The Political Economy of Green Technology adoption

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Abstract

This study delves into the connection between political coalition progressiveness and the effectiveness of climate policies aimed at improving industrial energy efficiency. Our analysis, which uses a unique dataset, uncovers a strong and consistent positive correlation between political progressiveness and the implementation of climate policies. This highlights the crucial role that political dynamics play in shaping environmental governance. Even after controlling for GDP per capita, the correlation remains, demonstrating the complex interplay between political and economic factors. Our research contributes to the ongoing discussions on green technology adoption by providing empirical evidence of the significance of political will in driving climate policy outcomes. The results underscore the importance of aligning political ideologies and economic considerations for a sustainable future in the face of climate change challenges.

1 Introduction

Many developing countries continue to rely on neoliberal export-oriented growth strategies based on primary commodities (E. Gudynas, 2018; Hausmann & Klinger, 2008). The export-oriented growth model has contributed significantly to economic growth and poverty alleviation but has also led to environmental degradation and social inequality (Campanini Gonzales, 2022; E. Gudynas, 2018; Panel, 2011; Stonich, 1992). The international development community then focused on addressing the growing concern over these unsustainable development strategies. The concept of green growth was introduced, aiming to reconcile low-carbon and sustainable development together with job creation and poverty alleviation (Adams, 2008; De Serres et al., 2010; M. Jacobs, 2013).

To map the abstract concept of green growth to a specific development strategy and to describe the resulting development strategy in terms of green performance, we need to make a few more observations. One of the most pronounced manifestations of the dependence on natural resources is a low level of economic diversification (Lashitew et al., 2021). To effectively address the ongoing challenges presented by the extractivist model and promote sustainable progress, it is crucial to move away from the focus on exporting natural resources in their raw form and instead adopt a diversified and value-added approach (Lashitew et al., 2021; M. Svampa, 2019; M. N. Svampa, 2012). Sustainable economic diversification will help developing countries reduce their vulnerability to fluctuations in commodity prices (Collier & Goderis, 2008; Ross, 1999), and mitigate the adverse environmental and social effects often associated with extractive industries (Gamu et al., 2015; Su et al., 2020). The analysis employed in this paper stays agnostic about how economic diversification is achieved in developing economies. Instead, we direct our attention to the underlying dynamics governing the relationship between economic diversification and energy intensity, recognizing that the process of economic diversification often triggers shifts in the energy efficiency of the economy. Before analyzing these underlying dynamics, we must understand the fundamental forces through which economic diversification influences aggregate energy intensity. For economic diversification to impact energy intensity, two conditions need to be fulfilled: First, some sectors are shrinking while others are growing or the existing sectors change their modes of production. Second, these changes must be correlated with aggregate energy consumption[1]. Therefore, two of these underlying forces[2] in the relationship between economic diversification and energy intensity are the composition and technological effect (Grossman & Krueger, 1995). The composition effect refers to changes in the structure of the economy due to shifts in the relative importance of sectors. The technological effect results from effective policies that stimulate the adoption of green technologies developed by the technology-leading countries to encourage efficiency in energy use (Tao et al., 2021). The adoption of these technologies leads to lower aggregate energy intensity given the composition of the economy and supports the transition to a lower-carbon economy due to improved energy efficiency (Gallagher

[1] See Hardt et al. (2021) for an empirical analysis of the latter condition.

[2] By using economic diversification as our measure for economic development, we eliminate the scale effect, as economic diversification is independent of scale. The scale effect refers to the higher level of energy use due to a larger scale of production, irrespective of the structure of the economy and the aggregate energy efficiency, often observed along the process of economic development.

et al., 2006; K.-H. Lee & Min, 2015).

If green technological adoption can contribute to sustainable economic diversification, why are some developing countries, especially those with more resources, failing to implement green technologies in their process of economic diversification? While there may be multiple factors at play, political dynamics are certainly one of them, often overlooked in the literature (Resnick et al., 2012). For example, according to Dunning (2005), resource dependence results from strategic decisions made by incumbents to limit the ability of political opponents to challenge their power. Implementing any development strategy affects different groups in a heterogeneous way, generating supporters and opponents of the proposed changes (Bunte, 2019; Frieden, 1991; Resnick et al., 2012). This, in turn, impacts the choices made by governments regarding whether or not to undertake the reforms and how to execute them. As governments have electoral motives, they will implement policies only when such policies do not cause substantial losses to a significant portion of the electorate or create a clash with powerful interest groups (Evans et al., 1985; Leeds et al., 2009; Mattes et al., 2015; Resnick et al., 2012). Green technology adoption exhibits a strong temporal component as the benefits are accrued in the future while the costs associated with them are often immediate (Resnick et al., 2012). Additionally, those who ultimately benefit from these transformations may not be the same as those who make sacrifices in the short term. Thus, examining the preferences of relevant distributional coalitions and understanding the resulting clashes within the socioeconomic systems are crucial for a better understanding of the obstacles to the adoption of green technologies.

This paper aims to understand the impact of distributional coalitions on the adoption of green technologies and, therefore, predominantly directs its focus toward understanding the strength of the technological effect in the process of economic diversification. As a result, the primary question addressed in this paper is the following: What is the impact of distributional coalitions on the nature and existence of the adoption of green technologies? To answer this question, this paper relies on political economy and technology diffusion theory to better understand the barriers to the implementation of green technologies on the path to economic diversification in resource-rich countries. Previous studies on the adoption of green technologies in the political economy (Balmaceda, 2018; Båtstrand, 2015; Carter et al., 2018; Corral-Montoya et al., 2022; Hess & Renner, 2019; McLean & Plaksina, 2019; Parente & Prescott, 1994) as well as the diffusion literature (Bessen, 2002; Blackman, 1999; Butler & Sellbom, 2002; Fichman, 1992), have produced valuable insights, but we need to consider them simultaneously to better understand the variation in the success of the adoption of green technologies. Firstly, we provide insights into economic diversification, energy intensity, and the transfer of green technology, establishing the groundwork for our analysis. Secondly, we employ a dual strategy: introducing a basic demand model of technology adoption and incorporating insights from political economy theory to derive conceptual predictions. This approach enhances our understanding of the variations in green technology adoption and elucidates how governments make choices influenced by the relative bargaining power of distributional coalitions. Thirdly, we collect and utilize data to construct a unique dataset, from which we derive an index measuring governments' progressiveness in intervening in their domestic economy to enhance energy efficiency in the industry. Subsequently, we test the prediction that our index is significantly positively correlated with the number of implemented climate policies using an ordered probit model. The concluding sections present and discuss our results, reflecting on their implications.

