International Business and the Challenge of Financing a Just Climate Transition*

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Climate change and the associated issue of curbing carbon emissions has risen on the agenda of policymakers worldwide. However, global coordination on matters such as harmonized regulation has been subject to significant political frictions and the large inter-governmental transfers needed to finance the transition of developing economies have proven hard to come by. Recently, there have been considerable responses to climate change from the private sector, with stakeholders placing increasingly more pressure on firms, and financial markets mobilising increasingly more capital towards the reduction of negative externalities. We argue that although multinational enterprises (MNEs) have been a big contributor to the problem, they can be an important part of the solution - they have unique features that enable them to play an important role in the fight against climate change. MNEs have extensive and efficient internal markets for governance, financing and technology, that enable them to circumvent country-specific frictions to climate action such as heterogeneous regulation, corruption, and the lack of technology. We analyse how different public and private incentive mechanisms could be designed to leverage MNEs' unique features, realign their incentives with those of the collective and engage their potential to play a role in decarbonizing the economy. Lastly, we discuss challenges, opportunities and open research questions.

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INTRODUCTION

The global sustainability issues resulting from climate change have received increased recognition in recent decades, given the substantial disruptions that it poses to the processes and institutions that support human life and well-being. Although the issue of climate change has risen on the agenda of policymakers worldwide, disagreement persists. The importance of taking measures to prevent climate change is widely accepted in Europe. However, even if Europe gets to net zero emissions by 2050, this is a small part of the global problem. As shown in Table 1, the proportion of greenhouse gasses (GHG) emitted in the European Union (EU) is 7.5% of the total. The United States (US), another country where there is concern, at least by some part of the population, about reducing GHG emissions, is a large emitter at 13.5%. However, the largest emitter by far is China at 30.1%. Other significant contributors are India and Russia.

Table 1: **Percentage of total 2021 annual global emissions** (Source: Global Carbon Budget (2022) - Friedlingstein et al. (2022)).

Country	Share of global emissions (2021)
China	30.1
United States	13.5
Europe[a]	9.5
EU27[b]	7.5
India	7.3
Middle East[c]	7.0
Russia	4.7
Latin America[d]	4.6
Japan	2.9
Australia	1.1
United Kingdom	0.9

[a] EU27 and all other countries in Europe not belonging to the European Union, excluding Russia

[b] EU27 stands for the 27 countries pertaining to the European Union as of February 2020

[c] Arabian Peninsula, the Levant, Turkey, Egypt, Iran, and Iraq

[d] All countries South from Mexico excluding Caribbean countries

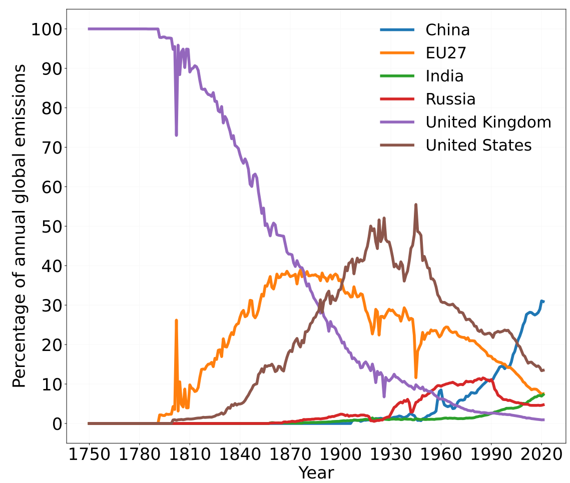

Figure 1: **Percentage of annual global CO_2 emissions for different countries and world regions in 2021** (Source: Global Carbon Budget (2022) - Friedlingstein et al. (2022)).

