about the environmental impacts of the green credit policy due to lack of data and concerns regarding data quality. Zhang et al. (2011) argue that the green credit policy was not fully implemented due to its wide-ranging impact on high-polluting and high energy-consuming industries, vague policy details, unclear implementing standards, and lack of environmental information (Zhang, Yang, and Bi 2011a). There is also a concern that the implementation of the green credit policy in China depends excessively on "peer pressure"[2] from banks, lacking the claw of enforceable implementation. Luo, Fan and Zhang (2017) find that green credit can enhance the short-term profitability of energy-saving and environmental enterprises in China, but that it does not have a significant impact on the financial performance and operational efficiency of those enterprises.

Figure 2. Average green credit & black credit as percentage of corporate loans (2012–2016)



Source: Ho (2018)

TARGETED LENDING SUMMARY:

– Mixed evidence about the impact of target lending on bank behavior regarding green finance.
– Bottom-up reporting casts doubt on data quality and points to the necessity of monitoring, verification, and transparent data reporting.

2 Interview by Fang Zhang in China (Official, China Banking Regulatory Commission, China, Jan. 10th, 2017.)

4.2 GREEN BONDS

Green bonds are bonds earmarked for projects with environmental benefits, and climate bonds primarily finance climate change mitigation and adaptation (Meng, Lau, and Boulle 2018). Bond instruments are believed to be useful for addressing access to finance and providing cheaper and longer-term finance for green projects (Agarwal and Singh 2017; Ng and Tao 2016; Wang and Zhang 2017). Green bonds can be raised from a broad set of investors across the whole risk spectrum and they can be traded on exchanges. Green bonds offer investors the opportunity to directly invest in specific projects with tangible environment impacts and obtain financial returns (Wood and Grace 2011; Ehlers and Packer 2017). From a policy perspective, green bond policies can also heighten awareness of environmentalism among investors and financers with sufficient size and frequency (Office of the Comptroller 2014). Increasing issuances of green bonds by public sector actors also sets an example for the private sector.

Because green bonds are relatively new, government regulation is largely missing and governance is instead decentralized and primarily self-regulated by private or non-governmental actors. Government regulation could help improve accountability, legitimacy, standardization, and consistency (Park 2018; Weber and Saravade 2019).

The first green bond was issued in 2007 by the European Investment Bank and was dedicated to renewable energy and energy efficiency projects. A number of other governments have since implemented policies to encourage the green bond market, including Australia, the United States, China, and India. Climate "aligned" bonds were estimated at about $895 billion globally in 2016, of which $221 billion were labeled as green bonds (Climate Bonds Initiative 2017). Another estimate concludes that there are about $250 billion in outstanding green bonds compared with $100 trillion in conventional bonds. The market for green bonds is thus still very small compared with the wider global bond market (Karpf and Mandel 2018).

China's central bank, the People's Bank of China (PBOC), as well as the National Development & Reform Commission (NDRC) separately issued green bond guidelines in December 2015 and January 2016. Later, the China Securities Regulatory Commission (CSRC), which regulates listed companies, also issued green bond guidelines. Although there is no special financial support underlying green bonds, they are allowed to have a faster approval process, and the green bond market has thus boomed in China. The total issuance of green bonds in China increased from almost nothing to $36.2 billion in 2016, accounting for 39% of the global market, and then reached $37.1 billion in 2017. Most green bonds in China have a three- or five-year tenor, longer than what Chinese banks and project developers have come to rely on in recent years and still shorter than the international market, where the majority of bonds have a tenor between 5 and 10 years.

Despite the rapid growth, there are multiple problems emerging with China's green bond market. The green bond policy has not significantly reduced the costs of finance for green projects as there are no significant interest rate differences between the two kinds of bonds (Hexun News 2018). Up to 50% of bond proceeds are used to repay bank loans and invest in general working capital rather than being invested in green projects, in comparison with international norms where up to 95% of proceeds are invested in green initiatives. In addition, some projects in China that count for green bonds (including clean coal technologies and improvements in coal-fired power efficiency) would not be considered green or "climate bonds" by international standards such as the Climate Bonds Standard.[3] There is little transparency on how the money raised through green bonds is being used. Lastly, most issuers of green bonds in China are still banks, state-owned enterprises, or large players, while private and small and middle enterprises (SMEs) rarely issue green bonds.

The Indonesian government has used the proceeds from green "sukuk," a bond issued in line with Islamic finance principles, to finance a list of budget expenditure items that are tagged as green according to pre-defined criteria. In doing so, the Indonesian government has sought to instill transparency in how it uses proceeds and has sought to mobilize finance for public expenditure rooted in national planning processes rather than a parallel set of projects created just for the bond issuance.[4]

The first Indian green bond was issued in 2015, and 27 other green bonds were issued by 18 issuers through May 2019. Government backed entities have accounted for 37% of the green bonds, non-financial corporations for another 37%, banks for 11% and India's development bank for the remaining 11% (Dutt et al. 2019).

Empirical evidence is only just emerging regarding the performance of green bonds. In one assessment of 1,065 green bonds indexed by Bloomberg, a very small negative yield premium was found, but the study author concludes it is too small to be a "disincentive to keep on investing in green bonds" (Zerbib 2019). In a U.S.-specific study of municipal (specifically sub-national) bonds issued by sub-national U.S. government entities, 1,800 green bonds had been issued by 189 distinct issuers at a value of $12 billion compared with $3 trillion in conventional municipal bonds during the same period. The authors find that the yield for U.S. municipal green bonds is systematically below that of conventional municipal bonds and the spread widens over time. In other words, investors in green bonds appear to accept lower yields, especially over longer periods. Yet the premiums associated with green bonds appear to increase as credit quality improves, so green bonds are "becoming an increasingly attractive investment" (Karpf and Mandel 2018).

3 https://www.climatebonds.net/standard/
4 Personal correspondence with an official from Indonesia's Ministry of Finance in 2018 with Rishikesh Bhandary.

GREEN BONDS SUMMARY:

– Green bonds don't appear to reduce the cost of capital; yields are somewhat below conventional bonds; longer tenors can be helpful.
– Lack of transparency means it is unclear what the green bonds are financing; this problem is compounded by the lack of an internationally-agreed-upon definition of green bonds (in particular, what sector-specific actions should look like).

4.3 LOAN GUARANTEES

Loan guarantees (LG) are employed to induce lenders to extend loans to individuals and firms they would otherwise not accept as loan clients (Vogel and Adams 1997). Under this policy, there is a contractual obligation among the government, private creditors, and a borrower—such as banks and other commercial loan institutions—that the government will cover the borrower's debt obligation in the event that the borrower defaults. The government therefore reduces the high risk (or perceived high risk) to alter lender behavior. This policy has historically been used to support SMEs, home ownership, and higher education in both developed and developing countries (Cowling and Mitchell 2003). The policy proved to be effective in expanding loans to SMEs in the UK (Cowling and Mitchell 2003), France (Lerner and Schoar 2010), and Japan (Uesugi, Sakai, and Yamashiro 2010), and indeed in achieving additionality because loans were disbursed that would not otherwise have been extended (Riding, Madill, and Haines 2007).

Loan guarantees have also been used to support clean energy projects either by national governments or multilateral financial institutions including the IFC and World Bank (Multilateral Investment Guarantee Association). LGs can provide access to low-cost capital for projects that might otherwise be considered high risk by the commercial banking and investment community (Brown 2012). IFC's experience shows that when loan guarantee programs are effectively structured, one dollar in GEF funds can directly leverage $12–15 of commercial investment into energy efficiency projects and indirectly catalyze long term growth of financial commitments to the sector (Maclean et al. 2008). LGs were also found to be useful in increasing the uptake of off-grid rural energy (Shi, Liu, and Yao 2016).

Since 2005, the United States has used loan guarantees to support the commercialization and deployment of advanced energy, tribal energy, and construction of new or renovation of old auto manufacturing factories to produce cleaner vehicles. The loan guarantee program for energy was created by Congress in the Energy Policy Act of 2005 and was substantially expanded during the Obama Administration in the context of the American Reinvestment and Recovery Act, intended to help bring the United States out of recession. As of 2019, the loan program office (LPO) in the

U.S. Department of Energy manages a portfolio comprising more than $30 billion in loans, loan guarantees, and conditional commitments covering more than 30 projects (Department of Energy 2019b). The Department of Energy claims that each dollar appropriated for the program leverages up to thirteen dollars in private sector investment. The actual and estimated loan losses since 2005 as a percentage of total disbursements has been only 2.91% (DOE 2019a). The program also played a role in altering lender behavior by subsidizing loan-recovery risk. Until the program provided a loan guarantee, there were no utility scale PV projects in the United States because no financial institution was willing to finance the first one. The program supported five PV projects and then 30 PV projects were subsequently commercially financed without any loan guarantees.[5] The same phenomenon occurred with utility-scale thermal plants.[6]

Applying to the loan guarantee program was a time-consuming process for firms and created high transaction costs for project developers.[7] Firms themselves also needed to provide some finance to the US government upfront, and many smaller and medium-sized enterprises couldn't afford to do that, limiting the participation of small firms. Another drawback to the LG model in the United States is that it has been plagued by the perception that the government, rather than the market, picks winners based on their political influence due to a lack of transparency regarding the decision-making process in this policy.[8] The high profile Solyndra bankruptcy threw the program's credibility into question, bringing reputational concerns that discouraged large financial institutions from participating in this program. As an interviewee from a large investment bank claims, "If you lend the money (through LG program), someone writes a paper about it and then criticizes that you either take advantage of the government if the project succeeds or you lose face if the project fails."[9] Finally, Congressional authorizations for LGs were highly skewed towards very expensive forms of low-carbon energy with 28% of the authorizations for nuclear energy and 15% for advanced fossil energy, both of which have proven to be much more expensive than renewable energy. The Vogtle nuclear power plant is estimated to now cost $25 billion, compared with the original estimate of $14 billion (Grantham 2017).

LOAN GUARANTEE SUMMARY:

– Reduces cost of capital; cost-effective for provider; major advantage that guarantee may never get used.
– Can support large-scale RE deployment, but depending on policy design, can involve high transaction costs.

5 Interview by Fang Zhang in the United States (Former official, Department of Energy, United States, March 2, 2017)
6 Ibid
7 Ibid
8 Fang Zhang interview. Former official, the Council of Economic Advisers (CEA), Mar. 29th, 2018.
9 Fang Zhang interview. Banker, Morgan Stanley Energy Partners, Apr. 30th, 2018.

4.4 WEATHER INDEX-BASED INSURANCE

Index-based insurance is an innovative tool that countries have started to pilot and bring to scale. Several contract types include area-yield, weather-based index, and satellite-based index (Clement et al. 2018). Index-based insurance provides payouts based on a measurable condition that is related to agricultural production loss, such as drought. As index-based insurance relies on external data to make payouts, it eliminates the need to verify individual insurer claims, which is attractive in resource-constrained settings where transaction costs may make such financial products prohibitive. However, index-based insurance has been unevenly offered and purchased in developing countries. In a set of case studies from India, Mongolia, and Africa, index-based insurance led to the adoption of more profitable production technologies in India and Ethiopia and, in most cases, to increased income (Greatrex et al. 2015). Although a theoretical concern was that very poor farmers would not purchase the insurance, evidence from Senegal, Kenya, and Mongolia suggests that many do purchase it, especially in the context of insurance-for-work programs (Greatrex et al. 2015). One factor slowing the rate of scale-up is basis risk. In other words, the risks that farmers are insured for are not the risks that the farmers actually end up experiencing (Clement et al. 2018). For example, an insurance program may set the trigger for a pay-out at the district level, however, impacts at such a geographic scale may not reflect what an insurance policyholder experiences individually. Some scholars emphasize that, rather than there not being enough demand, the key question is what service does the insurance actually provide (Greatrex et al. 2015). Another key challenge if the capital pool is small is that the insurance providers will need access to reinsurance to back up the capital, which can be highly expensive, and out of the reach of farmers in developing countries.

The public sector plays a very important role in supporting the use of insurance from feasibility analyses, capacity building, data infrastructure, and regulatory measures (Warner et al. 2013). The most common means is to provide insurance premium subsidies. Mahul and Stutley (2010) find that while the offering of an agriculture insurance premium subsidy is not a precondition for a high penetration rate, those countries that do have high penetration rates without subsidies are those that already have a history of insurance programs such as multi-peril crop insurance. But there is also concern that such subsidies distort the price signal and can provide a disincentive to reduce vulnerability (Collier, Skees, and Barnett 2009). Notably, climate change also poses challenges for index insurance as events will be more unpredictable and may not spread risk evenly across different regions, categories of people, or time scales (Warner et al. 2013). Climate change is also likely to increase the price of insurance products (Collier, Skees, and Barnett 2009).

WEATHER INSURANCE SUMMARY:

– Problems emerge with basis risk — i.e., the risks that farmers are insured for are not the risks that farmers end up experiencing because of climate change.
– Insurance premium subsidies can help scale up use of insurance but can also distort price signals.
– Little apparent national level uptake; mostly pilot/sub-national levels.
– Challenges are emerging in setting up the index insurance because climate change is inherently unpredictable.

4.5 FEED-IN-TARIFFS

A feed-in-tariff (FiT) is a policy instrument designed to accelerate investment in renewable energy technologies by providing either a fixed total electricity price per kWh or a fixed premium on top of the wholesale rates of electricity for fixed periods (Couture, Cory, and Kreycik 2010). Given the low financial risk and long-term price security that a FiT provides, FiTs are recognized as an effective policy option to incentivize specific types of capacity additions and generation (Menanteau, Finon, and Lamy 2003). By 2017, more than 113 countries or states/provinces had adopted a FiT policy (REN21 2018).

The effectiveness of a FiT in reducing risks or incentivizing deployment has been widely examined and generally acknowledged in Germany (Mitchell and Hennessy 2003), the UK (Cherrington et al. 2013), and Europe more generally (Jenner, Groba, and Indvik 2013). A global study found that FiT policies helped countries mobilize 2-3 times more green investment than in the absence of these policies (Eyraud, Clements, and Wane 2013). The results of the use of FiTs in China and Spain were mixed. In China, tariffs were originally set too low for investors to accrue a reasonable rate of return, but tariff rates were subsequently adjusted three times and eventually the domestic market for PV developed rapidly (Ye, Rodrigues, and Lin 2017). A review of FiTs in developing countries found that FiTs may not have had the intended effects due to: tariffs that are insufficient for cost recovery; inconsistent and uncoordinated policymaking; and wider political and regulatory risks (Barroco and Herrera 2019).