2 Background

This section analyzes the complex interplay between economic diversification, energy intensity, and green technology transfer. These are crucial themes underlying our analysis of the adoption of green technology in developing economies. Economic diversification is essential in reducing dependence on natural resources, a process closely correlated with energy intensity in the economy. As we strive to reduce energy intensity while diversifying our economies, the transfer of green technology emerges as a practical solution.

2.1 Economic Diversification

Overcoming the dependence on primary commodity exportation has not been easy for developing economies, considering that the region has lived for centuries under the primacy of and dependency on its traditional comparative advantages: natural resources (Ahmadov, 2012; Bastida, 2014; Dietsche, 2014; Gelb, 2010; Lashitew et al., 2021). Exporting countries that rely heavily on specific natural resources have unique characteristics and encounter specific difficulties compared to countries with a more balanced range of resources (Gelb, 2010). For example, the mineral sector typically has limited connections with the rest of the economy regarding production, and the revenue generated from natural resources is highly concentrated. Despite recent progress made in diversifying their economies, developing countries face significant challenges, such as a large informal economy, weak capacity for innovation, inadequate governance and institutions, and low investment capacity (Anderson et al., 2016; Barbier, 2016; Dercon, 2014). To reduce the dependency on natural resources, an essential strategy is to pursue economic diversification. This process involves expanding a country's economy beyond its conventional or primary activities, moving away from a limited range of industries or sectors. The goal is to establish a more diverse and balanced economic foundation that can withstand external shocks, such as sudden shifts in commodity prices or global demand for specific goods and services. However, the link between historical reliance on natural resources and the pursuit of economic diversification is uncertain due to several factors that have prevented a clear answer from emerging: classification problems of resource sectors (Corden & Neary, 1982), boom-bust dynamics in commodity prices (Lashitew et al., 2021), time-dependence of the relationship (Venables, 2016), and uncertainty about the causal mechanisms underlying the relationship (Frankel, 2012). While the natural resource sector can potentially be a catalyst for diversifying economies, the success of such efforts depends on a variety of factors, including the level of resource dependence and abundance, the quality of human and intellectual capital, and the effectiveness of policy measures (Barbier, 2016).

A critical policy question is why developing economies should choose sustainable economic diversification over conventional export-oriented strategies. For economic diversification to be successful in these economies, in line with Barbier (2020), it must meet two crucial criteria. First, it must align with the primary development goal of poverty alleviation, mainly focusing on rural areas where the majority of extreme and moderate poor reside. Second, for economic diversification to effectively contribute to poverty alleviation, it must address key structural issues related to natural resource use and rural poverty in these areas. These issues include the heavy dependence on primary production, the concentration of rural poverty in marginal agricultural areas, and significant land use changes associated with agriculture and other primary production activities. Numerous examples demonstrate the efficacy of economic diversification in poverty reduction and long-term sustainability. Countries like Malaysia, Thailand, and Brazil serve as noteworthy illustrations where successful diversification efforts have contributed significantly to these positive outcomes. Barbier (2011) emphasized a few commonalities of these success stories. First, there is resource-enhancing technological change in primary production activities. More specifically, successful resource-based development results from adapting and applying global innovations and technologies to suit local geological conditions and production opportunities. Second, strong forward and backward linkages exist between the resource-based primary production sector and the rest of the economy. The potential and feasibility of such linkages depend on the context, the type and quality of the resource, the existing capabilities, comparative advantages, and the political space and instruments (Bastida, 2014). Finally, substantial knowledge spillovers exist in primary production and across resource-based activities. Success in sustainable economic diversification hinges on resource-enhancing technological change, strong linkages within the economy, and knowledge spillovers.

Thus, in order to achieve sustainable economic diversification in developing economies, it is essential to strategically move away from traditional reliance on primary production, which involves embracing innovation, developing strong economic connections, and prioritizing knowledge and technology transfer. It is important to note that policies must be contextualized and adaptable to address the multifaceted challenges of individual developing economies. While obstacles may arise, the potential for sustainable and inclusive development through economic diversification is significant as it provides long-run economic benefits and serves as a means to address pressing social issues, such as poverty reduction in rural areas (Barbier, 2020).

2.2 Energy Intensity

Along the process of economic diversification, aggregate energy intensity changes significantly (Lee & Shan-Ju, 2022). Energy intensity reflects the efficiency of energy use (measured by the technological effect) and the structure of the economy (measured by the composition effect). Reducing energy intensity[3] can contribute to lower energy costs, improved energy security, and lower greenhouse

[3]Energy efficiency is often measured by energy intensity, which is a way to approximate the amount of energy needed to satisfy the desired services at a macro level. Comparing energy intensity across countries is a relatively simple way to gauge energy efficiency, but it is not always a perfect correlation. For example, an economy based on services in a mild climate may have lower energy intensity than an industry-based economy in a colder climate, despite using energy more efficiently. It is important to note that lower intensity trends do not necessarily indicate efficiency

gas emissions. According to the IEA (2023), energy intensity of the economy, as measured by the amount of energy used to generate a unit of GDP, decreased globally by 36 % between 1990 and 2020. In 2020, the world experienced a notable deceleration in the rate of energy efficiency improvement, dropping to a mere 0.6 percent compared to the preceding decade's average of 1.8 %. This unexpected downturn was primarily a consequence of the global upheaval caused by the COVID-19 pandemic, marked by widespread lockdowns and severe travel restrictions (IEA, 2023). These measures, coupled with substantial shifts in the global economy coinciding with the initial lockdowns, contributed to the decline in energy efficiency trends. The challenging scenario persisted into 2021, as a robust surge in energy demand outpaced the modest gains in energy efficiency. Despite recent advancements spurred by new policies and enhanced energy security measures, the improvements were deemed insufficient to meet the ambitious target set by Sustainable Development Goal 7.3, which calls for an average annual efficiency improvement of 3.4 % (IEA, 2023). Efforts to improve global energy efficiency are expected to have a significant impact on reducing energy intensity. The Nationally Determined Contributions (NDCs) introduced at COP26 are a notable example of policies aimed at addressing the ongoing energy crisis. According to predictions in the Stated Policies Scenario, global energy intensity is expected to decrease by an average of 2.4 % per year from 2021 to 2030, surpassing the average rate observed in the previous decade. While this projected rate of improvement is commendable, it falls short of the ambitious SDG 7.3 target for 2030, which requires a 3.4 % annual improvement (IEA, 2023). However, there is reason for optimism, particularly in the developing economies of Asia. Developing Asia is leading the way with a projected annual improvement of 3.4 % in energy intensity between 2020 and 2030 (IEA, 2023). This progress suggests that with continued concerted global efforts and strategic policies, a more sustainable and energy-efficient future is possible.