The challenge of financing a just climate transition

Notwithstanding the 2021 snapshot presented in Table 1, there is still considerable debate about who are the biggest contributors and the associated issue of who is most responsible to take climate action. Figure 1 shows the historic share of GHG emissions from 1750-2021. While the UK was the largest emitter until the late 19$^{\text{th}}$ century, the countries that currently comprise the EU 27 briefly took over this position, then the US did, until recently when China became the largest emitter. The graph shows that historically it is the advanced countries that were the major emitters, and it is only in the last few years that emerging economies have taken that position. One important issue that has come up is who should pay for the cost of moving away from fossil fuels and reducing emissions to net zero (Fankhauser et al., 2021) Developed countries argue that each country should bear the majority of the costs of their own net zero policies. Many developing countries such as India, argue that developed countries that have been responsible for large emissions during their industrialisation should be responsible for bearing most of the costs of their transition. This debate is known as the climate justice debate (Shue, 2014). Indeed, at the 2009 COP15 meeting in Copenhagen developed countries committed to jointly mobilize USD 100 billion a year by 2020 to help developing countries adapt to climate change (OECD, 2022). The funds, mobilised through the so-called Green Climate Fund (GCF), were still about USD 17 billion short as of 2020. This shortfall worsened the tensions between the Global North and Global South countries, with the latter facing most of the irreversible damages of global warming while in urgent need for economic development, and the former failing to own responsibility for it.

The financial resources that need to be mobilized in order to achieve the Paris Agreement goal of keeping the temperature rise under 1.5°C are significant, and well beyond the scope of what governments can provide.[1] Furthermore, governments face serious political constraints to implementing regulation and tools that support the climate transition. Such political frictions are compounded in developing countries facing other stringent problems such as poverty, higher exposure to climate shocks and consequent adaptation needs, as well as global equity considerations related to fact that countries that have contributed the least are affected the most and are also the ones with the least resources to invest in adaptation and mitigation. Global coordination on matters such as harmonized regulation has proven practically impossible and large inter-government transfers, such as those mobilised through the GCF, have proven hard to come by.

The role of finance in a politically fragmented world

Against the background of fragmented and largely missing public coordinated action, the last years have seen considerable responses to climate change from the private sector. In particular, the capital deployed through financial markets has increased considerably. As of 2022, debt markets alone have mobilized cumulatively over USD 6 trillion to finance sustainability related projects, which is orders of magnitude larger than the 2009 pledge to developing countries.[2] Furthermore, financing agreements can be designed to make the provision of funds at favorable or concessional rates, conditional on the borrower taking climate action. This type of financial innovation, which makes the cost of debt contingent on the borrower's carbon emissions, can be equivalent to a carbon tax in that it provides the same carbon reduction incentives (Allen et al., 2023).The implication is that it is possible to substitute politically fraught regulation with a market solution.

The capital needed to finance the climate transition might therefore exist (especially if public funds are used to de-risk and leverage private investments) and recent estimates indicate that it is in the interest of everyone to pay the polluter to stop polluting (Adrian et al., 2022). However, simply transferring the resources necessary from developed to developing economies to finance the changes needed to prevent climate change is problematic. Significant concerns exist regarding corruption, lack of transparency and the extent to which emerging economies have the technical capabilities to implement the changes needed.

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[1] Such investment estimates range from USD 5 trillion per year by 2030 (World Resource Institute, 2021) to USD 6.9 trillion per year (OECD, 2022).

[2] Granted, these have different purposes but the point is that the capital mobilized through markets is not trivial and markets can play an important role.

Multinational enterprises (MNEs) have potential to address climate change

In this paper, we argue that MNEs can act as conduits for transferring the resources necessary to finance the climate transition and implementing the actions needed. MNEs have extensive internal markets for governance, financing and technology that enable them to circumvent country-specific frictions to climate action such as heterogeneous regulation, institutional failure, and technical capabilities to implement the changes needed.

Through their internal governance markets that operate across national boundaries, MNEs can potentially coordinate actions better than governments. Furthermore, they are under intense scrutiny and pressure from various stakeholders (including shareholders, activists, media and consumers) and have recently been pushed to extend their corporate governance standards across countries and drive change in places where it would likely not happen otherwise. Additionally, MNEs have superior access to external capital, and internal capital markets that enable them to distribute financial resources efficiently across borders. MNEs' superior access to capital has not only supported their research and development (R&D) and innovation capabilities but has also allowed them to diffuse and implement technological innovations in developing countries. Their ability to adapt and respond to local market needs has enabled accelerating the expansion of low-carbon energy technologies in critical emerging markets. We discuss concrete examples illustrating how MNEs respond to country-specific conditions to develop firm-specific advantages (FSAs), how FSAs contribute to the emergence of country-specific advantages (CSAs), and how MNEs have optimally recombined FSAs in financing, innovation, technological know-how, collaborations and partnerships to develop and implement climate solutions in developing markets.