In Spain, the government established a FiT in 1998 whereby renewable energy generators could choose between two alternatives, a fixed feed-in tariff or a premium. The FiT was modified in 2004 and 2007. At first, Spain's FiT was famously generous and investments flooded into the sector. By 2008, 40 percent of the world's total solar installations were built in Spain (Voosen 2009). This boom was followed by a spectacular bust, when the government was forced to step in to reduce the unsustainable costs of the FiT. By 2012, Spain was receiving 32% of its total power demand from renewable sources (Couture 2013). Meanwhile, as the FiT framework

forced the utilities to pay above-market rates to the producers of wind and solar and did not allow them to charge the cost of the feed-in tariff to ratepayers, the electricity system deficit increased over time and became unsustainable. The country's electricity system deficit stood at over €24 billion by 2012 (del Rio and Mir-Artigues 2014). In 2013, the government removed the FiT for new renewable energy projects. The debts incurred during the growth period led to tougher and retrospective revisions of contracts to providers of renewable energy, which reduced returns considerably. The government drastically cut other support and new installations stagnated between 2012 and 2015. Spain's rate of new renewable installation subsequently fell behind that of many other European countries.

Surveys among venture capital and private equity funds show that investors perceive FiTs to be the most effective renewable energy policy (Bürer and Wüstenhagen 2009). The tariff structure (whether it is a total fixed electricity price or a fixed premium above the wholesale electricity rate) matters for financiers (Cherrington et al. 2013). The effectiveness of FiTs can be limited if the tariffs are too low, the cap is too low (e.g., Austria), FiTs values are guaranteed for too short a number of years (e.g., Austria, Cyprus, Luxembourg, and the Netherlands), or administrative procedures are too complicated or obstructive (e.g. Cyprus, Greece, and France) (Dusonchet and Telaretti 2010). Haas et al. (2011) compared FiT schemes to green certificate trading and conclude that FiTs are more stable, easier to implement, easier to change and adapt to the market, and cheaper from an administrative point of view, since it is not necessary to create and operate a market for green certificate trading.

By providing a steady stream of revenue, FiT policies address the main risk that developers using project finance face: revenue risk. In contrast to conventional balance sheet financing, project finance can lead to higher rates of finance mobilization by broadening the base of developers and allocating risk across these actors more efficiently. Initial evidence suggests, however, that project finance has been underutilized. One study found that factors including dispatch policies, capacity caps, and tight deadlines actually discouraged project finance (Barroco and Herrera 2019). Therefore, despite providing a revenue guarantee, experience suggests that the specific design details of FiTs, along with the interaction with related policies, ultimately shapes outcomes.

SUMMARY OF FiTS:

– FiTs can reduce risks for investors and incentivize financial mobilization in an effective manner.
– FiTs have won the confidence of financiers but critical ingredients need to be in place: tariffs that can provide a reasonable rate of return for investors; suitable duration; simple administrative procedures.
– Flexibility to adjust FiTs is crucial as the cost of technologies change over time.

4.6 NATIONAL DEVELOPMENT BANKS

National development banks (NDBs) are government-backed, sponsored, or supported financial institutions that have a specific public policy mandate (Smallridge and de Olloqui 2011). NDBs can both complement and catalyze private sector players as NDBs are driven by strategic mandates rather than short-term commercial considerations (Smallridge et al. 2012; Kumar 2016; Mazzucato and Semieniuk 2018). Zhang (2019) emphasizes that NDBs can provide an important policy coordinator function for finance mobilization in the context of renewable energy deployment. Zhang also emphasizes that NDBs cannot act effectively by themselves and that the effectiveness of NDBs in mobilizing climate finance is conditioned on the existence of market-formation policies for climate-friendly technologies and industries.

Another unique advantage of NDBs is that they have lengthy track records and a wealth of experience bridging the gap between governments and private sector (CPI and IDB 2017). NDBs can sometimes provide cheaper finance as they often have high credit ratings and subsidies from governments. State-owned banks have also demonstrated other capacities to shape green finance, such as de-risking low-carbon projects, enabling financial sector learning, establishing trust for projects, and taking a first or early mover role to help projects gain a track record (Geddes, Schmidt, and Steffen 2018). Mazzucato and Penna (2016) emphasizes that NDBs can create and shape markets, rather than only fixing markets. For developing countries, NDBs can also be an effective tool to leverage intermediate international financial resources (Smallridge et al. 2012). State clean energy financing programs have successfully engaged diverse stakeholders to help mobilize capital (Belden, Clemmer, and Wright 2015).

Increasingly, NDBs directly fund or direct financial flows to support low-carbon and climate-resilient investment (Griffith-Jones 2016; CPI and IDB 2017). Some NDBs, such as KfW and BNDES, have halted financing for conventional thermal power plants. Germany's KfW has been a leader in supporting Germany's energy transition, known as the *Energiewende*. Total green finance provided by KfW domestically in 2014 was $21.9 billion. This amount represented 40.3% of total lending by KfW that year. It is important to note the key role that KfW played in the initial phase of introduction of solar PV to Germany. In fact, KfW funded all the investment in solar PV during 2007–2008 in Germany, when solar PV technology was still immature. By funding and showcasing new technologies and sectors, KfW played a catalytic role and successfully crowded-in private financing. Since 2012, at least half of the new investment in solar PV in Germany has come from private or other non-KfW sources (Griffith-Jones 2016). One factor contributing to KfW's success in this regard is its lender-education programs. These initiatives have increased local lenders' familiarity and comfort with clean energy projects, which in turn facilitated market development and lowered financing barriers (Belden, Clemmer, and Wright 2015). Griffith-Jones (2016) also emphasizes that KfW uses fairly simple, even "old-fashioned" financial instruments, which can help to reduce transactions costs and reduce hidden risks or combine finance together with technical assistance.

SUMMARY OF NATIONAL DEVELOPMENT BANKS:

- Strategic/policy mandate means that short-term commercial considerations are de-prioritized over policy objectives.
- Existing history (track record/experience, credit rating, etc.) allows for NDBs to engage with private actors effectively.
- Catalytic role of KfW in crowding in private financing (with the help of lender-education programs, among others) is a model that could be used by others.

4.7 DISCLOSURE POLICIES

The number of companies reporting climate change information has grown over the years (CDP 2018), but the consistency and quality of information that companies provide over time has varied (Cumming and MacIntosh 2006). Companies tend to report physical climate risks less often than they report transition risks such as regulatory risks (Kouloukoui et al. 2018). While most of the scholarship finds that energy-intensive sectors and "environmentally sensitive" sectors have a higher propensity to voluntarily disclose their greenhouse gas emissions (Halkos and Skouloudis 2016), others find that carbon intensive firms are not more likely to disclose their emissions than other firms (Stanny and Ely 2008). It is likely that many factors mediate the relationship between carbon intensity and disclosure. The level of competition and profitability of the industry are two examples of factors that can affect disclosure (Jira and Toffel 2012). Similarly, with regards to physical climate risks, firms may interpret the same information in different ways. Firms in similar situations and contexts may perceive climate impacts differently and formulate different climate strategies (Gasbarro and Pinkse 2016).

The academic literature has largely focused on determining the propensity of firms to disclose climate-related information based on factors such as stakeholder pressure, company attributes, sector of operation, and performance. Firms are more likely to disclose if they, or other similar firms, have been the target of shareholder pressure, may be subject to government regulations, or are more visible (Haque and Deegan 2010; Reid and Toffel 2009; Jira and Toffel 2012; Dawkins and Fraas 2011). Studies also find the role of institutional investors, including pension funds, to have had influence in encouraging companies to disclose (Sjöström 2008; Cotter and Najah 2012; Smith, Morreale, and Mariani 2008; Lee and Kim 2015). Disclosure by companies can quell litigation complaints (Field, Lowry, and Shu 2004) while litigation against peers can also drive disclosure.

The cost of providing the information may be a barrier to climate disclosure (Haque, Deegan, and Inglis 2013). Company attributes can be predictive of reporting outcomes. Larger firms are more likely to disclose, especially those with an existing reporting

history (Hahn, Reimsbach, and Schiemann 2015; Gonzalez-Gonzalez and Zamora Ramírez 2016). Some studies, however, do not find the size of company to be a salient factor (Kouloukoui et al. 2018; Amran, Periasamy, and Zulkafli 2014). The role of the board of directors in influencing climate disclosures is important (Kouloukoui et al. 2018), with boards having a higher number of independent directors showing better reporting outcomes (Jaggi et al. 2018). The relationship between the environmental performance of a company and its propensity to disclose is not yet clear. Some have found a positive relationship (Giannarakis et al. 2018), while much of the accounting literature finds a negative association between environmental performance and disclosure rates.

How useful is the information that firms disclose? The literature has primarily discussed the accounting notion of materiality and comparability of information. If information is material to understanding financial performance, it can help to make asset allocation decisions in a manner that reflects asset level risks. The lack of standardized reporting formats impacts comparability. Scholars do not find the reported information useful for decision-making purposes (Kolk, Levy, and Pinkse 2008). If investor usability is the question, then there has to be better standardization of disclosure data (Andrew and Cortese 2011). A key question that decisionmakers need to consider is what information is of material importance to financial performance. Sector-specific guidance on materiality may help (Eccles et al. 2012). The existence of multiple standards in the insurance sector has also hampered comparability (Jones and Phillips 2016).

Scholars have also argued that mandatory reporting could be beneficial because it can reduce the negative reactions shareholders may have to disclosures when it is a part of a wider policy process (Baboukardos 2017). Luo et al. (2012) find that investor needs do not explain climate disclosure patterns, suggesting that the actual content of what companies disclose may not be useful in decision-making. An area ripe for further examination is the contention that the impact of climate disclosures is felt through process innovation rather than product innovation (D. Li et al. 2018).

While the literature primarily uses climate disclosure as an umbrella term to include transition and regulatory risks in addition to physical climate risks, the focus of existing work is largely on the former. In banking, there is a growing awareness of the need to integrate climate considerations into credit risk management frameworks. Participation by banks remains voluntary and partnership-driven (such as Partnership for Carbon Accounting Financials). There is international guidance available via the Task Force on Climate-related Financial Disclosures, but regulatory frameworks are nascent.

According to a recent report from U.S.-based CERES, "At a time when investors need reliable, financially relevant, material corporate disclosures on sustainability, companies are leaving gaps between what investors demand and what they provide" (Ceres 2019). This failure to fully disclose is particularly noteworthy given that the U.S. Securities and Exchange Commission (SEC) has required firms to disclose risks related to climate change since 2010 (Securities and Exchange Commission 2010). It does not appear that the SEC has enforced this rule given the unevenness in disclosure.

SUMMARY ON DISCLOSURE:

– What information is reported matters: is reported information useful or not to make capital allocation decisions? Physical climate risks are underreported in comparison to transition (regulatory) risks.
– How material is the information; how comparable is it?
– US SEC requires disclosure and yet disclosure is not common, so enforcement is essential if the policy is to be effective.
– Challenges in institutionalizing disclosure policies are common.

4.8 TAX CREDIT POLICY

Tax credits are a fiscal policy that can compensate investors or consumers for production or use of renewable energy. We distinguish tax credits from tax incentives. The latter can refer to a broad range of government policies such as import duty exemptions for renewable energy or corporate tax holidays. The credit is usually adjusted over time to account for inflation or changes in the cost of the technology. Economists are often critical of subsidies as inefficient methods of achieving policy goals and prefer price-based instruments such as instituting a carbon price (Metcalf 2008). Tax credits, depending on their specific design, may not provide a level playing field for all emissions-reduction technologies and may favor more expensive technologies over cheaper ones if the tax credit is only provided to certain technologies and not others (or provided to some at a different level). To the extent that these subsidies are financed by distortionary taxes on other economic activities, they reduce economic efficiency (Metcalf 2009) subsidies lower the cost of energy (on average. How consumers respond to incentives such as tax credits shapes the effectiveness of these policies. There is evidence to suggest that structuring incentives in the form of cash rebates rather than tax credits is more effective (Gallagher and Muehlegger 2011; Matisoff and Johnson 2017; Sarzynski, Larrieu, and Shrimali 2012).

In the United States, tax credits have been the main policy vehicle used at the federal level to incentivize the deployment of renewable energy since they were established in the Energy Policy Act of 1992 to partially compensate for the higher costs of renewable energy technologies at the time, and thereby incentivize the production of renewable energy. In the United States, tax credits for renewable energy sources has been defined as "a per-kilowatt-hour tax credit for electricity generated using qualified energy resources" (Sherlock 2018). Both Production Tax Credits (PTC) for wind and Investment Tax Credits (ITC) for PV have been employed off and on for many years. The U.S. Congress has repeatedly gone back and forth between letting the PTC and ITC expire and then belatedly extending the tax credits, which created substantial uncertainty for investors. The PTC was extended 11 times since 1992 but was often allowed to lapse before being re-instated (Sherlock 2018). The start-and-stop pattern of investment has stifled

momentum behind renewable energy development in the United States and shook investor confidence. The ITC and PTC are again scheduled to expire by 2021.

In addition to incorporating environmental externalities into the cost of renewables, the PTC and ITC policies catalyzed other financial actors beyond those firms who are directly targeted by the policy. The reason is that smaller project developers typically do not have sufficient tax liability to capture all the tax credits and therefore need to partner with actors in the financial community who provide equity investments in exchange for tax credits. In so doing, they mobilize additional finance to support renewable energy developers. A drawback, however, is that incorporating third-party tax equity investors adds extra legal costs to establish the contracts for these financial transactions.