Advanced economies often have undergone industrialization and technological advancements and generally exhibit lower energy intensity. They often transition towards service-oriented economies with a greater emphasis on technology and innovation, resulting in more efficient use of energy (Voigt et al., 2014). For example, economies specializing in producing agricultural products tend towards the textile sector in the early stages of economic diversification (Ali et al., 2022). The textile sector creates a more diversified economy but is also more pollution-intensive than most agricultural activities. As the economy becomes more diversified, the textile sector is, for example, replaced with a more complex financial services sector. That change allows the country to shift from energy-intensive industries (e.g., textile industry) to technology-intensive industries (e.g., financial services), which may reduce the amount of energy used per unit of GDP. This shift away from energy-intensive industries (composition effect), coupled with investments in clean and renewable energy (technological effect), contributed to lower overall energy intensity in advanced economies. In contrast, developing economies often exhibit initially high energy intensity due to various factors such as outdated technology, inefficient production processes, and a higher share of energy-intensive industries (Miketa, 2001; Muhammad et al., 2022; Voigt et al., 2014). The reliance on natural resource

improvements.

exports, like minerals or fossil fuels, can further contribute to elevated energy intensity. Extracting, processing, and transporting natural resources typically involve energy-intensive processes (Mielke et al., 2010). Countries heavily reliant on the export of natural resources may experience a dual challenge: not only are their economies exposed to volatile commodity prices, but the extraction and processing of these resources often demand substantial energy inputs (Dargahi & Khameneh, 2019). Additionally, these economies may face many challenges in adopting cleaner and more energy-efficient technologies, such as large initial investment costs and potential resistance from established industries (Resnick et al., 2012). To address high energy intensity, developing economies need targeted policies, which involve investing in cleaner technologies, promoting energy-efficient practices, diversifying their energy sources and removing barriers to green technology transfers from advanced economies.

2.3 Green Technology Transfer

To help developing economies reduce aggregate energy intensity along their process of economic diversification, there needs to be collective efforts by the advanced economies to promote green technology transfer. Green technology transfer is a complex process involving more than just the transfer of physical technologies and developing local capacity and expertise to absorb, adapt, and improve the technologies that are transferred (Hall & Helmers, 2010; Lema & Lema, 2012). Developing economies face multiple challenges in reducing their energy intensity and sustainably diversifying their economies (Chen et al., 2021; Sorrell, 2015). They often need more financial resources, technical expertise, and infrastructure to independently adopt and implement green technologies. Green technology transfer can cover various sectors, such as renewable energy, waste management, water purification, and sustainable agriculture. By sharing knowledge and providing access to the newest green technologies, advanced economies can enable developing nations to leapfrog over traditional, environmentally detrimental development paths and embrace sustainable practices (Hall & Helmers, 2010). Advanced economies can also benefit from expanding their markets and enhancing innovation capabilities through technology transfer (Stewart & Stewart, 1992).

However, green technology transfer is not a one-way or passive process. It requires active and creative efforts from both the suppliers and the recipients of technology and a conducive policy and institutional environment (Lema & Lema, 2012). Green technology transfer is not an alternative to localized innovation but a complementary and dynamic activity that can enhance developed and developing economies' technological capabilities and competitiveness. To this end, training programs and educational initiatives can be implemented to cultivate the skills needed to adopt and maintain green technologies efficiently. Moreover, green technology transfer requires different types of cross-border interactions and organizational arrangements, depending on the nature and complexity of the technologies and the capabilities of the recipients (Lema & Lema, 2012). Some of these arrangements include trade, foreign direct investment, joint ventures, licensing, joint R&D, foreign acquisitions, and overseas R&D. These arrangements can facilitate different flows of technology, such as capital goods, equipment designs, skills, know-how, and experience. Some of these flows are more conducive to technological learning and innovation than others and thus have more potential to foster low-carbon development paths.

Hence, the partnership between developed and developing nations, with the backing of global organizations and programs, is instrumental in facilitating the sharing of expertise and innovative solutions. Collaborative efforts between developed and developing economies, supported by international organizations, can facilitate knowledge transfer and technology exchange (Lema & Lema, 2012). A prime example is the Technology Mechanism established by the United Nations Framework Convention on Climate Change (UNFCCC), which includes the Climate Technology Centre and Network (CTCN) and the Technology Executive Committee (TEC) (United Nations, 2010). Their primary objective is to facilitate the advancement and dissemination of eco-friendly technologies to tackle climate change issues in less developed nations. Furthermore, encouraging private sector participation in technology transfer can be facilitated by developing policies and regulations that are favorable (Forsyth, 2005). Tax breaks, subsidies, and favorable market conditions are incentives that can attract investment in sustainable projects and expedite the deployment of green technologies. Thus, fostering green technology transfer is essential for developing economies to mitigate energy intensity and achieve sustainable economic diversification. Through active and creative efforts, coupled with conducive policies and partnerships, the exchange of knowledge and technologies can lead to mutually beneficial outcomes, advancing global sustainability goals and promoting environmentally conscious development paths.

3 Conceptual Framework

Given the presence of greener technologies on the global market and the necessity to transfer these technologies from advanced to developing economies, we must understand why some countries are more successful in adopting these technologies than others. The exploration of the variance in the adoption of (green) technology is frequently conducted through the lens of technological diffusion theory, with a comparatively lesser emphasis on political economy theory. Although these studies have produced valuable insights, it is necessary to incorporate political, social, and technological aspects as explanatory components when analyzing why certain countries have successfully implemented green technologies on their path to diversifying their economies while others have not.

3.1 Technological Diffusion Theory

Technology diffusion refers to the process by which innovations spread within and across economies (Stoneman, 1985). Thus, the analysis does not try to analyze the generation of innovations but rather where, how and when these new innovations are diffused and then adopted. We will discuss the case of the international transfer of (green) technology where green technology is invented in a technology-leading country and then analyze the adoption of this new technology in a developing economy trying to green their production structures along the path of diversifying their economies.