Importantly, we note that emissions are highly concentrated among a small number of large corporations that operate internationally. Steenbergen and Saurav (2023) estimate that 157 large MNEs jointly account for up to 60% of global industrial emissions, either through direct activities (10%) or indirectly via their supply chains (50%). As MNEs are a major contributors of global emissions, they are also in a position to become significant actors of decarbonation efforts. Rather than focusing our discussion around the idea that MNEs are solely culprits, our aim is to emphasize the important effect that engaging these companies positively would have.

We discuss incentive tools and mechanisms that can be employed to engage MNEs' potential to play a role in the challenge of decarbonizing the economy. We first note that MNEs might have self-interested incentives for climate action. Given their size, which in many instances surpasses that of entire countries, and the fact that they operate across many countries, they are in a unique position to internalize the global externality, in a manner that transcends the country-specific focus of many other stakeholders, including governments. Setting incentives such that MNEs' objectives are aligned with societal priorities can be done through public measures such as regulation, private measures such as contracting and other forms of engagement with actors, or a combination of the two. Our contribution is to emphasize a corporate finance perspective as we discuss the role of private levers provided through market solutions, and which operate through corporate governance and financing channels.

In the sections that follow, we first review the relevant literature and then discuss features of MNEs that provide them with unique advantages to tackle the risks of climate change. Next, we analyse how different public and private mechanisms could be designed to leverage MNEs' unique features and realign their incentives with those of the collective. Finally, we discuss opportunities, challenges and open questions.

LITERATURE REVIEW

Over the past two decades IB scholars have started to rethink how core frameworks such as the eclectic paradigm, the ownership, location, and internationalization advantage (OLI) model and the country matrix model (Dunning, 1977; Dunning & Lundan, 1993; Rugman, 1981), could allow to understand how MNEs could address the challenge of climate change and be affected by its rising underlying risks. Since then, IB scholars have studied different components of this crucial societal research question.

Ciravegna et al. (2023), H. H. Huang et al. (2017), and Romilly (2007) analyse the impact on MNEs revenues deriving from heterogenously distributed climate physical risks and discuss how internationalization can hinder or favour adaptation. Alongside the need to adapt, authors such as Guest (2010) and Sachs and Sachs (2021) call for the need to understand and rethink the role of MNEs to address the challenge of climate change mitigation. In response to the increasingly recognised role of MNEs in tackling the climate mitigation challenge, early studies such as Kolk and Pinkse (2008) and Pinkse and Kolk (2011) focused on whether and how MNEs could seize the opportunity to develop "green" firm-specific advantages (FSAs), and help reconfigure key FSAs that are key to firm performance.

On the other hand, the existing tension between the need to realign the imperatives to tackle both climate change and economic stability which are determined by the collective with the decisions of MNEs based on self-interest and independent of the collective interest has been a research topic tackled by several authors from different angles. For instance, Doh et al. (2021) analyse the challenges and different paths of technological development and cooperations that MNEs can engage to achieve the needed Long Term Energy Transition (LTE) to decarbonize the economy. The response and effectiveness of different mechanisms to incentivise MNEs to reduce carbon emissions has been analysed for the case of carbon markets and pricing (Nippa et al., 2021) in the case of the EU's Emission Trading Scheme), or the potential of introduction of new technologies to improve the transparency and reliability carbon disclosures at MNE-level (Ciulli & Kolk, 2023) to address the pitfalls of voluntary disclosures (Aragón-Correa et al., 2016).