Another related shortcoming of U.S. tax credit policy is that the PTC requires benefits to be monetized within 5–10 years rather than over longer periods of time. The government-guaranteed subsidy only lasts up to 10 years, which limits the project's long-term viability and discourages banks from providing loans longer than 10 years. Meanwhile, tax equity providers withdraw from projects after the tax credit benefit ends. This withdrawal leaves developers with the task of restructuring the financial package, adding cost and risk to the project. The PTC policy also curbs the use of cheaper debt instruments. The ratio of debt in American renewable energy projects is much lower than in Germany, China and India. If the ratio of debt were higher in the United States, the overall financial costs would likely drop for the renewable energy sector.

Tax credits can be an expensive policy to maintain for governments. In the United States, The Joint Committee on Taxation (JCT) estimated that foregone revenues (or "tax expenditures") for the PTC were $4.8 billion in 2018 (Sherlock 2018).

SUMMARY OF TAX CREDITS:

– Uncertainty of a policy instrument that relies on regular budget appropriations.
– The problem with 'picking winners'.
– Affordability of the policy, and wider distortionary (sometimes regressive) effects introduced by taxing one part of the economy to finance another.

4.9 NATIONAL CLIMATE FUNDS

National climate funds are funding vehicles designed by governments to mobilize, access, and channel climate finance. National development banks (section 4.6) may host national climate funds, and some funds, such as Ethiopia's Climate Resilient Green Economy Facility, are intended to evolve into full-fledged banks themselves.[10] National climate funds display diversity in their design features, including their legal forms, areas of focus, governance arrangements, and the financial instruments at their disposal. For funds desiring to attract external finance, these design features play an important role in shaping the ability of the fund to win the confidence of fund contributors.

The first wave of national climate funds mostly focused on building awareness of climate change amongst sectoral ministries. By supporting climate-related projects in sectoral ministries, funds such as the Bangladesh Climate Change Resilience Fund and the CRGE Facility of Ethiopia hoped to build capacity on climate programming as well as integrate climate considerations into sectoral planning. In Ethiopia, the CRGE Facility sought to increase the engagement of sectoral ministries by utilizing a network of focal points embedded in each ministry. Evidence suggests that Ethiopia and Bangladesh have had mixed experiences in involving focal points (Bhandary 2019). Their activities are sensitive to the availability of funding, and their placement within the sectoral ministries varies. Overall, the use of focal points has been inconsistent and sporadic. Comparative work on how the network of these focal points can help advance a more coordinated approach to implementing climate policy is an area ripe for further study.

As national climate funds are just one channel amongst a range of other options through which climate finance can flow, developments in the global climate regime have affected the relative attraction of these funds. After the establishment of the Green Climate Fund, donors became highly motivated to re-route their climate finance through the GCF, sometimes at the cost of national climate funds themselves. For national climate funds, reorienting their strategies to access funds from the Green Climate Fund has resulted in both challenges and opportunities. The GCF's requirement for fund recipient entities to demonstrate how they meet standards and safeguards has nudged these funds to demonstrate sound governance. Yet countries like Bangladesh and Ethiopia have found that their approach to climate change policy and programs has not resonated with the GCF's strategy.

Of all of the design features of national climate funds, the fund's trustee is among the most important choices to make. Evidence suggests that there are a number of advantages to having an independent trustee manage a national climate fund (Bhandary 2019). First, independent agencies or banks are able to ensure sound fiduciary risk management, which in turn makes it more likely that the fund is able to attract a larger number of financiers. Second, by vesting the responsibility of the fund to an independent trustee, the government reduces opportunities for political interference. Once visionary patrons of the national climate fund leave office, without the necessary institutional arrangements in place, there is no guarantee that subsequent governments

will not use the fund for other purposes. Third, when projects funded by the national climate fund are tightly coupled with existing policies, they reinforce those policies and create a virtuous cycle of implementation. For example, the Amazon Fund provided substantial funds to support the government's efforts to monitor and enforce actions to reduce deforestation (Amazon Fund 2018).

SUMMARY OF NATIONAL CLIMATE FUNDS:

- Functions range from supply-side measures, such as provision of grants, to demand-side measures, such as awareness raising and capacity building.
- Legal forms of national climate funds vary; an independent trustee is necessary but not sufficient to communicate credibility to donors.
- National climate funds can be linked to climate policies to create virtuous cycles of implementation.

5. Effectiveness of Climate Finance Policies in Practice

Existing research often evaluates the effectiveness of green finance in terms of its contribution to policy goals, to what extent the policy alters the behavior of financiers, or how much finance is mobilized (van Rooijen and van Wees 2006). Other important dimensions of green finance implementation are often intentionally or unintentionally neglected. We establish a more comprehensive set of criteria to evaluate the selected policy instruments (see Table 3), including: 1) mobilization effectiveness in terms of the volume of finance mobilized and to what extent long-term or cheaper finance has been leveraged, 2) economic efficiency, which refers to the cost-effectiveness of the specific policy to shape financial mobilization. 3) environmental integrity (whether the policy leads to real and verifiable emission reductions or improved adaptation capacity); 4) and equity, which refers whether the policy enables equal access to finance among different stakeholders.

The empirical evidence presented in Section 4 is used to evaluate the climate finance policy instruments in this section against these four criteria. Each criterion is examined in turn, and then all of the policies are rated against the criteria based on the empirical evidence presented in Section 3 in Table 4. Recognizing that the evaluation is subjective, we employ a simple qualitative rating system to provide an overall impression of how the policy is performing in practice, providing a check plus (√+), meaning very effective; check (√), meaning effective; or check minus (√-), indicating not very effective, for each criterion.

Table 3: Criteria for evaluating climate finance policy

Criteria	Metric or indicator
Mobilization effectiveness	Volume of finance mobilized; term of finance (long or short), cost of capital
Economic efficiency	Net cost of policy to government or public (cost minus benefit)
Environmental integrity	Emissions reductions or measurable adaptation benefit
Equity	Access to finance by all stakeholders

5.1 MOBILIZATION EFFECTIVENESS

Significant progress has been made to improve the measurement of the volume of private finance leveraged by public green finance. How public finance affects the cost of capital or investor behavior is underexamined. It is challenging to evaluate the effectiveness of green finance policy interventions due to data constraints and methodological issues (i.e., defining accounting boundaries, attributing causality to public interventions, addressing time lags, avoiding double counting) (OECD 2017; McNicoll et al. 2017). Some studies have focused on specific barriers for green finance, mainly the high risks, to evaluate to what extent green finance policy can shape behaviors of financiers or investors (Polzin et al. 2019; Schmidt 2014; Waissbein et al. 2013). Schmidt (2014) identifies how de-risking low carbon investments, through both financial and policy tools, can lead to reductions in the cost of finance. De-risking instruments are especially useful in developing countries where financing costs are usually high. Schmidt (2014) underscores the need for better data to investigate the empirical relationship between de-risking instruments and financing costs. The effectiveness of policy de-risking measures, such as improvements in the enabling environment, is even more challenging to assess given that their impacts take time to materialize. Polzin et al. (2019) find that very effective instruments to incentivize renewable energy investments are those that reduce the risk while increasing the return. According to Waissbein et al. (2013), investing in de-risking measures appears to be cost-effective when measured against paying direct financial incentives to compensate investors for higher risks. Therefore, governments should use scarce public funds to reduce and mitigate risks (e.g., loan guarantees) rather than literally paying for electricity tariffs.

Among the nine policy cases, there is more consensus on the effectiveness of FiTs and NDBs in mobilizing climate mitigation finance relative to the other policies. This is not to say that FiTs are necessarily the best policy tool for achieving the highest rates of installed capacity. FiTs for renewable energy in electric power, even though they are concentrated in a single sector, have attracted the richest study (Couture and Gagnon 2010). Surveys show that FiTs are the favored policy for most investors, including institutional investors (Polzin et al. 2015) and venture capitalists. FiTs are also the

policy measure preferred by investors when it comes to immature technologies because FiTs allow investors to calculate returns for risky technology with certainty.

NDBs have tools at their disposal that can alter the behavior of other financial institutions or investors. As discussed in Section 2, NDBs not only have directly provided concessional finance to firms, but can also leverage more private finance through de-risking and learning spillovers by helping new entrants build track records, or even creating markets that didn't exist before (Geddes, Schmidt, and Steffen 2018; Mazzucato and Penna 2016).

Green bond policies and guidelines have contributed to the emergence of a vibrant green bond market in a number of countries and a correspondingly rapid growth in the volume of green finance. But whether the green bond market has actually reduced the cost of capital for green projects remains disputed. Some emerging studies argue that green bonds can be equally or more competitive than traditional bonds (Partridge and Medda 2018) while others observe a negative premium for green bonds (Shishlov, Morel, and Cochran 2016; Zerbib 2016). Similarly, the lack of internationally-agreed-upon standards for green bonds, along with uneven transparency guidelines, has meant that there is insufficient clarity on how proceeds from green bond issuance are being spent.

The impact of climate disclosure policies on financial mobilization appears to be mixed. Some studies find that disclosure helps by lowering the cost of capital or equity (L. Li et al. 2017; Maaloul 2018), while others find that emissions intensity is positively correlated with a higher cost of debt (Kumar and Firoz 2018). In China, private companies have faced a higher cost of debt than state owned enterprises for the same level of climate risk (Zhou et al. 2018). Carbon disclosure could negatively impact shareholder value as investors believe such information to be bad news about the company (Lee, Park, and Klassen 2015) but in the longer term, disclosure may motivate firms to actively invest in cleaner projects. Others have found that regular or irregular reporting does not affect share prices, but when companies in environmentally intensive industries report frequently, it can affect share price volatility (Bimha and Nhamo 2017). In contrast, Lee et al. (2015) find that firms can mitigate share price volatility through frequent reporting.

Much less research exists on the mobilization effectiveness of loan guarantee and priority lending programs. In the case of the U.S. Department of Energy (DOE)'s loan guarantee program, $35.7 billion in loans and loan guarantees were issued, with $2.69 billion in interest paid and only $810 million in losses as of June 2019 (DOE 2019a). According to DOE's loan program office, the program "continues to attract private investment", and between 2017–2018, 9 projects were acquired either on the open market or via private placement, which in turn "incentivizes developers to allocate capital to new projects" (DOE 2019b). One concern raised early in the history of the loan guarantee program was that loan repayment obligations could actually increase the risks of default for certain projects as loan repayment demands cash flow from early-stage companies at a time when they may already have high cash flow requirements (Brown

2012), but there is no evidence this actually occurred. The loan guarantee program may not have encouraged firms to take sufficient risk from an innovation point of view, and therefore may also not have leveraged new and additional finance, but without a rigorous, independent, assessment it is not possible to determine either way.

There is likewise little empirical evidence about the efficacy of targeted lending from a financial mobilization point of view. Some even dispute whether or not targeted lending policy should be used, but analysts are highly constrained by lack of data. Furthermore, there is the risk of how priority lending policies that require exposure to sectors like agriculture may in fact lead to higher risks for the financial system as a whole. Besides India, China has utilized green priority lending policies, which they label the "green credit" policy. Bai (2011) argues that the green credit policy has proven effective in restricting bank lending to energy-intensive and high-pollution projects within China. Many banks have established their own internal policies and measures for incorporating environmental aspects into current practices. But others have argued that the impact of green credit policy has been limited due to uneven implementation, vague policy details, unclear implementing standards, and lack of environment data (Zhang, Yang, and Bi 2011).

5.2 ECONOMIC EFFICIENCY

The use of public finance to mobilize private investments (often measured by the leverage ratio), and the government's cost of administering the green finance policy are two ways to measure economic efficiency. In general, it was difficult to find publicly available data on compliance and administrative costs and benefits. There are often three types of costs accompanying a specific policy: the cost of setting up the policy, the cost of funding the subsidy needed to energize and sustain the policy, and the transaction costs, which refer to the additional costs incurred by financiers or investors to take advantage of the policy.

Of the nine polices, FiTs and loan guarantee programs have been most questioned regarding their economic efficiency. A typical critique of FiTs is that they lead to higher costs for renewables due to the lack of price competition (Menanteau, Finon, and Lamy 2003). Butler and Neuhoff (2008), however, argue that the German feed-in tariff may have led to cheaper prices paid per wind energy delivered due to greater competition among project developers for good sites (not for prices). Undoubtedly, FiTs can cause costs to accumulate rapidly if the scale of deployment becomes larger than anticipated (Frondel, Ritter, and Schmidt 2008). In both Spain and Germany, the increasing cost burden gradually contributed to political resistance to the feed-in tariff. Studies have found that increases in generation capacity due to the FiT can lead to a decrease in wholesale electricity prices (Clò, Cataldi, and Zoppoli 2015). It is unclear, however, if the wholesale price reductions are steep enough to compensate for the FiT program (Gelabert, Labandeira, and Linares 2011). A key variable in this regard is how externalities (such as carbon) are priced. Similarly, policymakers face

the trade-off between a high tariff that guarantees installation targets will be met but at a high production cost and a low tariff that comes with the uncertainty of how project developers will respond (Drechsler, Meyerhoff, and Ohl 2012). Policy adaptability, therefore, is key.

The empirical evidence about the net cost or benefit of loan guarantee programs for clean energy is thin. The administrative costs incurred by creating and maintaining new institutions and the transaction costs that may be imposed on the lending and borrowing parties could be a disadvantage, but it is not clear how high these costs actually are (Vogel and Adams 1997). Although the Department of Energy's loan guarantee program for advanced manufacturing and cleaner energy was controversial in the United States due to at least one symbolic and public failure, the overall losses for the portfolio were very low at only 2.91% of disbursements (Department of Energy 2019a), and the net benefits have not been calculated, although data do exist about the number of new jobs created and CO_2 emissions avoided that is available on the Department of Energy's loan program office website.

There is almost no research on the economic costs or benefits of the other types of green finance polices, including green bonds, priority lending, NDBs, and information disclosure.

5.3 ENVIRONMENTAL INTEGRITY

The environmental integrity of each green finance policy is assessed based on whether and how much the finance mobilized by the specific green finance policy was used to achieve emissions reductions or adaptation/resilience capacity. The environment integrity of FiT, NDBs, and loan guarantee policies is relatively straightforward, as the sectoral impact of each can be easily measured. Indeed, DOE's loan guarantee program office reports that nearly 50 million metric tons of CO_2 have cumulatively been avoided since 2010 as a result of the program (DOE 2019b). Policy interactions, however, are an important consideration and may impact overall environmental effectiveness. For example, the ability of FiT programs in European countries to contribute towards greenhouse gas mitigation was constrained by the regional emissions trading program (EU ETS) whose targets were not updated frequently enough to reflect the increase in power generation capacity through renewables (Frondel et al. 2010).