Some understanding of the classic technology diffusion theory is essential if we are to gain insights into the processes of green technology adoption in developing economies. Since the classical work of Reinganum (1981) who used a game theoretical approach to model technology diffusion based on the processes described by Schumpeter, the literature has grown significantly, drawing on insights from economics (Blackman, 1999), sociology (Cowan, 1987), political science (Milner, 2006), and management studies (Fichman, 1992). A comprehensive review of the literature is beyond the scope of this paper. Instead, the insights obtained from a basic demand-side model developed by Reinganum (1981) will be sufficient for our analysis. As the presentation of the model in the original paper is highly mathematical, we follow the conceptual illustration of Stoneman (1985) without losing much of the insights and adjust the model slightly to fit our analysis better.

3.1.1 A basic demand-model of technology adoption

There is a new green technology available on the global market. Let there be n firms in the domestic economy, potentially adopting a new green technology developed by a technology-leading country in which firms are heterogeneous with respect to their profits. Firm $i's$ profits when m other firms are adopting the new technology at time t is $\pi_{it,1}(m,n)$ if it adopts the new technology and $\pi_{it,0}(m,n)$ if it does not. In the classic version of the model, both $\pi_{it,1}$ and $\pi_{i,0}$ decline with both m and n because as the use of the technology extends, firms will increase their output and prices will fall, leading to lower profits in the economy (Reinganum, 1981). In our version, we will not assume this as the new green technology does not necessarily use inputs more efficiently in the traditional sense but merely makes the process less environmentally damaging. Let the costs of adopting the new green technology in period t be $C_{t,1}$. Then a firm that only considers the short-term and is only focused on maximizing profits will adopt the new technology in time t if

$$\pi_{it,1}(m,n) - \pi_{it,0}(m,n) > C_{t,1} \tag{1}$$

As firms are heterogeneous, some firms might adopt the new technology while others may not. If for firm i we have $\pi_{it,1}(m,n) - \pi_{it,0}(m,n) > \pi_{jt,1}(m,n) - \pi_{jt,0}(m,n)$ for every $j \neq i$, but still $\pi_{it,1}(m,n) - \pi_{it,0}(m,n) < C_{t,1}$, the green technology is not adopted in the domestic economy without any government intervention. There is potential scope for the government to reduce $C_{t,1}$ to encourage the wider spread of the new green technology. Let $S_{t,1}$ be a general subsidy received by the firm in period t. Then the new decision rule becomes

$$\pi_{it,1}(m,n) - \pi_{it,0}(m,n) > C_{t,1} - S_{t,1} \tag{2}$$

Models similar to the one presented above normally assume that $C_{t,1}$ falls over time, and as it does so, adoption of the technology increases, leading to a diffusion path. Although Schumpeter's $C_{t,1}$ would be more endogenously determined compared to our version, it is still clear why this basic model has a Schumpeterian flavor. This basic model is particularly relevant in highlighting a central assumption in classical diffusion theory on which we will build our argument later, namely: firms in the domestic industry will only adopt the new green technology when they can receive market benefits (i.e. increased profits) or when governments incentives industries financially (e.g., through subsidies).

3.1.2 Uncertainty and Expectations

The static model presented above ignores two important aspects of the diffusion process. First, the industry does not only care about current profits but also about future profits, potentially at a discount rate. Hence, they would be willing to adopt the new green technology even if $\pi_{it,1}(m,n) - \pi_{it,0}(m,n) < C_{t,1}$, under certain conditions. Second, the diffusion process and the associated outcomes involve a large degree of uncertainty as the process takes place in an environment where information is imperfect. Hence, under certain conditions, firms should be willing to allocate some of their current resources towards securing greater profitability in the future. For example, companies may make investments if they anticipate reduced expenses as a result of increased efficiency or improved adherence to government regulations. The willingness of industries to invest in green technologies can be hindered by significant risks associated with the expected returns on such investments. Industries must also consider the likelihood of experiencing exogenous shocks, such as changes in market conditions or government policies (McLean & Plaksina, 2019). For instance, sudden drops in energy prices or the adoption of stringent emissions standards by governments can serve as exogenous shocks. Industries may have varying approaches to dealing with these two types of risks. Specifically, technology-specific risks can be reduced by initiating pilot projects, which enable companies to test technology and identify problems before full-scale implementation. Other types of investment risks, such as shifting market or policy conditions, are harder to control. As a result, decision-makers in industries evaluate the available evidence to estimate the ease of adoption and use of the new technology, its impact on profitability, and the success of other companies in developing and deploying the technology to increase competitiveness. As a result, the decision rule presented above is too simplistic to capture real-world decision-making. Therefore, we present the following decision rule

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t\left[\pi_{it,1}(m,n) - \pi_{it,0}(m,n)\right] > \mathbb{E}\sum_{t=0}^{\infty}\beta^t C_{t,1} \tag{3}$$

where E is the expectations operator, and β is a discount factor between 0 and 1. The decision rule above applies to the scenario without government support. If the government contributes to the industry's innovative efforts by providing a general subsidy, green technology is adopted when the sum of expected discounted lifetime profits exceeds the sum of the expected discounted lifetime costs associated with the adoption corrected for a general subsidy, leading to the following decision rule

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t\left[\pi_{it,1}(m,n) - \pi_{it,0}(m,n)\right] > \mathbb{E}\sum_{t=0}^{\infty}\beta^t\left[C_{t,1} - S_{t,1}\right] \tag{4}$$

We have now presented the final decision rule of the domestic firm that is considering adopting a new green technology available on the global market. As the simple rule shows, the role of the government can be highly influential in the widespread adoption of green technologies in the domestic economy. The technology diffusion literature mostly tries to understand the determinants of the size of the cost of adoption (C_t) and identify which barriers exist that prevent the adoption of a new green technology (Bessen, 2002; Butler & Sellbom, 2002; Parente & Prescott, 1994; Smith & Ulu, 2012). However, the endogeneity of the presence of the general subsidy (S_t) to the social and political dynamics is much less studied, although potentially serving a crucial role in the adoption of green technologies, as argued above.