As the effectiveness of different regulatory incentive mechanisms to drive decarbonization has been studied (Hartmann et al., 2020) for the case of hydrocarbon MNEs), the engagement of MNEs with public decision-making processes has been the focus of several studies. Bass and Grøgaard (2021) and Lawton (2022) analyse the roles of MNEs to drive and influence the shaping of policies aimed at achieving energy transition. Jensen et al. (2010) focus on the interplay between the level of compliance with reporting requirements depending on the strength of political repression across countries. Patnaik (2019) studies the level of stringency of policies depending on the political alignment of MNEs constituents and that of governments. As well, Lashitew (2021) and Yu et al. (2023) focus on the need of policies and institutions to be designed to prevent "greenwashing" by MNEs leveraging on non-transparent disclosures and asymmetry of information with investors.

In this paper, we first identify the different features and channels inherent to MNEs that can be deployed to address the challenges of mitigation of and adaptation to climate change. Subsequently, we extend the dimensions through which we can understand how MNEs can confront climate change. In effect, while IB scholars have approached this question through the angles of regulation, macro-economic, or socio-technical, analysing the drivers that influence the governance, capital structure, and decision making at the firm-level using the viewpoint of corporate finance could provide new valuable insights.

FEATURES

We identify four MNE features that enable them to play an important role in the fight against climate change and illustrate using examples how these capabilities have been successfully employed to that end. We first illustrate how the size and reach of MNEs can enable them to achieve impact at scale. Subsequently, we discuss how MENs' superior resources enabled them not only to develop new technologies relevant to the climate crisis but also to deploy technology to emerging markets lacking such capabilities and resources. Subsequently, we present how resources and technology inherent to MNEs can be deployed and result in key components of the response to the climate change challenge. We then discuss how the collaboration and partnerships that MNEs engage in have been used to develop and disseminate innovative mitigation solutions. Finally, we analyse how access to capital can be leveraged to enable developing and upscaling innovative and effective climate change solutions.

Size and Reach

MNEs' large scale of their operations and global extent of their supply chain has been studied and linked to their ability to acquire important economic and political influence (Sun et al., 2021). The magnitude of their operations and reach are also, under certain conditions, instrumental to address the climate change mitigation challenge. One such instance is when the operations of only a few MNEs play a significant role in preserving or degrading climate processes influencing the global temperature-carbon dynamics. We also illustrate how MNEs cross-national footprint allows disseminating regulation aimed at decarbonizing the economy and adapting to climate change.

Averting triggering a tipping element of the climate system

The Amazonian rain forest is one of the central elements driving the dynamics of the Earth's climate system. It holds 25% of its land-based biodiversity (Dirzo & Raven, 2003) and is one the largest global land carbon sinks with approximately 15% of land-based photosynthetic activity (Malhi et al., 2008). Crucially, it stocks approximately 733 Gt of carbon dioxide (CO_2), the equivalent of over 20 years of the current annual amount of anthropogenic carbon emitted, and plays a key role in regulating regional and global-level climate variability.

Recent estimates indicate that approximately 15% of the original Amazonian rainforest surface has been damaged by mining (Sonter et al., 2017) or agricultural activity (Albert et al., 2023). The ongoing agriculturally driven degradation is contributing to a loss of resilience of the Amazon that could lead to its tipping towards a Savannah-like ecosystem (Bochow & Boers, 2023). The expansion of agricultural production of soybeans driven by the soaring demand from China and the global feed industry has been one of the main drivers of deforestation.

With only five commodity trading groups (Cargill, Bunge, ADM, Louis Dreyfus, COFCO) supplying 80% of China's imports of Brazilian soybean – and China accounting for close to 70% of Brazil's soybean exports (Trase, 2023) – MNEs could play a central role in drastically curtailing deforestation and averting a catastrophic decrease of carbon sequestration. With only 13% of the 2,388 municipalities growing soybean responsible for 95% of deforestation, targeted measures could allow to significantly curtail the risk of further irreversible degradation (Reis & Moro, 2022).