The environmental integrity of green bonds has been questioned because of the lack of international standardization in green bond instruments (Agarwal and Singh 2017). Which types of projects are allowed to be financed, and whether they are really green or not, makes a big difference to the final environmental outcomes of the use of green bonds (Agarwal and Singh 2017; Chiang 2017; Wood and Grace 2011). A standardized monitoring and evaluation process would reduce controversy and allegations of "greenwashing." As the largest issuer of green bonds, China could do much more

to validate the environmental benefit of its green bonds. Current guidelines allow technologies which are not recognized internationally (such as "clean coal" plants) to be eligible for green bonds. In 2017, 38% of China's total issuance of green bonds did not meet international norms for being green (Climate Bonds Initiative 2018). Meanwhile, China allows green bond issuers to use up to 50% (versus only 5% for green bonds according to the Climate Bonds Taxonomy) of bond proceeds to repay bank loans and invest in general working capital, which is not necessarily green (ibid).

Significant data and research gaps exist regarding the environmental integrity of the targeted lending and disclosure policy instruments.

5.4 EQUITY

The equity criterion focuses on whether the policy enables equal access to finance among different stakeholders. Equity also refers to the economic and social impacts (welfare) of climate finance policies on both consumers as well as producers. There is increasing concern about the equity impacts of green finance policy, but the existing literature is far from adequate.

Of the nine types of policies, there is relatively more evidence about the distributional impact of feed-in tariffs (Yamamoto 2017). FiTs mitigate risks and therefore enable all renewable energy producers, even small actors, to take advantage of them. But in Germany, trade-sensitive and energy-intensive industries were exempted from paying the surcharge that financed the FiT in an effort to avoid harming their international competitiveness. This exemption allowed some firms but not others to benefit, creating some inequity among firms. Pirnia, Nathwani, and Fuller (2011) argue that the Ontario FiTs had a very large negative impact on consumer welfare, together with a large transfer of wealth to FiT-eligible producers. Similarly, Grösche and Schröder (2014) found that a levy on consumers, proportional to electricity consumption (and not income), led to the FiT having a regressive effect. Nelson, Simhauser, and Kelley (2011) reached a similar conclusion that wealthier households are beneficiaries under the current FiT for residential photovoltaic solar technologies in Australia and the FiTs are generally a regressive form of taxation in most Australian jurisdictions. In addition, FiTs may also lead to perverse effects such as undermining the level of competition between energy producers (Frondel et al. 2010).

There is far too little evidence about the equity impacts of other green finance policies. The case studies revealed that big firms were favored more than small and medium firms in China's green bond market. Under the loan guarantee program in the United States, large and established companies such as Ford were favored with direct loans rather than only loan guarantees. While risk-based pricing methods would be a sensible suggestion for weather insurance, the equity dimension of charging high insurance premiums to highly vulnerable populations also needs to be considered (Picard 2008).

Table 4. Comprehensive assessment and rating of climate finance policy in practice

	Mobilization effectiveness	Economic efficiency	Environmental integrity	Equity
Targeted lending	Insufficient data in general. Directing banks' lending from black sectors to green sectors (China).	The cost of setting up the policy is low and no subsidy is required	Dedicated lending to green sectors (+), renewable energy (+), agriculture (uncertain). How "green" the lending is depends on monitoring and evaluation processes	Meant to address distributional concerns, but insufficient data to evaluate
Rating for targeted lending	n/a, √ (China)	√+	√	n/a
Green bonds	Expanding pool of finance but may not necessarily reduce capital costs.	The cost of setting up the policy is low, and no subsidy is required.	Depends on definitions and monitoring and evaluation processes	Big players are favored and small and medium firms are marginalized
Rating for green bonds	√ /√+	√+	√– (China)	√–
Loan guarantees	De-risks low-carbon projects and induces private investments	An institution to manage the program must be created. Subsidies are required but may not be required if no defaults occur. Transaction costs can be high for firms.	Depends on the eligibility definition of the policy	Most of the money has gone to large and established companies rather than startups.
Rating for loan guarantees	√+	√	√+	√
Weather index-based insurance	Insufficient data	Insufficient data	Insufficient data	Equal opportunity for SMEs and private households
Rating for weather indexing	n/a	n/a	n/a	√
Feed-in-tariff (FiT)	Mobilizes private finance very effectively	Requires substantial subsidies	Clear definition of eligible technologies	Depends on design. Can burden consumers or taxpayers more than firms.

Table continues on next page.

Table 4. *Continued*

	Mobilization effectiveness	Economic efficiency	Environmental integrity	Equity
Rating for FiT	√+	√–	√+	√
National development banks (NDB)	Expands pool of available finance and increases provision of long-term finance	The cost of setting up the policy is low if an NDB is already available, and only a small subsidy is required	Depends on what is supported but can be very beneficial to national firms	All depends on who is supported, but evidence suggests that SMEs can be targeted effectively
Rating for NDBs	√+	√+	√+ (KfW) √– (CDB)	√+
Disclosure Policies	Impacts on firms can be mixed. Unclear at national or subnational level.	The cost of setting up the policy is low. Implementation costs to ensure compliance may be high in certain cases.	Information not necessarily usable to investors	Insufficient data
Rating for disclosure policies	√/√–	√+/√-	√	n/a
Tax credit policy	Can mobilize private finance, but sufficient tax liability is required	Costly to government budget	Can be effective at spurring deployment or uptake of certain technologies depending on design. Additionality can be questioned.	Equal access but can be regressive depending on design
Rating for tax credits	√	√–	√/√+	√+
National climate funds	Huge variability. Very high in some instances where high credibility, very low in others	Administrative and transaction costs can be high. Trusteeship can add cost.	Strong benefits have been identified if fund is operational	Depends on design because agency of national government can be high or low depending on degree of autonomy from donors
Rating for national climate funds	√– (Indonesia) √+ (Brazil)	√	√	√

Tax credits are equally available to all, but one must have a big enough tax burden to take advantage of them. Lower income households or small firms may not have a sufficiently large tax liability to be able to benefit from tax credit policy instruments, so they can be somewhat regressive by primarily conferring benefits to wealthier households and firms. The additionality of tax credits can be questioned for wealthier firms and households as well. In other words, would they have made the purchase or investment anyway?

6. Design Features of Climate Finance Policies

Specific aspects of policy design and implementation strongly shape how effective an individual climate finance policy is in practice. The effectiveness of policies to stimulate renewable energy, for example, is best guaranteed if policy objectives and instruments are clear and stable over time (van Rooijen and van Wees 2006). Any uncertainty regarding goals, vision, or future direction will reduce the effectiveness of policies at mobilizing investment requiring multi-year payback periods.

Frequent shifts in policy negatively impact climate finance, as investors face uncertainties about the direction of policy and cannot calculate a predictable return on investment. In terms of predictability, the feed-in tariff is probably the leading climate-finance policy instrument because it is considered the most likely to secure financial revenue for the duration of the policy (because it is always clarified up front). Despite the long-term clarity of FiTs in their policy design, it is clear that, in practice, they cannot always be counted upon by investors since some governments, most infamously Spain's, had to unexpectedly reduce or cancel their FiTs due to very high costs.

The policy lesson to be learned is to anticipate that there may be reductions in technology costs (which means that a lower subsidy is needed) or that the production of renewable energy may be higher than was anticipated (economies of scale effect) in which case the public cost burden may become be too high. In either case, a well-designed policy could anticipate such events and schedule reviews based on triggers so that if the technology cost goes down, for example, the subsidy would likewise go down. These lessons indicate that financial sustainability is also a key feature of effective green finance policy. Van Rooijen and van Wees (2006) also emphasizes the importance of serious stakeholder participation in the design.

If the influence of stakeholders in renewable energy policymaking had been stronger in the past, it is likely that suggestions for policy improvements would have been implemented earlier. In the United States, for example, the production tax credit for renewable energy has been notoriously unstable. The renewable energy industry experienced many boom and bust cycles as a result. A further consequence of these

cycles was the loss of manufacturing capacity and associated jobs. Industry, labor, and environmental stakeholder participation in the design of the PTC policy would likely have anticipated the problems that ensued.

Simplicity, clarity and transparency are also important design features of good green finance policies. Another success of the FiT in Germany was that it was framed in such an understandable and transparent way that investors could be easily mobilized at scale. Due to the poor transparency of the U.S. loan guarantee program, however, many firms were not sure they were eligible or that they would be selected. Lack of transparency also makes such programs vulnerable to political interference or even pure corruption, which obviously results in less-than-optimal decision making (Brown 2012). Index-based insurance products are often difficult for consumers to understand so its uptake by buyers is weak (Linnerooth-Bayer and Hochrainer-Stigler 2015).

The mechanism by which a policy is implemented and enforced is crucial for the credibility of the policy. One fundamental criticism of the U.S. loan guarantee program was the lack of transparency in the selection process, which made it vulnerable to accusations that the government was picking winners rather than establishing a market-based mechanism. The effectiveness of targeted lending can be undermined when allocations are subject to political gaming and moral hazard problems (Calomiris and Himmelberg 1994; Vittas and Wang 1991). Lessons from earlier programs include the need for targeted lending programs to be bounded in scope, channeled through institutions that are sound, and subject to clear and transparent review criteria (Vittas and Cho 1995; Narayanan 2016). Creation of political autonomy is especially important to ensure equality of access and the durability of policy.

Consistency and coordination among different climate finance policies, and coordination between financial and environmental policies, are also key to the achievement of policy goals. For instance, NDBs are highly sensitive to the enabling policy framework of their government. Clear policy objectives, targets, frameworks, and guidelines are key to their success. A combination of market-based and fiscal incentives used together with regulatory measures such as codes and standards could further strengthen the effectiveness of clean energy investments, especially when all are placed in the context of a longer-term strategic plan (Polzin et al. 2015). Notably, consistency between climate finance policy and macro financial policies is important too. The macro-level requirement for banks to control risk can create challenges for targeted lending requirements, for example.

Table 5. Comparisons of key features of climate finance policy in practice

	Stability and Durability	Simplicity	Transparency	Consistency and coordination	Adaptability
Targeted lending	Can be stable, difficult to remove	Clarity in terms of sectoral coverage	Usually lacking in transparency	Consistent in priority sectors	Easy to adapt as new sectors are targeted
Green bond policy	Once the market is established, green bonds appear to be durable	Definitions and standards are still needed in most countries.	Usage of bond proceeds is usually not disclosed.	Lack of consistency on definition of green bond across countries. Usually uncoordinated with other policies.	Adaptable because bonds can be issued for any type of investment. Standardization of definitions will still be needed.
Loan guarantee program	Fiscal nature makes it highly sensitive to politics and budget allocations	The application process is complicated, especially for SMEs	Low transparency regarding the selection process. The U.S. program was plagued by accusations of political interference	Consistency depends on budget authorization. Some degree of coordination with other policies in the United States (e.g. fuel efficiency standards for vehicles)	Can be revised if goals are achieved (e.g. decide not to issue new guarantees for certain technologies)
Weather indexed insurance	Once the market is built, it can be durable	Insurance contract, which is index-based, is hard to understand.	Insufficient data	Consistent where it exists, but unevenly available across countries. No evidence of coordination with other policies.	Can be adapted for each insurance policy renewal
Feed-in-tariff	Typically established by law and therefore stable	The standard contract for feed-in tariffs is typically short and easy to understand.	Policy information is usually readily available on government websites and other platforms	Consistent unless cost of policy becomes overwhelming and then unexpected changes to policy occur. Coordination with other policies such as portfolio standards.	Can be revised if reviews and revisions are planned up front, either through the use of triggers or use of regular calendar reviews

Table continues on next page.

Table 5. *Continued*

	Stability and Durability	Simplicity	Transparency	Consistency and coordination	Adaptability
National development banks	Stable, but their priorities are subject to government goals and objectives	The application process is simple.	Information is usually readily available on NDB bank websites	Very consistent, highly coordinated with other policies	Can adjust their investment portfolios according to government priorities
Disclosure Policies	Stable but incomplete	Should be simple but lack of standardization and enforcement	Uneven enforcement has resulted in little data that is publicly available	Inconsistency across companies and countries, uncoordinated with other policies	Standardization is necessary, which will make adjustments harder, but not impossible if they are regularly updated
Tax credits	Fundamentally unstable and subject to politics	Sometimes hard to determine eligibility, can be complex	Information is usually readily available on government websites	Consistent due to clear eligibility requirements, not coordinated with other policies	Can be adjusted with each fiscal year
National climate funds	Mixed record of stability	Depends on disclosure	Mixed	Inconsistent due to dependence on various funding sources. Some are highly coordinated with other policies, others are not.	Can be adjusted depending on the autonomy of the fund

Policies and their effectiveness cannot be studied in isolation, but need to be considered in a broader national policy context, including investment and development (Corfee-Morlot et al. 2012). Abdmouleh, Alammari and Gastli (2015) also echo this argument and claim that most countries adopt a 'policy package' approach, rather than choosing stand-alone policies. Since this mechanism works in the interactive mode, success or failure of one individual policy will depend on the effectiveness of other complementary policies. Moreover, other political, social and economic factors contribute to the impact of these policies.