3.2 Political Economy Theory

We now examine the dynamics present in the political landscape that determine the presence and size of the general subsidy. It is as if we are making the general subsidy endogenous to the underlying social and political systems where welfare-maximizing groups interact with each other to protect their interests. Instead of formally modeling the endogeneity of the general subsidy, we will take a more qualitative approach, which is more commonly employed in political science literature (Bunte, 2019). A complicating factor in the implementation of green technologies in the process of diversification in resource-rich economies is the presence of rent-dependent actors related to natural resource extraction, making a political economy perspective necessary to better understand resistance to economic diversification and adapting green production practices (Balmaceda, 2018; Bems et al., 2023; Corral-Montoya et al., 2022; McNeish, 2018). The political economy perspective acknowledges the ongoing historical process that interweaves political, economic, and social factors of change. For example, Ake (1987) argues that the political economy approach considers the relatedness of social life and material existence. Marchak (1985) defines the political economy perspective as the examination of power relationships that stem from or rely on a property rights system, the historical progression of such relationships, and their cultural and social manifestations. Onimode (1985), in the tradition of Marx, emphasized that political factors significantly influence the forces and relations of production that compromise the modes of production where the pursuit of profit and the exploitation of resources can lead to unsustainable practices and the degradation of the natural environment. Building on these insights, the analysis employed in this paper aims to gain valuable insights for understanding the adoption of green practices in a relatively low level of abstraction.

3.2.1 Distributional Coalitions

A green growth approach generates substantial domestic resistance as these strategies create domestic winners and losers (Resnick et al., 2012). Groups in society form distributional coalitions to protect their interests and gain more power (Cameron, 1988; Olson, 1982). Olson (1982) and Cameron (1988) define distributional coalitions as specific groups in society who aim to maintain and strengthen their position. The government's choice of promoting the adoption of green technology can be explained by the relative power of these distributional coalitions (Flores et al., 2022). The bargaining power of these coalitions is influenced by several factors, including resource ownership, organizational capacity, networks and alliances, and access to information. The specific strategies adopted then lead to distributional consequences, which refers to the way in which political decisions create winners or losers (Bunte, 2019). These distributional coalitions involve a wide range of stakeholders, including governments, local communities, suppliers, industry associations, consumers, non-governmental organizations, environmental organizations, civil society, academia, and (foreign) investors.

To operationalize the analysis, the classification of stakeholders will be limited to domestic industry, local communities, and government agencies. These groups are responsible for representing other stakeholders' interests to varying degrees. For instance, environmental agency members frequently belong to the local communities, work in academia, or are farmers. Importantly, following the literature, the classification problem regards those who possess tangible, fixed assets as part of the industry since their income is reliant on the profitability of their organization. On the other hand, members of local communities do not have ownership of any assets, and thus they are forced to sell their labor (Cohen, 1985). This is based on the assumption that these laborers do not hold any stocks in the manufacturing company. It is important to note that salaried government workers are constituents of the local communities, as their primary source of income is their wages (Bunte, 2019; Tomz, 2004). However, the analysis still considers them separately since they have varied interests and perform a specific role in the processes that lead to the successful adoption of green technology.

3.2.2 Interests and Motivations

We need to understand the economic goals and the environmental and social considerations of these distributional coalitions. The decision-making process of industry is more complex than the decision rule above illustrates. Still, industry is primarily concerned about profit maximization, market expansion and resource access are prioritized (Gudynas, 2019; Khan, 2017; Sörlin, 2022). Apart from economic interests, industry may also engage in social responsibility, adopting sustainable practices, addressing environmental concerns, and enhancing public and environmental well-being (Ahen, 2019). However, this social and environmental ethical behaviour may be motivated by the need to reduce societal unrest and sustain unsustainable production activities. Thus, industry is interested in political decisions that provide them with favourable conditions for production, reduced regulations, tax incentives to maximize profitability (e.g. in the form of a general subsidy), and access to global market chains (Lall, 2002).

The economic goals of local communities are focused on job creation, poverty alleviation and improving infrastructure, which directly impacts their prosperity and quality of life (Addison & Roe, 2018; Vela Almeida, 2020). Diversifying the economy by building new industries is seen as a way to increase living standards and provide financial stability for families (Avilés Irahola et al., 2022; Wolff, 2017). Local communities are also interested in preserving the social and environmental environment and often advocate for political decisions that limit unsustainable production activities as they may significantly harm the local ecosystems (Bell, 2018; Hinfelaar & Achberger, 2017; Vela Almeida, 2020). Therefore, these communities prioritize political decisions that promote job creation, fair compensation for local resource use, and investments in local infrastructure (Unctad, 2015).

Governments in countries with a large extractive and industry can earn significant revenues from these sectors (McMillan & Waxman, 2007). However, these sectors are also fraught with several challenges, such as environmental degradation, social inequality, and potential political instability (Bell, 2018). Government agencies have a critical role to play in managing these challenges and ensuring that the benefits of extractive activities are equitably distributed (McMillan & Waxman, 2007). These agencies are often faced with competing objectives, such as maximizing the revenues from resource extraction and industry exports, fostering economic development and employment opportunities, guaranteeing national resource security, financing public services and infrastructure projects, and safeguarding the welfare and interests of local communities (Goode, 2010). Hence, although they favor sustainable over unsustainable production practices, the presence of general subsidies are often limited to constraints along various dimensions. Obviously, the government should remain uninvolved in the adoption of green technology by domestic industry when the costs are low enough for the industry to adopt the technology without support. If this is the case, $\pi_{it,1}(m,n) - \pi_{it,0}(m,n) > C_{t,1}$ for every i, and consequently $S_{t,1} = 0$. However, if there exists i such that $\pi_{it,1}(m,n) - \pi_{it,0}(m,n) < C_{t,1}$, government assistance can influence the adoption of the new green technology in the domestic economy and $S_{t,1} \geq 0$. In this case, the government will contribute when the benefits of the adoption of the new green technology outweigh the cost of support.

These costs and benefits are not merely monetary amounts but also involve electoral costs and benefits. Importantly, local communities are important voting groups, and governments often rely on the support of these communities to secure votes during elections. Therefore, prioritizing policies that cater to the welfare and interests of these communities can increase the chances of re-election, as well as promote social stability by addressing their concerns and avoiding protests or social disruption that could lead to political instability (Bunte, 2019). However, governments may also be motivated to maximize revenues from export revenues to support economic development, create employment opportunities, and maintain national resource security (Collier & Goderis, 2008). This could be especially essential in developing economies, where governments rely on the revenue generated by extractive activities to fund public services and infrastructure projects (Venables, 2016). Thus, providing support to the industry and thereby influencing the adoption of green technology and eco-friendly policies can be seen as partly motivated by political economy dynamics.