The increase in reliability and transparency of commodity origination in supply chains can be a major driver in ensuring MNEs source from deforestation-free areas. The recent example of Indonesia and the decoupling of the increase of production of palm oil with deforestation provides a useful example. In this case, close to 90% of palm oil exports are bought by trading groups from refineries that report publicly the origin of their sourcing with clear transparency commitments (Heilmayr & Benedict, 2022). There have been attempts to introduce similar traceability initiatives in Brazil. For instance, the satellite-based system for "Real-Time Detection of Deforestation" was launched in 2004 in collaboration between the US National Aeronautics and Space Administration and the Brazilian National Institute for Space Research. Evidence indicates that it has effectively contributed to reduce deforestation through better enforcement by the government (Assuncao et al., 2023).

In effect, while designing and enforcing legislation across all the Amazon deforestation frontlines entails complex multi-stakeholder implementation, MNEs, through the control of their supply chains, can effectively enhance the enforcement of restricting purchases of agricultural commodities grown in non-authorised forested areas. The Amazon Soy Moratorium (ASM) agreement that was reached between the six largest commodity trading MNEs in Brazil to ban the purchase of crops grown in deforested land illustrates the potential that joint MNEs action can achieve (Heilmayr et al., 2020).

Supply chains and procurement

In addition to their size and extensive reach due to direct operations, MNEs have extensive supply chains that span multiple countries. They can leverage their influence to promote sustainable practices among their suppliers and encourage the adoption of environmentally friendly technologies and processes throughout the value chain.

Over 70% of the world's cocoa is produced in West Africa. Subject to current technological and crop management conditions and in a medium-high emission scenario, projections indicate that over half of the current cocoa production area will become unsuitable, with systemic implications for the global cocoa value chain (Schroth et al., 2016). With its exposure to such a systemic risk, the food company Nestlé has engaged in efforts to address the risk of climate change. As one of the world's largest cocoa buyers, it has pioneered the practice of directly improving the sustainability of its value chain by piloting in 2020 an "Income Accelerator" program for cocoa farmers in Ghana and the Ivory Coast. The program, which consisted of cash incentives to farmers complemented with agricultural extension services, was highly successful, with farmers' crop yields increases and reductions in the risk for pests and diseases. Ultimately it enabled better adaptation to unfolding climate change and changes of weather patterns. Nestlé helped to raise awareness of these farmers' poor living conditions and sent the message that MNEs can and should play a role in improving them, exposing other market players to public scrutiny (Fairtrade Foundation, 2022). In 2023, Nestlé partnered with Mars, Cargill, Ferrero, and other large MNE buyers of cocoa in supporting the "Cocoa premium scheme" implemented in Ghana and the Ivory Coast. These MNEs agreed to pay a country premium that will enable cocoa regulators to set up a floor price with 70% retained by farmers. Crucially, without the commitment from these large cocoa buyers, the regulation could not be implemented because of the exposure to the risk of market failure due to reduced demand.

In addition to improving the sustainability conditions of the value chain, food companies have an environmental responsibility with respect to the carbon footprint they produce through the value chain. MNEs are increasingly engaging in the so-called practice of "insetting", which involves tackling the carbon emissions of their suppliers. The World Economic Forum (WEF, 2022) defines it as the practice of focusing on doing more good rather than doing less bad within one's value chain through the implementation of nature-based solutions such as reforestation, agro-forestry, renewable energy and regenerative agriculture. Traditionally, MNEs' predominant approach to reducing their net environmental footprint has been through the practice of "offsetting", which involves investing in projects that remove carbon from the atmosphere to obtain carbon credits used in calculating net emissions. The use of offsets is now controversial given severe proven methodological pitfalls leading to substantial overestimates of claimed benefits and carbon abatement (West et al., 2023), and perhaps explains the move towards insetting. Importantly, there are many sectors in which the bulk of emissions comes from the value chain and not from MNEs' direct operations.