National macro-economic policy and financial system health can also shape the empirical performance of certain green finance policies. For instance, the growth of a big green bond market requires both a mature bond market and supportive policies aimed at reducing the capital market bias for conventional power generation technologies (Meng, Lau, and Boulle 2018; Ng and Tao 2016; Wang and Zhang 2017). Lack of environment and climate data, as well as lack of ratings, indices, and listings

discourage green bond and green insurance. Studies are consistent in stressing the need for intermediary organizations that can market green insurance products (Hazell et al. 2010; Chantarat et al. 2015; Warner et al. 2013). If insurance service providers have to reach households themselves, the transaction costs would make the premiums prohibitively expensive. As social networks foster trust, they may also help to increase the uptake of climate insurance products (Trærup 2012). Research has also found that private insurance providers may not be willing to enter the market with products that can be easily replicated. Packaging index-based insurance with other financial products such as rural savings programs could reduce transaction costs as well as reduce basis risk (Chantarat et al. 2015). A key challenge if the capital pool is small is that the insurance providers will need access to reinsurance to back up the capital. As reinsurance can be highly expensive, and out of reach of farmers in developing countries, Meze-Hausken et al. (2009) have found that pooling insurance programs from different geographic locations can help provide the necessary capital pool provided that they are not exposed to similar climate risks (Meze-Hausken, Patt, and Fritz 2009).

Finally, there is also a concern that climate change itself may create challenges for certain green finance policies. For instance, climate change poses challenges for index insurance, particularly slow onset events. With climate change, insurers may be underestimating future risks due to expected variability. The viability of insurance models is thus in question.

7. Findings and Knowledge Gaps

What works and what doesn't work in climate finance policy?

There is no policy "silver bullet" because climate finance policies work best when they are nested in a coherent and aligned set of policies aimed at the achievement of climate-related goals. The impact of climate finance policies depend on the details of policy design, characteristics of the local market, country conditions (including macroeconomic conditions, institutional structures, and the maturity of the country's financial system), and the cost of and familiarity with the technologies that are being deployed in that country. Because all of the above conditions can change over time, climate finance policymaking should be a dynamic process and regular reviews of the efficacy of climate finance policies should be conducted and revisions made, as appropriate.

That being said, it is clear that some climate finance policies are more effective than others depending on the criteria being used to evaluate them. Feed-in tariffs, tax credits, loan guarantees, and national development banks are all effective at mobilizing private finance, but some of them come at considerable cost. National climate funds, targeted lending, disclosure, and green bonds could all theoretically be effective policy instruments, but evidence to date is either weak or thin due to specific policy design decisions or lack of available data to properly evaluate them.

Climate finance policies that work best are those that are (1) stable and predictable, (2) clear, understandable, and transparent to stakeholders, (3) consistent and aligned with other relevant climate and financial policies, (4) protected from the influence of political pressure, and (5) dynamic and adaptive so that climate finance policies influence the market at the right time and phase down and out as appropriate to ensure that public finance crowds in private finance.

Success in climate finance policy not only includes the mobilization of additional finance, but also the achievement of climate goals (environmental integrity), minimization of public cost (economic efficiency), and careful incorporation of equity (fairness) considerations. In fact, establishing criteria to measure the success or failure of climate finance policy should be something that all governments routinely do when designing new or reforming old climate finance policies.

National experience with different climate finance policies has been mixed, in part because some of the policy instruments (e.g. weather indexed insurance, climate bonds) are relatively new. Pros and cons exist for each policy type as elucidated in Table 6, so there is no perfect policy instrument. Feed-in tariffs and tax credits can work well to mobilize private climate finance due to their superior clarity, but they can be very costly to implement. Loan guarantees and national development banks have both proven very effective at mobilizing climate finance, but both are vulnerable to the political priorities of the prevailing government. Targeted lending and disclosure policies could prove to be successful climate policy tools in the future, but insufficient evidence currently exists about their efficacy. Green bonds appear to be growing very rapidly but their lack of standardization internationally hinders their environmental integrity.

Climate finance policy is currently highly skewed towards mitigation. Climate finance policy for adaptation and resilience measures is almost non-existent so there are few known examples of how private finance was mobilized through policies other than the emerging evidence on weather-indexed insurance. The evidence base must grow to be able to evaluate climate finance policy for adaptation/resilience going forward.

Table 6. Pros and cons of climate finance policy instruments

Policy instrument	Pros	Cons
Feed in tariff	Mobilization of finance, environmental integrity,* transparency	Economic cost
Tax credit	Mobilization of finance, environmental integrity,* transparency, equal access,	Instability, economic cost, can benefit bigger/wealthier firms
Loan guarantee	Mobilization of finance, environmental integrity*, can be inexpensive	Vulnerable to political influence, can benefit bigger/wealthier firms
National development banks	Mobilization of finance, environmental integrity,* can benefit SMEs or neglected sectors	Vulnerable to political influence
Targeted lending	Mobilization of finance, environmental integrity,* can benefit SMEs or neglected sectors	Vulnerable to political influence
Disclosure	Transparency	Mobilization of finance, environmental integrity is unclear
Green bonds	Mobilization of finance, can be inexpensive	Environmental integrity unclear due to lack of standardization
Weather index-based insurance	Administrative ease, addressing adaptation need	Mobilization of finance unclear
National climate fund	Gives country a degree of autonomy and credibility, mobilization of finance, environmental integrity	Mobilization of finance, vulnerable to political influence unless insulated or autonomous

**If climate-friendly sectors or technologies are targeted*

7.1 KNOWLEDGE GAPS

Numerous challenges emerge when one tries to empirically assess the impacts of climate finance policy. The biggest problem is the lack of data availability from the private sector (Chawla and Ghosh 2019). Public sector expenditures are easier to track because they are usually reported in the context of national budgeting processes, but even then, sometimes the public investments are not transparently reported. A consequence of the lack of data availability is the inability to ensure that there is no double counting. In order to enhance the effective assessment of climate finance policy, governments and firms alike should work to improve transparent disclosure of data about climate finance expenditures and investments. Specifically, all governments could address this gap by producing an annual report that specifies how much funding was used to support different types of climate finance (both mitigation and adaptation)

domestically *and* internationally. To the extent that the government is aware of mobilizing commercial finance, then it should report that too.

A second knowledge gap that exists, in part due to data deficiencies, is whether there is a "crowd-out" or a "crowd-in" effect for specific green finance policies. In other words, does public sector finance dis-incentivize private sector finance or does it attract it? Traditionally, the public finance literature has posited that public funding might crowd out private investments rather than crowd it in, which could lead to capital allocation inefficiencies (Cumming and MacIntosh 2006; Stiglitz 1994; Lazzarini et al. 2014). On the other hand, most of the evidence reviewed in this paper suggests that public policies, including provision of some types of public finance, actually crowd in private investments by reducing commercial risk. We find that policies can reduce commercial risk in two main ways: by reducing the cost of capital and by demonstrating commercial viability for certain climate-related technologies. In short, we do not yet find compelling evidence for the hypothesis that public finance crowds out private climate finance.

It is also essential to clarify in which areas concessional climate finance is still needed. The theoretical justification for concessional climate finance is that some cleaner or more resilient technologies are more expensive than dirtier or less resilient technologies, and that therefore, they should be subsidized. With the rapid declines in the costs of wind and solar, for example, the incremental costs of these technologies have nearly evaporated in many (but not all) countries. Yet, because these renewable energy technologies are intermittent, their complementary technologies (e.g. energy storage) are often a necessity yet still out of reach. Where there is no need for subsidies and concessional finance, climate finance could be freed up for more pressing concerns. How and when to remove public support for certain technologies or interventions is a key question deserving of more research.

Specific to some of the individual climate finance policies examined in this paper, we identify some particular knowledge gaps as follows:

- When should national development banks, as a crucial source of public finance, phase out their support for low-carbon industries so that private investments flow in?
- If priority lending results in a greater uptake of agriculture loans, but the underlying returns are highly sensitive to climate impacts, how do stress tests factor this in? In instances that have been reported on the contraction of credit upon removal of targets, why did that occur? How does the domestic market (level of competitiveness) determine the impact of these policies (Zinman and Karlan 2009)? And, how do lending requirements impact the banks themselves?
- The relationship between targeted lending policies and green finance policy outcomes is not clear. The IMF has expressed concern about priority sector lending policies distorting the risk-based credit allocation processes of bank arguing that such policies build systemic risk in the financial system. A clear area for further

research is the extent to which directed lending policies in fact do increase systemic risk in the system, how they affect the credit allocation processes, and the impact of withdrawing directed lending programs on credit availability in those sectors. As directed lending programs can be geared towards achieving multiple objectives such as financial inclusion, there are methodological challenges to understanding impact (Kochar 2011). The cost of customer acquisition under the targeted lending program may also become high.

- Does risk associated with green bonds discourage foreign investment? If so, why do countries set up their own definitions of green bonds rather than adopting international standards for green bonds? Why do countries avoid adherence to international norms in green bonds, and how could they be harmonized?

- There are a number of clear gaps in the existing literature on information disclosure. First, how climate disclosures impact the firm has received inadequate attention (Hahn, Reimsbach, and Schiemann 2015). Relatedly, most of the literature focuses on limited time horizons (for an example of a longitudinal analysis, see Doran and Quinn (2009). Second, how can climate disclosures be useful? Gaps in the literature point to the importance of granularity in what is reported and the consistency of reporting. Third, while the literature finds a significant influence from peer firms, how national policies drive disclosure need to be examined. Fourth, the existing literature largely focuses on companies, but it is important to include cities or other government jurisdictions in the analysis (Mia, Hazelton, and Guthrie 2018). Finally, the primary assumption that information disclosure leads to better asset allocation needs to be examined and evaluated in finer detail. Do investment managers actually have the incentives to make allocation decisions on the basis of the long-term underlying risks if their incentives are driven by short-term market returns?

- A key knowledge gap lies in the limited understanding of the interaction between insurance policies, production decisions such as agricultural input use, and climate forecasts interact (Carriquiry and Osgood 2012). For example, the availability of climate forecasts can introduce challenges in terms of how insurance products are priced. If insurance products are priced before farmers have access to climate forecasts, "adverse selection" problems inevitably will occur. Information asymmetries will be hard to avoid. Furthermore, as reinsurance companies price their products using seasonal climate information, insurance providers need to be able to reflect sensitivity to such prices in order to be sustainable.

7.2 POLICY IMPLICATIONS

In order to truly mobilize climate finance at the scale that is required, all development aid, economic development measures, and infrastructure investment would have to be "climate proofed". In other words, climate considerations would need to be mainstreamed into all investment decisions in both the public and private sector and if this was done, then the painstaking work of improving the measurement and tracking of climate finance would not be necessary. This mainstreaming or climate-proofing will not occur without new public policies. Policy would need to correct for market failures in financial markets, particularly with respect to information asymmetries. Even more important would be to nest climate finance policies in a comprehensive set of regulatory, fiscal, industrial, market-based, and other climate change policies that disincentivize investment in polluting technologies and incentivize investment in low or zero-carbon technologies. This reality points to the need for comprehensive policy support in developing countries to create the policy institutions that will steer international climate finance providers away from project-by-project boutique approaches to actually achieving scale.

A few specific policy implications emerge from the findings of this paper. First, lack of government regulation can inhibit effective mobilization of climate finance. The lack of commonly agreed, enforceable international standards for green bonds, for example, has called into question whether or not these bonds are truly green. When policies do exist, they need to be enforced to be effective. The uneven enforcement of the disclosure rules of U.S. Security and Exchange Commission is a good example of this problem. Some of the climate finance policies reviewed in this paper have proven economically costly. To make government funds go further, it may be wiser for governments to choose instruments that reduce and mitigate risks, such as loan guarantees, national development banks, targeted lending, or national climate funds. Technological change is inherently dynamic and often disruptive to markets. Climate finance policies must anticipate change and be able to be responsive to it. Lack of stakeholder participation in policymaking processes can lead to sub-optimal decision making. Wider engagement is likely to lead to identification of probable challenges, which in turn can lead to improved policy decisions.

Finally, will climate change itself undermine the effectiveness of climate finance policies? If financial investments are not considered in the context of future climatic change, they are vulnerable. There is some emerging evidence already that investments in carbon-intensive technologies in some countries have become stranded. New coal-fired power plants in the United States, for example, do not appear to be able to compete with natural gas or renewables in some regions purely on market grounds, setting aside the additional social costs of carbon. Much less studied is whether investments in infrastructure are resilient to future climate change. For example, a new commercial development in a low-lying coastal area will be vulnerable to sea-level rise. Even if that commercial development was built to very high standards in terms of energy efficiency and green building principles using climate finance, if the whole development is vulnerable to climate change itself, it may turn out to be a poor investment.

References

Abdmouleh, Zeineb, Rashid A. M. Alammari, and Adel Gastli. 2015. "Review of Policies Encouraging Renewable Energy Integration & Best Practices." *Renewable and Sustainable Energy Reviews* 45 (May): 249–62. https://doi.org/10.1016/j.rser.2015.01.035.

Agarwal, Swati, and Tamiksha Singh. 2017. "Unlocking the Green Bond Potential in India." TERI. https://www.teriin.org/projects/nfa/files/Green-Bond-Working-Paper.pdf.

Amazon Fund, 2018. 2018. "Amazon Fund Activity Report 2017." Amazon Fund. http://www.amazonfund.gov.br/export/sites/default/en/.galleries/documentos/rafa/RAFA_2017_en.pdf.

Amran, Azlan, Vinod Periasamy, and Abdul Hadi Zulkafli. 2014. "Determinants of Climate Change Disclosure by Developed and Emerging Countries in Asia Pacific." *Sustainable Development* 22 (3): 188–204. https://doi.org/10.1002/sd.539.

Andrew, Jane, and Corinne Cortese. 2011. "Accounting for Climate Change and the Self-Regulation of Carbon Disclosures." *Accounting Forum*, Special issue: Social and Environmental Accounting and Accountability, 35 (3): 130–38. https://doi.org/10.1016/j.accfor.2011.06.006.

Baboukardos, Diogenis. 2017. "Market Valuation of Greenhouse Gas Emissions under a Mandatory Reporting Regime: Evidence from the UK." *Accounting Forum* 41 (3): 221–33. https://doi.org/10.1016/j.accfor.2017.02.003.

Bai, Yunwen. 2011. "Financing a Green Future: An Examination of China's Banking Sector for Green Finance." *IIIEE Master Thesis*. http://lup.lub.lu.se/student-papers/record/2203222.

Barroco, Jose, and Maria Herrera. 2019. "Clearing Barriers to Project Finance for Renewable Energy in Developing Countries: A Philippines Case Study." *Energy Policy* 135 (December): 111008. https://doi.org/10.1016/j.enpol.2019.111008.