3.2.3 Conservative and Progressive Governments

Having defined the relevant distributional coalitions and described their objectives, we may ask how these interests affect the political decisions made by government agencies. We recognize the duality of the objectives of the government and assume that government officials want to remain in office while trying to maximize government revenues simultaneously. Contrary to the assumption that governments inherently prioritise sustainable practices, we argue that political decisions are predominantly driven by short-term electoral motives. Governments strategically respond to the perceived electoral preferences of local communities concerned about the enduring impact of unsustainable activities. This rests on the assumption that the ideological beliefs of policymakers do not directly influence their political decisions. Some empirical papers suggest the opposite (A. M. Jacobs, 2009; McNamara, 1999). However, Bunte (2019) argues that despite politicians having personal ideological beliefs, they are often elected because their views align with those of influential interest groups. The electoral process ensures that politicians' preferences match those of the dominant interest groups. Conversely, politicians whose views diverge from these powerful groups are likely to lose their positions. In this way, the trade-off between short-term economic gains and long-term sustainability can be reframed as a distinctly short-term dilemma[4]. Leaders aiming to retain their positions tend to implement policies that key distributional coalitions prefer (Leeds et al., 2009; Mattes et al., 2015), which allows distributional coalitions to influence government decisions (Moravcsik, 1997). In line with the works of Frieden (1991) and Bunte (2019), the approach employed in this paper assumes that the primary role of the government is to consolidate the preferences of distributional coalitions, considering their respective impact and subsequently cater to the politically most powerful groups.

The dynamics between distributional coalitions and government decision-making, as previously outlined, have significant implications for political parties within democratic systems. The power and influence of relevant distributional coalitions play an important role in determining the political strength and decision-making authority of conservative and progressive parties (Hess & Renner, 2019; McLean & Plaksina, 2019). On the one hand, labor might vote for progressive parties as they often champion social and environmental justice and advocate for government intervention to create jobs and reduce poverty. On the other hand, the industry might vote for conservative parties as they often prioritize traditional values, limited government involvement, and pro-business measures. Specifically, the role of conservative and progressive parties in influencing policies, such as providing subsidies for eco-friendly production methods, is of great importance. Progressive parties exercise considerable influence in promoting government involvement in key areas such as environmental protection, social welfare initiatives, and labor rights. Their public policies often revolve around promoting the adoption of environmentally friendly production techniques through subsidies and other incentives, reflecting their strong dedication to sustainability (Båtstrand, 2015; Carter et al., 2018). On the other hand, conservative parties typically prioritize reducing government regulations, reducing taxes, and developing policies to protect the competitiveness of the domestic industry, which can lead to a preference for market-driven solutions that prioritize profits rather than direct subsidies to green the production practices (Båtstrand, 2015; Carter et al., 2018). Creating a functional government within a democratic system characterized by an abundance of political parties necessitates the formation of political coalitions. These coalitions, which align to a lesser or greater degree with each party's agenda, play a pivotal role in influencing the type of policies

[4] For instance, Garri (2010) demonstrated in a two-period model that politicians, driven by different motivations, might provide a public good for immediate payoff to avoid being perceived as ineffective even if this is suboptimal.

implemented. Balancing the interests of the local communities and industry within these political coalitions determines the eventual policies implemented by the government.

3.2.4 Dynamics and Expected Outcomes

Based on our observations, we can make some general predictions. The predictions will be presented in their most general form, which then can be translated to predictions for specific cases (i.e., the adoption of a specific green technology at a specific location and time). Based on the final decision rule, providing more and higher general subsidies to potential adopters of new green technologies is likely to enhance the likelihood of widespread adoption among domestic firms. Then based on our political economy theory of technology adoption, we can make the following predictions. Firstly, government policies are significantly influenced by key distributional coalitions that exert their power via the democratic voting system. Secondly, conservative parties lean towards reduced regulations and therefore reduce the number of subsidy programs to support firms in reducing energy intensity. Thirdly, progressive parties focus on environmental protection and government intervention, and therefore increase the number of those subsidy programs. Finally, if a political coalition is formed with a conservative and progressive party, policy outcomes are likely to be shaped by a nuanced negotiation of preferences influenced by the relative political bargaining power of each party.

Thus, the conceptual framework presented above integrates basic insights from the technological diffusion literature and builds a political economy theory of green technology adoption to better understand the success of green technology adoption in some developing countries. By examining the decision-making processes of firms, the role of government subsidies, and the dynamics among distributional coalitions and the government, this framework offers a perspective that goes beyond economic considerations.

4 Empirical Evidence

The remainder of the paper aims to test whether countries with a progressive stance towards government intervention in industry to green productive practices are more likely to implement such policies than more conservative governments. We aim to test the predictions by constructing a unique index of the progressiveness of the government and then test whether it is a significant predictor for the number of climate policies implemented aiming to reduce energy intensity in the industry. The goal is not to establish causal relationships but rather to discover some interesting tendencies that require further exploration.

4.1 Data

To test the conceptual predictions presented in the previous section, a unique dataset was created by combining information from various sources. First, we collected data on all climate policies implemented worldwide via the IEA's Policies and Measures Database[5] (International Energy

[5] The database is available at https://www.iea.org/policies.

Agency, 2023), which provides data on existing or planned government policies and measures to reduce greenhouse gas emissions, improve energy efficiency, and support the development and deployment of renewables and other clean energy technologies. Specifically, we include those policies pertaining to payments, finance, and grants with the objective of advancing energy efficiency and encouraging the use of renewable energy in industry. For example, it includes government-sponsored grants for solar panel installations, financial incentives for energy-efficient infrastructure projects, and industry-led investigations into cutting-edge carbon capture technologies. We collapsed the data based on country and year to get the total number of climate policies implemented for an individual country in a given year. Second, we collected election data from The Manifesto Project[6](The Manifesto Project, 2023), which documents political parties' election manifestos in order to study their policy preferences. The dataset covers over 1,000 parties globally since 1945, with regular biannual updates. The Manifesto Corpus, which is a digitalized and multilingual collection, consists of machine-readable electoral programs that have been quasi-sentence unitized and coded using the Manifesto Coding scheme, with metadata such as party and election date. With coverage of over 60 countries and nearly 40 languages, the corpus comprises more than 3,000 machine-readable programs and over 1.8 million coded quasi-sentences. The ultimate goal of The Manifesto Project is to conduct substantive analyses of parties' roles in the political process, with an emphasis on programmatic representation quality. Finally, macroeconomic data was collected from the World Economic Outlook Database[7] (International Monetary Fund, 2023).