One such sector is food, where market concentration across the food value chain has accelerated over the past decade through mergers (Lianos & Katalevsky, 2022). While the effect of the consolidation and vertical integration of supply chains is debated (Hernandez et al., 2023), the environmental footprint of a small number of MNEs is also equally concentrating and reaching significant scale. For instance, the carbon footprint of Mars is equivalent to that of a country the size of Finland, with more than 80 percent of total emissions embedded in the goods and services that Mars buys (Mars, 2023). After limited progress on targets, Mars has recently pledged USD 1 billion to cut emissions. These resources will be focused on the transition to 100 percent renewable energy, improving supply chain traceability, scaling up climate smart agriculture, changing recipes and improving logistics. Mars buys raw material from 100 countries around the world. Through these activities, this major MNE in the international agri-food system intends to halve its current annual emissions of close to 50 million tons of CO_2 equivalent (Friedlingstein et al., 2022) by 2030.

MNEs as vehicles for "exporting" regulation

We have argued that MNEs can drive change not only through their own operations but also through leveraging influence along large international supply chains. Given their cross-country operations, they can act also as vehicles for "exporting" regulation, conceptualized as the cross-border extension of standards and processes that enable MNEs to comply with regulatory requirements uniformly across jurisdictions. MNEs can thus serve as institutional carriers that diffuse practices and regulations across the globe.

For instance, regulators in the US and the EU have issued sweeping mandates for supply chain traceability – the US in food and the EU in consumer goods such as apparel and electronics. In 2022 the FDA passed the so-called Final Rule (or "Requirements for Additional Traceability Records for Certain Foods") which requires the FDA to designate foods for which additional record keeping requirements are appropriate and necessary to protect public health (Suominen, 2023). It requires companies to keep additional records for designated foods and establishes a framework for end-to-end traceability throughout the food industry. Covering firms producing, manufacturing, processing, packing, or holding foods for US consumption, the Final Rule has extraterritorial implications, shaping the data and operations of businesses in the food sector around the world. The European Commission is planning to roll out the European Digital Product Passport (DPP) in 2026 in the apparel, batteries and consumer electronics sectors with other sectors to follow in the next ten years. Under the DPP, products sold in the EU will need to carry a passport with a unique product identification master data on the product, its "anatomy", and supply chain (Jansen et al., 2023). The passport applies to both a finished product sold in Europe and each of its individual parts and can have many use cases, but for the EU, it is first and foremost aimed at promoting environmental sustainability and recyclability of goods to extend products' life cycles. Traceability mandates are also under discussion in Australia, Japan and China, and leverage expanded capabilities offered by digitization such as blockchain technology. Such traceability mandates have significant extraterritorial implications. For example, America's consumer goods giant Procter & Gamble, which has 80,000 suppliers, manufacturing plants, distributors, and retailers operating in more than 180 countries will be required to provide end-to-end traceability of its products at all points of retail for products sold in the EU.

Resources and Technology

The field of IB provides a valuable conceptual framework to understand the processes at play that determine the decision of MNEs to invest in technological transfer and investment in emerging economies. The ability of MNEs to accelerate the process of technological innovation by leveraging dynamic capabilities and through internationalisation is a central feature that has been leveraged in order to gain competitive advantage. Given that MNEs are multi-locational firms and embedded within different business systems (Beugelsdijk, 2022), they have the ability to accelerate R&D, adapt and respond to local market needs and introduce new technologies and can thus accelerate the expansion of low-carbon energy technologies in critical emerging markets.

The rise of renewable energy sources

Vestas, a leading Danish wind turbine manufacturer with leading global presence, provides a valuable illustration of how resource and technology transfer by MNEs to emerging economies can spur the development of markets for renewable energy. Technology transfer by Vestas has played a key role in China becoming the world leader in manufacturing wind turbines.

The Chinese government placed technology transfer at the centre of its strategy to achieve an end-to-end harnessing of supply chain know-how (Lewis, 2016). Since the early 2000s, a wide-ranging policy package to support the wind turbine industry included localization requirements, important direct and indirect subsidies, and preferential feed-in tariffs[3]. Importantly, as argued by Lewis and Wiser (2007), the ability of emerging markets such as China to provide an important market potential acts as a prerequisite for MNEs to engage in localisation and technology transfer.