Belden, Andrew, Steven Clemmer, and Kathryn Wright. 2015. "Financing Clean Energy: Cost-Effective Tools for State Compliance with the Clean Power Plan." Union of Concerned Scientists. https://www.ourenergypolicy.org/wp-content/uploads/2015/07/financing-clean-energy.pdf.

Bhandary, Rishikesh Ram. 2019. "Viruses and Venus Fly Traps: Explaning the Design and Effectiveness of National Climate Funds." Medford, MA: Tufts University.

Bimha, Alfred, and Godwell Nhamo. 2017. "Sustainable Development, Share Price and Carbon Disclosure Interactions: Evidence From South Africa's JSE 100 Companies." *Sustainable Development* 25 (5): 400–413. https://doi.org/10.1002/sd.1670.

Brown, Phillip. 2012. "Loan Guarantees for Clean Energy Technologies: Goals, Concerns, and Policy Options." R42152. Congressional Research Service. https://fas.org/sgp/crs/misc/R42152.pdf.

Bürer, Mary Jean, and Rolf Wüstenhagen. 2009. "Which Renewable Energy Policy Is a Venture Capitalist's Best Friend? Empirical Evidence from a Survey of International Cleantech Investors." *Energy Policy* 37 (12): 4997–5006.

Butler, Lucy, and Karsten Neuhoff. 2008. "Comparison of Feed-in Tariff, Quota and Auction Mechanisms to Support Wind Power Development." *Renewable Energy* 33 (8): 1854–67. https://doi.org/10.1016/j.renene.2007.10.008.

Calomiris, Charles W., and Charles P. Himmelberg. 1994. "Directed Credit Programs for Agriculture and Industry: Arguments from Theory and Fact." Working Paper 14336. World Bank. http://documents.worldbank.org/curated/en/968051468739802512/pdf/multi-page.pdf.

Carriquiry, Miguel A., and Daniel E. Osgood. 2012. "Index Insurance, Probabilistic Climate Forecasts, and Production." *Journal of Risk and Insurance* 79 (1): 287–300. https://doi.org/10.1111/j.1539-6975.2011.01422.x.

CDP. 2018. "Major Risks or Rosy Opportunity: Are Companies Ready for Climate Change?" CDP. https://6fefcbb86e61af1b2fc4-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/004/588/original/CDP_Climate_Change_report_2019.pdf?1562321876.

Ceres. 2019. "Disclose What Matters: Bridging the Gap Between Investor Needs and Company Disclosures on Sustainability." Ceres. https://www.ceres.org/sites/default/files/reports/2018-08/Ceres_DiscloseWhatMatters_Final.pdf.

Chantarat, Sommarat, Krirk Pannangpetch, Nattapong Puttanapong, Preesan Rakwatin, and Thanasin Tanompongphandh. 2015. "Index-Based Risk Financing and Development of Natural Disaster Insurance Programs in Developing Asian Countries." In *Resilience and Recovery in Asian Disasters: Community Ties, Market Mechanisms, and Governance*, edited by Daniel P. Aldrich, Sothea Oum, and Yasuyuki Sawada, 171–200. Risk, Governance and Society. Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-55022-8_9.

Chawla, Kanika, and Arunabha Ghosh. 2019. "Greening New Pastures for Green Investments." Issue Brief. Council on Energy, Environment and Water. https://www.ceew.in/sites/default/files/CEEW-Greener-Pastures-for-Green-Investments-20Sep19.pdf.

Cherrington, R., V. Goodship, A. Longfield, and K. Kirwan. 2013. "The Feed-in Tariff in the UK: A Case Study Focus on Domestic Photovoltaic Systems." *Renewable Energy* 50 (February): 421–26. https://doi.org/10.1016/j.renene.2012.06.055.

Chiang, John. 2017. "Growing the U.S. Green Bond Market: Volume 1: The Barriers and Challenges." https://www.treasurer.ca.gov/greenbonds/publications/reports/green_bond_market_01.pdf.

Clement, Kristina Yuzva, W. J. Wouter Botzen, Roy Brouwer, and Jeroen C. J. H. Aerts. 2018. "A Global Review of the Impact of Basis Risk on the Functioning of and Demand for Index Insurance." *International Journal of Disaster Risk Reduction* 28 (June): 845–53. https://doi.org/10.1016/j.ijdrr.2018.01.001.

Climate Bonds Initiative. 2017. "Bonds and Climate Change: The State of the Market in 2017." Climate Bonds Initiative. https://www.climatebonds.net/files/files/CBI-SotM_2017-Bonds%26ClimateChange.pdf.

———. 2018. "China Green Bond Market 2018." Climate Bonds Initiative. https://www.climatebonds.net/files/reports/china-sotm_cbi_ccdc_final_en260219.pdf.

Clò, Stefano, Alessandra Cataldi, and Pietro Zoppoli. 2015. "The Merit-Order Effect in the Italian Power Market: The Impact of Solar and Wind Generation on National Wholesale Electricity Prices." *Energy Policy* 77 (February): 79–88. https://doi.org/10.1016/j.enpol.2014.11.038.

Collier, Benjamin, Jerry Skees, and Barry Barnett. 2009. "Weather Index Insurance and Climate Change: Opportunities and Challenges in Lower Income Countries." *The Geneva Papers on Risk and Insurance - Issues and Practice* 34 (3): 401–24. https://doi.org/10.1057/gpp.2009.11.

Corfee-Morlot, Jan, Virginie Marchal, Céline Kauffmann, Christopher Kennedy, Fiona Stewart, Christopher Kaminker, and Géraldine Ang. 2012. "Towards a Green Investment Policy Framework: The Case of Low-Carbon, Climate-Resilient Infrastructure." OECD Environment Working Papers 48. https://doi.org/10.1787/5k8zth7s6s6d-en.

Cotter, Julie, and Muftah M Najah. 2012. "Institutional Investor Influence on Global Climate Change Disclosure Practices." *Australian Journal of Management* 37 (2): 169–87. https://doi.org/10.1177/0312896211423945.

Couture, T. 2013. "Pain in Spain: New Retroactive Changes Hinder Renewable Energy." Renewable Energy World. April 19, 2013. https://www.renewableenergyworld.com/2013/04/19/pain-in-spain-new-retroactive-changes-hinders-renewable-energy/.

Couture, T.D., K. Cory, and C. Kreycik. 2010. "A Policymaker's Guide to Feed-in Tariff Policy Design." National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy10osti/44849.pdf.

Couture, Toby, and Yves Gagnon. 2010. "An Analysis of Feed-in Tariff Remuneration Models: Implications for Renewable Energy Investment." *Energy Policy* 38 (2): 955–65.

Cowling, Marc, and Peter Mitchell. 2003. "Is the Small Firms Loan Guarantee Scheme Hazardous for Banks or Helpful to Small Business?" *Small Business Economics* 21 (1): 63–71.

CPI. 2018. "Global Climate Finance: An Updated View 2018." Climate Policy Initiative. https://climatepolicyinitiative.org/wp-content/uploads/2018/11/Global-Climate-Finance-An-Updated-View-2018.pdf.

CPI and IDB. 2017. "National Development Banks and Green Banks: Key Institutions for Mobilizing Finance Towards the Implementation of Nationally Determined Contributions (NDCs) and the Accomplishment of the Sustainable Development Goals. Key Findings from Mexico City Workshop." Climate Policy Initiative and Inter-American Development Bank. https://www.greenfinancelac.org/wp-content/uploads/2018/04/FINAL-DIGITAL-Key-Findings-for-IDB-NDBs-GIBs-Workshop-1.pdf.

Cumming, D.J. and MacIntosh, J.G. 2006. "Crowding Out Private Equity: Canadian Evidence." *Journal of Business Venturing* 21(5): 569–609. http://www.sciencedirect.com/science/article/pii/S0883-9026(05)00054-6.

Dawkins, Cedric, and John W. Fraas. 2011. "Coming Clean: The Impact of Environmental Performance and Visibility on Corporate Climate Change Disclosure." *Journal of Business Ethics* 100 (2): 303–22. https://doi.org/10.1007/s10551-010-0681-0.

Department of Energy. 2019a. "A Year of Continued Impact: Annual Portfolio Status Report. FY2018. Loan Program Office." Loan Programs Office, Department of Energy. https://www.energy.gov/sites/prod/files/2019/09/f67/DOE-LPO_FY2018_APSR_FINAL.pdf.

———. 2019b. "Investing in American Energy." Loan Programs Office, Department of Energy. https://www.energy.gov/sites/prod/files/2015/09/f26/loans-program-office.pdf.

Doran, Kevin L., and Elias Leake Quinn. 2009. "Climate Change Risk Disclosure: A Sector by Sector Analysis of SEC 10-K Filings from 1995-2008." SSRN Scholarly Paper ID 1416279. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=1416279.

Drechsler, Martin, Jürgen Meyerhoff, and Cornelia Ohl. 2012. "The Effect of Feed-in Tariffs on the Production Cost and the Landscape Externalities of Wind Power Generation in West Saxony, Germany." *Energy Policy*, Special Section: Frontiers of Sustainability, 48 (September): 730–36. https://doi.org/10.1016/j.enpol.2012.06.008.

Dusonchet, Luigi, and Enrico Telaretti. 2010. "Economic Analysis of Different Supporting Policies for the Production of Electrical Energy by Solar Photovoltaics in Western European Union Countries." *Energy Policy* 38 (7): 3297–3308. https://doi.org/10.1016/j.enpol.2010.01.053.

Dutt, Arjun, Abhinav Soman, Kanika Chawla, Neha Kumar, Sandeep Bhattacharya, and Prashant Vaze. 2019. "Financing India's Energy Transition: A Guide on Green Bonds for Renewable Energy and Electric Transport." Council on Energy, Environment and Water. https://www.ceew.in/sites/default/files/CEEW-Financing-India-Energy-Transition-A-Guide-on-Greenbonds-17Jun19.pdf.

Eccles, Robert G., Michael P. Krzus, Jean Rogers, and George Serafeim. 2012. "The Need for Sector-Specific Materiality and Sustainability Reporting Standards." *Journal of Applied Corporate Finance* 24 (2): 65–71. https://doi.org/10.1111/j.1745-6622.2012.00380.x.

Ehlers, Torsten, and Frank Packer. 2017. "Green Bond Finance and Certification," September. https://www.bis.org/publ/qtrpdf/r_qt1709h.htm.

Eyraud, Luc, Benedict Clements, and Abdoul Wane. 2013. "Green Investment: Trends and Determinants." *Energy Policy* 60 (September): 852–65. https://doi.org/10.1016/j.enpol.2013.04.039.

Field, Laura Casares, Michelle Lowry, and Susan Shu. 2004. "Does Disclosure Deter or Trigger Litigation?" SSRN Scholarly Paper ID 604683. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=604683.

Flåm, K.H., and J.B. Skjaerseth. 2009. "Does Adequate Financing Exist for Adaptation in Developing Countries?" *Climate Policy* 9 (1): 109–14. https://doi.org/10.3763/cpol.2008.0568.

Frondel, Manuel, Nolan Ritter, and Christoph M. Schmidt. 2008. "Germany's Solar Cell Promotion: Dark Clouds on the Horizon." *Energy Policy* 36 (11): 4198–4204. https://doi.org/10.1016/j.enpol.2008.07.026.

Frondel, Manuel, Nolan Ritter, Christoph M. Schmidt, and Colin Vance. 2010. "Economic Impacts from the Promotion of Renewable Energy Technologies: The German Experience." *Energy Policy* 38 (8): 4048–56. https://doi.org/10.1016/j.enpol.2010.03.029.

Gallagher, Kelly Sims, and Erich Muehlegger. 2011. "Giving Green to Get Green? Incentives and Consumer Adoption of Hybrid Vehicle Technology." *Journal of Environmental Economics and Management* 61 (1): 1–15.

Gallagher, Kelly Sims, and Xiaowei Xuan. 2018. *Titans of the Climate: Explaining Policy Process in the United States and China*. American and Comparative Environmental Policy. Cambridge, Massachusetts: The MIT Press.

Gasbarro, Federica, and Jonatan Pinkse. 2016. "Corporate Adaptation Behaviour to Deal With Climate Change: The Influence of Firm-Specific Interpretations of Physical Climate Impacts." *Corporate Social Responsibility and Environmental Management* 23 (3): 179–92. https://doi.org/10.1002/csr.1374.

Geddes, Anna, Tobias S. Schmidt, and Bjarne Steffen. 2018. "The Multiple Roles of State Investment Banks in Low-Carbon Energy Finance: An Analysis of Australia, the UK and Germany." *Energy Policy* 115 (April): 158–70. https://doi.org/10.1016/j.enpol.2018.01.009.

Gelabert, Liliana, Xavier Labandeira, and Pedro Linares. 2011. "An Ex-Post Analysis of the Effect of Renewables and Cogeneration on Spanish Electricity Prices." *Energy Economics*, Supplemental Issue: Fourth Atlantic Workshop in Energy and Environmental Economics, 33 (December): S59–65. https://doi.org/10.1016/j.eneco.2011.07.027.

Giannarakis, Grigoris, Eleni Zafeiriou, Garyfallos Arabatzis, and Xanthi Partalidou. 2018. "Determinants of Corporate Climate Change Disclosure for European Firms." *Corporate Social Responsibility and Environmental Management* 25 (3): 281–94. https://doi.org/10.1002/csr.1461.

Global Commission on Adaptation. 2019. "Adapt Now: A Global Call For Leadership on Climate Resilience." Global Center on Adaptation and World Resources Institute. https://cdn.gca.org/assets/2019-09/GlobalCommission_Report_FINAL.pdf.

Gonzalez-Gonzalez, Jose Maria, and Constancio Zamora Ramírez. 2016. "Voluntary Carbon Disclosure by Spanish Companies: An Empirical Analysis." *International Journal of Climate Change Strategies and Management* 8 (1): 57–79. https://doi.org/10.1108/IJCCSM-09-2014-0114.

Grantham, Russell. 2017. "Southern Company: Plant Vogtle Price Rises to $25B." *The Atlanta Journal-Constitution*, August 2, 2017. https://www.ajc.com/business/southern-company-plant-vogtle-price-rises-25b/VZ5KQKWuMIDy5JyyOUTFmO/.