4.2 The Progress Index

From the data provided by The Manifesto Project, we created a unique index that measures the government's position on government intervention in the domestic industry to foster environmentally sustainable production practices. The dataset includes all election results for political parties that have secured at least one seat in the parliamentary elections of Australia, Japan, New Zealand, North America, South Korea, and Western Europe, as well as those that have won two or more seats in Central and Eastern Europe and South America. Each observation details a country, political party, their party family (e.g. Ecological, Socialist, Conservative, etc), and the percentage of votes gained by each party. The study evaluates measurable aspects of quasi-sentences[8] found in the agendas of each political party, organized by various categories. By applying codes, these policy agendas are analyzed to assign numerical values to multiple dimensions based on the occurrence of specific words or sentences related to particular subjects outlined in the parties' formal policy documents. For example, if a party dedicates a substantial amount of quasi-sentences to the 'economy' category, it is likely placing a significant emphasis on economic policies within its agenda. Similarly, if a party allocates a significant portion to 'welfare and quality of life' it indicates a prioritization of

[6]The database is avaiable at https://manifesto-project.wzb.eu/.

[7]The dataset is available at https://www.imf.org/en/Publications/WEO/weo-database/2023/April.

[8]In the context of the coding unit, a quasi-sentence is defined as a single statement, and while a grammatical sentence can encompass multiple quasi-sentences, it should not extend beyond the boundaries of one grammatical sentence, with the exception of the preamble and headlines.

social welfare policies. After establishing the total number of quasi-sentences related to various topics in the party's manifesto, this number was subsequently transformed into a proportion of all the quasi-sentences in the manifesto. This conversion was achieved by dividing the count of quasi-sentences related to specific topics by the total number of quasi-sentences present in the entire manifesto. By comparing the quasi-sentences per topic among different parties, we can better understand their policy focuses and how they position themselves within the political landscape.

We created an index for each individual party that reflected their stance towards government intervention in the domestic industry to help them green their productive activities. Essentially, we calculated a weighted average of the relative number of quasi-sentences per relevant topic. This weighted average takes into account various topics, each assigned positive or negative weight, reflecting the government's inclination towards specific economic policies and interventions. Topics where the relative number of quasi-sentences contributed positively to the index, include support for supply-side-oriented economic policies that prioritize businesses over consumers, initiatives promoting a fair and open economic market, a commitment to modernizing industries, and advocating for direct government control of the economy. Positive attitudes towards all labor groups, the working class, and unemployed workers, as well as prioritizing sustainable economic development while opposing growth that harms the environment or society, were also positively weighed. On the other hand, topics with negative weights include favoring the free market and free-market capitalism as preferred economic models, negative references to labor groups and trade unions, and opposing the need for direct governmental control of the economy.

Hence, we developed a measure of progressiveness towards climate action for each political party in our dataset. Utilizing this party-specific metric as the foundation, we have established an election-country-specific index by calculating a weighted average across individual party indices. The weights were determined based on the percentage of votes received by each respective party. As a result, a party that demonstrates a significant level of progressiveness in favor of government intervention and secures a substantial vote share will result in a high election-country-specific index. Conversely, a party that exhibits a similar inclination towards government intervention but receives only a modest fraction of votes will result in a lower index, all else equal. In the subsequent analysis, we refer to the index we have generated as the Progress Index. Table 1 provides a breakdown of the Progress Index across quantiles of the logarithm of GDP. The table includes key statistical measures for the Progress Index within these quantiles. For each quantile, the table displays the minimum value, the first quartile, the mean (average), the third quartile, and the maximum value of the Progress Index. These values offer insights into the distribution and variability of the Progress Index across different levels of economic development, as represented by GDP quantiles. The results from t-tests indicate that there are statistically significant differences in means between the quantiles. The table also indicates trends such as the general increase in the mean Progress Index as GDP quartiles ascend, despite a slight drop from the 0.4 to the 0.6 quantile, suggesting a positive correlation between economic development and the political landscape's stance on government intervention and environmental sustainability.

Table 1: Progress Index for each 5-Quantile of log(GDP)

Quantile of log(**GDP**)	**Min.**	**1st Qu.**	**Mean**	**3rd Qu.**	**Max.**
0.2	2.808	2.808	4.576	4.359	11.345
0.4	11.34	17.20	21.49	25.01	30.79
0.6	7.348	15.477	18.842	21.781	42.904
0.8	7.476	18.030	22.648	27.313	41.685
1	1.588	20.922	26.081	31.607	58.823

Source: The Manifesto Project and World Economic Outlook Database

Indeed, the correlation coefficient between the log of GDP and the progress index is approximately 0.34. Table 2 showcases the energy efficiency policies implemented by countries between 2000 and 2022 to promote eco-friendly industrial activities. The table highlights the top and bottom 10 nations based on the total number of policies. The United States emerges as a frontrunner with 53 policies, followed closely by Germany with 44 policies. Australia and Canada exhibit comparable commitment with 38 policies each, while the United Kingdom completes the top five with 35 policies. These developed nations showcase a strong dedication to diverse energy policies, reflecting their advanced technology and strategic sustainability goals. On the other hand, the bottom 10 countries have a modest total of policies, indicating a limited spectrum of energy policies. These developing nations exhibit a more restrained approach, suggesting potential challenges or differing priorities in pursuing sustainable energy development.

Table 2: Number of Policies

Top 10		**Bottom 10**	
Country	**Total Policies**	**Country**	**Total Policies**
United States	53	Bangladesh	1
Germany	44	Chinese Taipei	1
Australia	38	Israel	1
Canada	38	Jordan	1
United Kingdom	35	Kenya	1
India	31	Myanmar	1
France	24	Romania	1
People's Republic of China	22	Saudi Arabia	1
Ireland	19	Thailand	1
Portugal	19	Azerbaijan	2

Source: International Energy Agency

The variation in the number of policies implemented between advanced and developing nations underscores the diversity in their commitment or capacity to offer subsidies to industries. Developed countries tend to have a broader range of policies aligned with their advanced technological and economic capabilities while developing nations exhibit a more restrained approach reflective of potential challenges or diverse development priorities. Indeed, the correlation coefficient is positive (0.295), although lower than initially expected. This disparity underscores the need to consider socio-economic factors influencing energy policy formulation and bridge the gap between developed and developing nations to achieve a more equitable global energy transition.