Greatrex, H., J. Hansen, S. Garvin, R. Diro, M. Le Guen, S. Blakeley, K. Rao, and D. Osgood. 2015. "Scaling up Index Insurance for Smallholder Farmers: Recent Evidence and Insights." Report. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://cgspace.cgiar.org/handle/10568/53101.

Griffith-Jones, Stephany. 2016. "National Development Banks and Sustainable Infrastructure; the Case of KfW." 07/2016. GEGI Working Paper. Global Economic Governance Initiative Boston University. https://www.bu.edu/pardeeschool/files/2016/07/GriffithJones.Final_.pdf.

Grösche, Peter, and Carsten Schröder. 2014. "On the Redistributive Effects of Germany's Feed-in Tariff." *Empirical Economics* 46 (4): 1339–83. https://doi.org/10.1007/s00181-013-0728-z.

Haas, Reinhard, Gustav Resch, Christian Panzer, Sebastian Busch, Mario Ragwitz, and Anne Held. 2011. "Efficiency and Effectiveness of Promotion Systems for Electricity Generation from Renewable Energy Sources – Lessons from EU Countries." *Energy* 36 (4): 2186–93. https://doi.org/10.1016/j.energy.2010.06.028.

Hahn, Rüdiger, Daniel Reimsbach, and Frank Schiemann. 2015. "Organizations, Climate Change, and Transparency: Reviewing the Literature on Carbon Disclosure." *Organization & Environment* 28 (1): 80–102. https://doi.org/10.1177/1086026615575542.

Halkos, George, and Antonis Skouloudis. 2016. "Exploring the Current Status and Key Determinants of Corporate Disclosure on Climate Change: Evidence from the Greek Business Sector." *Environmental Science & Policy* 56 (February): 22–31. https://doi.org/10.1016/j.envsci.2015.10.011.

Haque, Shamima, and Craig Deegan. 2010. "Corporate Climate Change-Related Governance Practices and Related Disclosures: Evidence from Australia." *Australian Accounting Review* 20 (4): 317–33. https://doi.org/10.1111/j.1835-2561.2010.00107.x.

Haque, Shamima, Craig Deegan, and Robert Inglis. 2013. "Disclosure of Climate Change-Related Corporate Governance Practices." In . Kobe, Japan. http://www.apira2013.org/proceedings/pdfs/K075.pdf.

Hazell, P., J. Anderson, N. Balzer, A. Hastrup Clemmensen, U. Hess, and F. Rispoli. 2010. "Potential for Scale and Sustainability in Weather Index Insurance for Agriculture and Rural Livelihoods." International Fund for Agricultural Development and World Food Programme. https://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp281391.pdf?_ga=2.245570884.1737750070.1547003456-1855627735.1547003456.

Hexun News. 2018. "2017 Green Bond Annual Summary." *Hexun News*, January 18, 2018. http://news.hexun.com/2018-01-18/192264467.html.

Ho, Harper Virginia E. 2018. "Sustainable Finance & China's Green Credit Reforms: A Test Case for Bank Monitoring of Environmental Risk." SSRN Scholarly Paper ID 3124304. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=3124304.

IPCC. 2018. "Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty." Edited by V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Citation.pdf.

Jaffe, Adam, Richard Newell, and Robert Stavins. 2005. "A Tale of Two Market Failures: Technology and Environmental Policy." *Ecological Economics* 54 (2–3): 164–74.

Jaggi, Bikki, Alessandra Allini, Riccardo Macchioni, and Claudia Zagaria. 2018. "The Factors Motivating Voluntary Disclosure of Carbon Information: Evidence Based on Italian Listed Companies." *Organization & Environment* 31 (2): 178–202. https://doi.org/10.1177/1086026617705282.

Jain, Sumit, Tapas Kumar Parida, and Soumya Kanti Ghosh. 2015. "Rethinking Priority Sector Lending for Banks in India." IIBF Macro Research Paper 2014-2015. Mumbai: IIBF. http://www.iibf.org.in/documents/reseach-report/Macro_Research_Rethinking_PSL_Final_Report.pdf.

Jenner, Steffen, Felix Groba, and Joe Indvik. 2013. "Assessing the Strength and Effectiveness of Renewable Electricity Feed-in Tariffs in European Union Countries." *Energy Policy* 52 (January): 385–401. https://doi.org/10.1016/j.enpol.2012.09.046.

Jira, Chonnikarn Fern, and Michael W. Toffel. 2012. "Engaging Supply Chains in Climate Change." SSRN Scholarly Paper ID 1943690. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=1943690.

Jones, Aled W., and Alexander Phillips. 2016. "Voluntary Business Engagement in Climate Change: A Study of the ClimateWise Principles." *Journal of Cleaner Production* 137 (November): 131–43. https://doi.org/10.1016/j.jclepro.2016.07.064.

Karpf, Andreas, and Antoine Mandel. 2018. "The Changing Value of the `green' Label on the US Municipal Bond Market." *Nature Climate Change* 8 (February): 161–65. https://doi.org/10.1038/s41558-017-0062-0.

Kochar, Anjini. 2011. "The Distributive Consequences of Social Banking: A Microempirical Analysis of the Indian Experience." *Economic Development and Cultural Change* 59 (2): 251–80. https://doi.org/10.1086/657122.

Kolk, Ans, David Levy, and Jonatan Pinkse. 2008. "Corporate Responses in an Emerging Climate Regime: The Institutionalization and Commensuration of Carbon Disclosure." *European Accounting Review* 17 (4): 719–45. https://doi.org/10.1080/09638180802489121.

Kouloukoui, Daniel, Sônia Maria da Silva Gomes, Marcia Mara de Oliveira Marinho, Ednildo Andrade Torres, Asher Kiperstok, and Pieter de Jong. 2018. "Disclosure of Climate Risk Information by the World's Largest Companies." *Mitigation and Adaptation Strategies for Global Change* 23 (8): 1251–79. https://doi.org/10.1007/s11027-018-9783-2.

Kumar, Nagesh. 2016. "National Development Banks and Sustainable Infrastructure in South Asia." 003/2016. GEGI Working Paper. GEGI Boston University. https://open.bu.edu/bitstream/handle/2144/23651/NDBSandSouthAsia.Final_.pdf?sequence=1&isAllowed=y.

Kumar, Praveen, and Mohammad Firoz. 2018. "Impact of Carbon Emissions on Cost of Debt-Evidence from India." *Managerial Finance* 44 (12): 1401–17. https://doi.org/10.1108/MF-03-2018-0108.

Lee, Su-Yol, and Young-Hoon Kim. 2015. "Antecedents and Consequences of Firms' Climate Change Management Practices: Stakeholder and Synergistic Approach." *Sustainability* 7 (11): 1–16.

Lee, Su-Yol, Yun-Seon Park, and Robert D. Klassen. 2015. "Market Responses to Firms' Voluntary Climate Change Information Disclosure and Carbon Communication." *Corporate Social Responsibility and Environmental Management* 22 (1): 1–12. https://doi.org/10.1002/csr.1321.

Leete, Simeon, Jingjing Xu, and David Wheeler. 2013. "Investment Barriers and Incentives for Marine Renewable Energy in the UK: An Analysis of Investor Preferences." *Energy Policy* 60 (C): 866–75.

Lerner, Joshua, and Antoinette Schoar, eds. 2010. *International Differences in Entrepreneurship*. National Bureau of Economic Research Conference Report. Chicago ; London: University of Chicago Press.

Li, Dayuan, Min Huang, Shenggang Ren, Xiaohong Chen, and Lutao Ning. 2018. "Environmental Legitimacy, Green Innovation, and Corporate Carbon Disclosure: Evidence from CDP China 100." *Journal of Business Ethics* 150 (4): 1089–1104. https://doi.org/10.1007/s10551-016-3187-6.

Li, Li, Quanqi Liu, Dengli Tang, and Jucheng Xiong. 2017. "Media Reporting, Carbon Information Disclosure, and the Cost of Equity Financing: Evidence from China." *Environmental Science and Pollution Research* 24 (10): 9447–59. https://doi.org/10.1007/s11356-017-8614-4.

Linnerooth-Bayer, Joanne, and Stefan Hochrainer-Stigler. 2015. "Financial Instruments for Disaster Risk Management and Climate Change Adaptation." *Climatic Change; Dordrecht* 133 (1): 85–100. http://dx.doi.org/10.1007/s10584-013-1035-6.

Luo, Changqing, Siyuan Fan, and Qi Zhang. 2017. "Investigating the Influence of Green Credit on Operational Efficiency and Financial Performance Based on Hybrid Econometric Models." *International Journal of Financial Studies* 5 (4): 27. https://doi.org/10.3390/ijfs5040027.

Luo, Le, Yi-Chen Lan, and Qingliang Tang. 2012. "Corporate Incentives to Disclose Carbon Information: Evidence from the CDP Global 500 Report." *Journal of International Financial Management & Accounting* 23 (2): 93–120. https://doi.org/10.1111/j.1467-646X.2012.01055.x.

Maaloul, Anis. 2018. "The Effect of Greenhouse Gas Emissions on Cost of Debt: Evidence from Canadian Firms." *Corporate Social Responsibility and Environmental Management* 25 (6): 1407–15. https://doi.org/10.1002/csr.1662.

Maclean, J., J. Tan, D. Tirpak, and V. Sonntag-O'Brien. 2008. "Public Finance Mechanisms to Mobilize Investment in Climate Change Mitigation." UNEP DTIE. http://www.climate-finance.org/sites/default/files/media/uneppublicfinancereport.pdf.

Mahul, Olivier, and Charles J. Stutley. 2010. *Government Support to Agricultural Insurance: Challenges and Options for Developing Countries*. The World Bank. https://doi.org/10.1596/978-0-8213-8217-2.

Matisoff, Daniel C., and Erik P. Johnson. 2017. "The Comparative Effectiveness of Residential Solar Incentives." *Energy Policy* 108 (September): 44–54. https://doi.org/10.1016/j.enpol.2017.05.032.

Mazzucato, Mariana, and Caetano C. R. Penna. 2016. "Beyond Market Failures: The Market Creating and Shaping Roles of State Investment Banks." *Journal of Economic Policy Reform* 19 (4): 305–26. https://doi.org/10.1080/17487870.2016.1216416.

Mazzucato, Mariana, and Gregor Semieniuk. 2018. "Financing Renewable Energy: Who Is Financing What and Why It Matters." *Technological Forecasting and Social Change* 127 (February): 8–22. https://doi.org/10.1016/j.techfore.2017.05.021.

McKinsey & Company. 2009. "Pathways to a Low-Carbon Economy Version 2 of the Global Greenhouse Gas Abatement Cost Curve." https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/sustainability/cost%20curve%20pdfs/pathways_lowcarbon_economy_version2.ashx.

McNicoll, Lauren, Raphaël Jachnik, Gaylor Montmasson-Clair, and Shakespear Mudombi. 2017. "Estimating Publicly-Mobilised Private Finance for Climate Action: A South African Case Study," September. https://doi.org/10.1787/a606277c-en.

Menanteau, Philippe, Dominique Finon, and Marie-Laure Lamy. 2003. "Prices versus Quantities: Choosing Policies for Promoting the Development of Renewable Energy." *Energy Policy* 31 (8): 799–812. https://doi.org/10.1016/S0301-4215(02)00133-7.

Meng, Alan Xiangrui, Ivy Lau, and Bridget Boulle. 2018. "China Green Bond Market 2017." Cliamte Bonds Initiative and China Central Depository and Clearing Company. https://www.climatebonds.net/files/reports/china_annual_report_2017_en_final_14_02_2018.pdf.

Metcalf, Gilbert E. 2008. "Using Tax Expenditures to Achieve Energy Policy Goals." *The American Economic Review* 98 (2): 90–94.

Metcalf, Gilbert E. 2009. "Tax Policies for Low-Carbon Technologies." Working Paper 15054. National Bureau of Economic Research. https://doi.org/10.3386/w15054.

Meze-Hausken, Elisabeth, Anthony Patt, and Steffen Fritz. 2009. "Reducing Climate Risk for Micro-Insurance Providers in Africa: A Case Study of Ethiopia." *Global Environmental Change* 19 (1): 66–73. https://doi.org/10.1016/j.gloenvcha.2008.09.001.

Mia, Parvez, James Hazelton, and James Guthrie. 2018. "Measuring for Climate Actions: A Disclosure Study of Ten Megacities." *Meditari Accountancy Research* 26 (4): 550–75. https://doi.org/10.1108/MEDAR-08-2017-0192.

Mitchell, Paul D., and David A. Hennessy. 2003. "Factors Determining Best Management Practice Adoption Incentives and the Impact of Green Insurance." In *Risk Management and the Environment: Agriculture in Perspective*, edited by Bruce A. Babcock, Robert W. Fraser, and Joseph N. Lekakis, 52–66. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-017-2915-4_4.

Narayanan, Sudha. 2016. "The Productivity of Agricultural Credit in India." *Agricultural Economics* 47 (4): 399–409. https://doi.org/10.1111/agec.12239.

Nelson, Tim, Paul Simshauser, and Simon Kelley. 2011. "Australian Residential Solar Feed-in Tariffs: Industry Stimulus or Regressive Form of Taxation?" *Economic Analysis and Policy* 41 (2): 113–29. https://doi.org/10.1016/S0313-5926(11)50015-3.

Ng, Thiam Hee, and Jacqueline Yujia Tao. 2016. "Bond Financing for Renewable Energy in Asia." *Energy Policy* 95 (August): 509–17. https://doi.org/10.1016/j.enpol.2016.03.015.

OECD. 2017. "Private Finance for Climate Action: Estimating the Effects of Public Interventions." OECD. http://www.oecd.org/env/researchcollaborative/WEB%20private-finance-for-climate-action-policy-perspectives.pdf.

Office of the Comptroller, Scott. 2014. "A Green Bond Program for New York City." https://comptroller.nyc.gov/wp-content/uploads/documents/Green_Bond_Program_-September.pdf.

Park, Stephen. 2018. "Investors as Regulators: Green Bonds and the Governance Challenges of the Sustainable Finance Revolution." SSRN Scholarly Paper ID 3142887. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=3142887.

Partridge, Candace, and Francesca Medda. 2018. "The Creation and Benchmarking of a Green Municipal Bond Index." SSRN Scholarly Paper ID 3248423. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=3248423.

Persson, Åsa, R.J.T. Klein, C.K. Siebert, and A. Atteridge. 2009. *Adaptation Finance under a Copenhagen Agreed Outcome*. Stockholm: Stockholm Environment Institute.

Picard, Pierre. 2008. "Natural Disaster Insurance and the Equity-Efficiency Trade-Off." *Journal of Risk and Insurance* 75 (1): 17–38. https://doi.org/10.1111/j.1539-6975.2007.00246.x.

Pillay, Kamleshan, Stine Aakre, and Asbjørn Torvanger. 2017. "Mobilizing Adaptation Finance in Developing Countries." *42*, March. https://pub.cicero.oslo.no/cicero-xmlui/handle/11250/2435614.

Pirnia, M., Jatin Nathwani, and David Fuller. 2011. "Ontario Feed-in-Tariffs: System Planning Implications and Impacts on Social Welfare." *The Electricity Journal* 24 (October): 18–28. https://doi.org/10.1016/j.tej.2011.09.009.

Polzin, Friedemann. 2017. "Mobilizing Private Finance for Low-Carbon Innovation – A Systematic Review of Barriers and Solutions." *Renewable and Sustainable Energy Reviews* 77 (September): 525–35. https://doi.org/10.1016/j.rser.2017.04.007.

Polzin, Friedemann, Florian Egli, Bjarne Steffen, and Tobias S. Schmidt. 2019. "How Do Policies Mobilize Private Finance for Renewable Energy?—A Systematic Review with an Investor Perspective." *Applied Energy* 236 (February): 1249–68. https://doi.org/10.1016/j.apenergy.2018.11.098.

Polzin, Friedemann, Michael Migendt, Florian A. Täube, and Paschen von Flotow. 2015. "Public Policy Influence on Renewable Energy Investments—A Panel Data Study across OECD Countries." *Energy Policy* 80 (May): 98–111. https://doi.org/10.1016/j.enpol.2015.01.026.

Reid, Erin M., and Michael W. Toffel. 2009. "Responding to Public and Private Politics: Corporate Disclosure of Climate Change Strategies." *Strategic Management Journal* 30 (11): 1157–78. https://doi.org/10.1002/smj.796.

REN21. 2018. "Renewables 2018 Global Status Report: A Comprehensive Annual Overview of the State of Renewable Energy." https://www.ren21.net/wp-content/uploads/2019/08/Full-Report-2018.pdf.

Reserve Bank of India. 2018. "Priority Sector Lending - Targets and Classification - Frequently Asked Questions." https://m.rbi.org.in/Scripts/FAQView.aspx?Id=87.

Riding, Allan, Judith Madill, and George Haines. 2007. "Incrementality of SME Loan Guarantees." *Small Business Economics* 29 (1–2): 47–61. https://doi.org/10.1007/s11187-005-4411-4.

Rio, Pablo del, and Pere Mir-Artigues. 2014. "A Cautionary Tale: Spain's Solar PV Investment Bubble." International Institute for Sustainable Development. https://www.iisd.org/gsi/sites/default/files/rens_ct_spain.pdf.

Roberts, J. Timmons, and Romain Weikmans. 2017. "Postface: Fragmentation, Failing Trust and Enduring Tensions over What Counts as Climate Finance." *International Environmental Agreements: Politics, Law and Economics* 17 (1): 129–37. https://doi.org/10.1007/s10784-016-9347-4.

Roberts, J.T., M. Stadelmann, and S. Huq. 2010. "Copenhagen's Climate Finance Promise: Six Key Questions." International Institute for Environment and Development. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7272.pdf.

Rooijen, Sascha N.M. van, and Mark T. van Wees. 2006. "Green Electricity Policies in the Netherlands: An Analysis of Policy Decisions." *Energy Policy* 34 (1): 60–71. https://doi.org/10.1016/j.enpol.2004.06.002.

Sarzynski, Andrea, Jeremy Larrieu, and Gireesh Shrimali. 2012. "The Impact of State Financial Incentives on Market Deployment of Solar Technology." *Energy Policy* 46 (July): 550–57. https://doi.org/10.1016/j.enpol.2012.04.032.

Schmidt, Tobias S. 2014. "Low-Carbon Investment Risks and de-Risking." *Nature Climate Change* 4 (March): 237–39. https://doi.org/10.1038/nclimate2112.

Securities and Exchange Commission. 2010. "Commission Guidance Regarding Disclosure Related to Climate Change." Securities and Exchange Commission. https://www.sec.gov/rules/interp/2010/33-9106.pdf.

Sherlock, M. 2018. "The Renewable Electricity Production Tax Credit: In Brief." CRS Report R43453. Congressional Research Service. https://fas.org/sgp/crs/misc/R43453.pdf.

Shi, Xunpeng, Xiying Liu, and Lixia Yao. 2016. "Assessment of Instruments in Facilitating Investment in Off-Grid Renewable Energy Projects." *Energy Policy* 95 (August): 437–46. https://doi.org/10.1016/j.enpol.2016.02.001.

Shishlov, Igor, Romain Morel, and Ian Cochran. 2016. *Beyond Transparency: Unlocking the Full Potential of Green Bonds*. https://doi.org/10.13140/RG.2.2.11081.85606.

Sjöström, Emma. 2008. "Shareholder Activism for Corporate Social Responsibility: What Do We Know?" *Sustainable Development* 16 (3): 141–54. https://doi.org/10.1002/sd.361.

Smallridge, Diana, Barbara Buchner, Chiara Trabacchi, Maria Netto, Jose Juan Gomes Loernzo, and Lucia Serra. 2012. "The Role of National Development Banks in Intermediating International Climate Finance Set Up Private Sector Investments." IDB Discussion Paper IDB-DP-249. Inter-American Development Bank. https://webimages.iadb.org/publications/english/document/The-Role-of-National-Development-Banks-in-Intermediating-International-Climate-Finance-to-Scale-Up-Private-Sector-Investments.pdf.

Smallridge, Diana, and Fernando de Olloqui. 2011. "A Health Diagnostic Tool for Public Development Banks." Technical Notes IDB-TN-225. Inter-American Development Bank. https://publications.iadb.org/en/health-diagnostic-tool-public-development-banks.

Smith, Jeffrey A., Matthew Morreale, and Michael E. Mariani. 2008. "Climate Change Disclosure: Moving towards a Brave New World." *Capital Markets Law Journal* 3 (4): 469–85. https://doi.org/10.1093/cmlj/kmn021.

Stanny, Elizabeth, and Kirsten Ely. 2008. "Corporate Environmental Disclosures about the Effects of Climate Change." *Corporate Social Responsibility and Environmental Management* 15 (6): 338–48. https://doi.org/10.1002/csr.175.

Trærup, Sara L. M. 2012. "Informal Networks and Resilience to Climate Change Impacts: A Collective Approach to Index Insurance." *Global Environmental Change* 22 (1): 255–67. https://doi.org/10.1016/j.gloenvcha.2011.09.017.

Uesugi, Iichiro, Koji Sakai, and Guy M. Yamashiro. 2010. "The Effectiveness of Public Credit Guarantees in the Japanese Loan Market." *Journal of the Japanese and International Economies* 24 (4): 457–80. https://doi.org/10.1016/j.jjie.2010.08.001.

UNCTAD, ed. 2014. *Investing in the SDGs: An Action Plan*. World Investment Report 2014. New York: United Nations.

Vittas, Dimitri, and Yoon Je Cho. 1995. "Credit Policies: Lessons from East Asia." WPS 1458. World Bank. http://documents.worldbank.org/curated/en/395781468752730652/pdf/multi-page.pdf.

———. 1996. "Credit Policies: Lessons from Japan and Korea." *The World Bank Research Observer* 11 (2): 277–98.

Vittas, Dimitri, and Bo Wang. 1991. "Credit Policies in Japan and Korea : A Review of the Literature." 747. Policy Research Working Paper Series. The World Bank. https://ideas.repec.org/p/wbk/wbrwps/747.html.

Vogel, Robert C., and Dale W. Adams. 1997. "The Benefits and Costs of Loan Guarantee Programs." *The Financier* 4 (1–2): 22–29. https://www.microfinancegateway.org/sites/default/files/mfg-en-paper-the-benefits-and-costs-of-loan-guarantee-programs-1996.pdf.

Voosen, Paul. 2009. "Spain's Solar Market Crash Offers a Cautionary Tale About Feed-In Tariffs - NYTimes.Com." 2009. https://archive.nytimes.com/www.nytimes.com/gwire/2009/08/18/18greenwire-spains-solar-market-crash-offers-a-cautionary-88308.html.

Waissbein, O., Y. Glemarec, H. Bayraktar, and T.S. Schmidt. 2013. "Derisking Renewable Energy Investment: A Framework to Support Policymakers in Selecting Public Instruments to Promote Renewable Energy Investment in Developing Countries." UNDP. https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/UNDP%20Derisking%20Renewable%20Energy%20Investment%20-%20Full%20Report%20(April%202013).pdf.

Wang, Yao, and Ricco Zhang. 2017. "China's Green Bond Market." 44. Internaitonal Capital Market Features. ICMA Group.

Warner, Koko, Kristina Yuzva, Michael Zissener, Susan Gille, Janina Voss, and Solveig Wanczeck. 2013. *Innovative Insurance Solutions for Climate Change: How to Integrate Climate Risk Insurance into a Comprehensive Climate Risk Management Approach*. UNU- EHS. http://collections.unu.edu/view/UNU:1850#viewMetadata.

Weber, Olaf, and Vasundhara Saravade. 2019. "Green Bonds: Current Development and Their Future." 201. CIGI Papers. Centre for International Governance Innovation. https://www.cigionline.org/sites/default/files/documents/Paper%20no.210_0.pdf.

Wilson, Charlie, Arnulf Grubler, Kelly S. Gallagher, and Gregory F. Nemet. 2012. "Marginalization of End-Use Technologies in Energy Innovation for Climate Protection." *Nature Climate Change* 2 (11): 780–88. https://doi.org/10.1038/nclimate1576.

Wood, David, and Katie Grace. 2011. "A Brief Note on the Global Green Bond Market." Initiative for Responsible Investment and the Hauser Center for Nonprofit Organizations. http://iri.hks.harvard.edu/files/iri/files/iri_note_on_the_global_green_bonds_market.pdf.

Yamamoto, Yoshihiro. 2017. "Feed-in Tariffs Combined with Capital Subsidies for Promoting the Adoption of Residential Photovoltaic Systems." *Energy Policy* 111 (December): 312–20. https://doi.org/10.1016/j.enpol.2017.09.041.

Ye, Liang-Cheng, João F.D. Rodrigues, and Hai Xiang Lin. 2017. "Analysis of Feed-in Tariff Policies for Solar Photovoltaic in China 2011–2016." *Applied Energy* 203 (October): 496–505. https://doi.org/10.1016/j.apenergy.2017.06.037.

Zerbib, Olivier David. 2016. "Is There a Green Bond Premium? The Yield Differential Between Green and Conventional Bonds." SSRN Scholarly Paper ID 2889690. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=2889690.

———. 2019. "The Effect of Pro-Environmental Preferences on Bond Prices: Evidence from Green Bonds." *Journal of Banking & Finance* 98 (C): 39–60.

Zhang, Bing, Yan Yang, and Jun Bi. 2011. "Tracking the Implementation of Green Credit Policy in China: Top-down Perspective and Bottom-up Reform." *Journal of Environmental Management* 92 (4): 1321–27. https://doi.org/10.1016/j.jenvman.2010.12.019.

Zhang, Chenghui, Simon Zadek, Ning Chen, and Mark Halle. 2015. "Greening China's Financial System." DRC FInance Research Institute and IISD. October 19 2019. https://www.iisd.org/sites/default/files/publications/greening-chinas-financial-system.pdf.

Zhang, Fang. 2019. "How Do Governments Mobilize Finance for Innovation: The Case of Domestic Clean Energy." PhD, Tufts University.

Zhou, Zhifang, Tao Zhang, Kang Wen, Huixiang Zeng, and Xiaohong Chen. 2018. "Carbon Risk, Cost of Debt Financing and the Moderation Effect of Media Attention: Evidence from Chinese Companies Operating in High-Carbon Industries." *Business Strategy and the Environment* 0 (0). https://doi.org/10.1002/bse.2056.

Zinman, Jonathan, and Dean Karlan. 2009. "Expanding Microenterprise Credit Access: Using Randomized Supply Decisions to Estimate the Impacts in Manila." 976. Working Papers. Economic Growth Center, Yale University. https://ideas.repec.org/p/egc/wpaper/976.html.

THE FLETCHER SCHOOL

TUFTS UNIVERSITY

The Climate Policy Lab (CPL)

Center for International Environment and Resource Policy (CIERP)

The Fletcher School
Tufts University
Cabot Intercultural Center, Suite 509
160 Packard Avenue
Medford, MA 02155

www.fletcher.tufts.edu/cierp

The Fletcher School at Tufts University was established in 1933 as the first graduate school of international affairs in the United States. The primary aim of The Fletcher School is to offer a broad program of professional education in international relations to a select group of graduate students committed to maintaining the stability and prosperity of a complex, challenging, and increasingly global society.

The Center for International Environment and Resource Policy (CIERP) was established in 1992 to support the growing demand for international environmental leaders. The Center provides an interdisciplinary approach to educate graduate students at The Fletcher School. The program integrates emerging science, engineering, and business concepts with more traditional subjects such as economics, international law and policy, negotiation, diplomacy, resource management, and governance systems.

The Climate Policy Lab (CPL) convenes teams of scholars and practitioners to evaluate existing climate policies empirically and works with governments contemplating new climate policies. The main questions the Lab seeks to answer are: Which climate policies work in practice? Which don't work? Why? Under what conditions would they work elsewhere? The scope of the Lab is global while remaining highly attuned to state, national, and bi-lateral policy processes. It has a particular emphasis on international comparative policy analysis.