4.3 Estimation Strategy

In order to evaluate our predictions, we tested whether the level of progressiveness demonstrated by political coalitions in promoting government intervention to improve industrial energy efficiency, as measured by our index, can be considered a significant indicator for the number of climate policies enacted in each country on a yearly basis. As our dependent variable, number of policies, is a discrete order variable, we employed an ordered probit model. The ordered probit model is particularly suited for situations where the dependent variable exhibits an ordinal nature, implying an inherent order or ranking of outcomes (Becker & Kennedy, 1992). This is precisely the case with our discrete and ordered variable representing the count of climate policies. The model assumes a latent variable, Y_i, underlying the observed ordinal categories, and this latent variable follows a logistic, normal, extreme-value, or Cauchy distribution. For our specific analysis, we estimated the following ordered probit model:

$$\text{probit } P(\text{Number of Policies} \leq k|x) = \zeta_k - \eta$$

In this equation, ζ_k represents the breakpoints determining the thresholds between different ordinal categories, and η is the linear predictor—a linear function of the explanatory variables without an intercept term. The ordered probit model's statistical assumptions are well-suited to our research framework. By utilizing the probit link function, the model assumes a standard normal distribution for the latent variable that underpins the ordinal categories. This is especially useful in investigating issues like political stances or climate policies that may display discernible thresholds or degrees of intensity. Additionally, the ordered probit model is proficient at calculating threshold parameters, which indicate the points at which the likelihood of moving from one category to the next changes. This is valuable when analyzing political party positions that might exhibit clear thresholds or levels of intensity in their attitudes toward government intervention. Our first model focuses solely on our index as the explanatory variable. However, we acknowledge the potential predictive power of GDP per capita regarding the number of implemented policies and its correlation with the progressiveness index. Thus, in Model 2, we introduce GDP per capita as a control variable to reduce endogeneity issues.

4.4 Results

The findings of the ordered probit regression models, which aimed to investigate the correlation between the progressiveness of political coalitions, as measured by the Progress Index, and the number of climate policies implemented, are displayed in Table 3. The empirical strategy considered two models: Model 1 concentrated solely on the Progress Index as the explanatory variable, while Model 2 introduced GDP per capita as a control variable to address one of the most obvious sources of endogeneity. According to the findings of model 1, there exists a statistically significant and affirmative correlation between the progressiveness of political coalitions and the number of climate policies. Thus, an increase in the Progress Index is likely to lead to a corresponding rise in the enactment of more climate policies. When introducing GDP per capita as a control variable in Model 2, the coefficient for the Progress Index remains statistically significant but decreases. Additionally, GDP per capita has a statistically significant positive correlation with the number of climate policies, close to the correlation coefficient presented earlier. Based on minimizing the AIC information criteria, it can be inferred that Model 2, which incorporates GDP per capita as a control variable, is a better fit for the data.

Table 3: Ordered Probit Regression Results

	Model 1		Model 2	
	Coefficient	(Std. Error)	Coefficient	(Std. Error)
Progress Index	0.030^{***}	(0.008)	0.016^{**}	(0.008)
GDP (logged)	-	-	0.283^{***}	(0.047)
AIC	632.499		592.874	
df	404		404	

*Note: *** indicates confidence at 1%, ** at 5% significance level.*

The study's results provide evidence that the degree of progressiveness towards providing subsidies to industry within political coalitions is a key factor in the number of climate policies that are implemented. Furthermore, the integration of GDP per capita as a control variable strengthens the model's explanatory capacity while also addressing potential endogeneity problems. It is noteworthy that the progressiveness of political coalitions continues to be a reliable predictor, even when accounting for GDP per capita. These findings expand our comprehension of the factors that influence the implementation of climate policies, emphasizing the significance of considering both political dynamics and economic indicators in such analyses.

5 Conclusion

We conducted an analysis to examine the relationship between political coalition progressiveness and the implementation of climate policies, with a focus on government intervention to promote energy efficiency improvements in industry. Our analysis was based on a theoretical framework that drew from political economy and technological diffusion literature, providing a solid foundation for understanding the dynamics between government decision-making, distributional coalitions, and the impact of political parties on the adoption of green technologies. We used an ordered probit model to conduct an empirical analysis, relying on a unique dataset that combined information from the IEA's Policies and Measures Database, The Manifesto Project, and the World Economic Outlook Database. By creating a Progress Index, we were able to measure the stances of political parties toward government intervention in domestic industries to encourage sustainable practices. Our findings consistently demonstrated a statistically significant and positive correlation between the progressiveness of political coalitions and the number of climate policies implemented, highlighting the essential role of political dynamics in shaping climate policy. To enhance the explanatory power of our model and address potential endogeneity concerns, we included GDP per capita as a control variable. The correlation between the progressiveness of political coalitions and climate policy implementation persisted even after accounting for economic indicators, underscoring the complex interplay between political and economic factors.

The results have significant implications, emphasizing the critical role that political ideologies and coalitions play in shaping climate policies. As the world struggles to address environmental sustainability, our study provides valuable insights into the factors influencing policy outcomes. However, our study has limitations, and ongoing research is necessary to refine our models and explore the complex nature of political and economic interactions. For example, while our ordered probit model offers insights into correlations, it remains challenged by the inability to account for unobserved variables that may influence political stances and policy outcomes concurrently. Future research endeavors might explore more advanced econometric methods or leverage instrumental variables to mitigate endogeneity concerns further. The temporal dynamics of policy implementation pose another layer of complexity. Our study spans data from 2000 to 2022, during which political and economic landscapes have undoubtedly undergone significant transformations. Understanding the nuanced temporal dynamics of policy responses to evolving global challenges and technological advancements requires further investigation. Future studies should delve deeper into the temporal aspects of policy implementation, consider additional contextual variables, and expand the geographical scope to encompass diverse political and economic landscapes. Furthermore, it would be interesting to analyze how macroeconomic factors influence the preferences of the various distributional coalitions. In summary, our research illuminates the complex interplay between political progressiveness and the resulting outcomes of climate policy. Through a combination of theoretical perspectives and practical data analysis, we provide a nuanced understanding that adds to the ongoing conversation about green technology adoption. Our findings highlight the critical need to synchronize political will and economic considerations in order to ensure a sustainable future in the face of the challenges presented by the energy transition.

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