Vestas installed its first wind turbines in China in 1986 in Shandong and Hainan island, and built its first turbines assembly factory in the North-Eastern port city of Tianjin in 2007 (Vestas, 2023). Through localisation requirements and technology transfer, the development of a domestic Chinese value chain developed with over 90% of turbines' components sourced domestically by 2010 (Perrot & Filippov, 2010). As well, the ability to adapt to the local market needs through the establishments of locally based R&D facilities played an important role in the dissemination and expansion of wind turbines manufacturing capacity and securing domestic market demand. An example is the development of purpose-made blades and turbines equipped with temperature control systems to maximize performance in regions characterized by extreme temperature seasonal variability and the low-to-medium winds of Inner Mongolia (NS-Energy, 2009). China is now the largest manufacturer of wind turbine and the largest exporter of wind turbines globally producing close to 50 percent more wind energy power than second-placed Europe (Reuters, 2023a), with six Chinese companies positioned amongst the world's top ten (Bloomberg, 2023).

Decarbonizing carbon intensive MNEs

The largest polluters also possess important resources to invest in R&D and drive innovation. Transition risk has incentivised hard-to-decarbonise sectors to invest in developing technologies to mitigate emissions. For instance, the shipping group Maersk has formed a green methanol start-up in an attempt to develop affordable fuel and increase supply of the fuel the Danish group views as essential to decarbonize shipping (Financial Times, 2023b). This comes after Maersk has pointed out that the oil industry is not producing cheap enough green fuel to decarbonize the sector, and is thus holding back the clean energy transition. Efforts to decarbonize from another major shipper, Cargill, are centered around investing in wind power ship propulsion rather than the development of zero-carbon fuels. Cargill is testing the use of sails on a midsized vessel fitted with 37.5 metre-high sails (Reuters, 2023b). In developing and testing this novel proof of concept technology, the company is effectively taking considerable risk on behalf of the entire industry, and may struggle to profit from its initial investment in the wind-powered vessel.

[3] Feed-in tariffs guarantee a price of purchase of energy produced by a given source of energy by the electric grid manager.

Another example, from the carbon-intensive sector of construction and building materials, illustrates how MNEs can leverage their FSAs to respond to country-specific constraints and opportunities. To address the rapid deforestation faced by many developing countries, caused by the use of burnt bricks as the main building material, Holcim, a large cement a construction materials MNE, developed Durabric, a low-carbon earth and cement brick. It was launched in Malawi in 2013 as an affordable low-carbon construction material made from earth, sand and cement compressed in a mould, which dries naturally. Durabric reduces greenhouse gas emissions tenfold compared to traditional fired bricks - it is estimated to save 14 trees per house built and has reduced CO_2 emissions by 45,000 tons between 2016 and 2020. Holcim is combining Durabric with 3D printing technology using Holcim's proprietary composite material, TectorPrint, which gives the walls structural function to bear the load of the building. This breakthrough will accelerate the scale-up of 3D printing for affordable housing. Through the joint venture with CDC Group, the UK Government's largest impact investor, Holcim scaled up this solution to provide affordable housing in Africa and in 2021 announced Africa's largest 3D-printed affordable housing project in Kenya (Holcim, 2021).

These examples illustrate that MNEs possess not only the capabilities and resources to take on the risk of developing novel solutions to climate change, but they also have the size to bring these solutions to scale and potentially shape entire industries and countries.

Collaboration and Partnerships

MNEs often have strong relationships with various stakeholders, including governments, NGOs, consumers, communities, investors, and academic institutions. They can leverage these relationships to advocate for climate-friendly policies, raise awareness about climate change, and steer consumer behavior towards sustainable choices. By working together, they can share knowledge, resources, and best practices, leading to more effective and coordinated efforts.

Achieving critical mass for decarbonation

MNEs may decide to collaborate with other large industry players to tackle the environmental challenge. An advantage of collaboration (vs. competition) is that of improving cost efficiency by sharing resources and reducing risks. Furthermore, collaboration can be a powerful way to both anticipate and influence regulatory action. These advantages have likely driven some of the most influential partnerships among MNEs in the energy and utilities sectors, such as those tackling methane emissions reduction and the development of carbon dioxide offset technologies such as the Carbon Capture Usage and Storage (CCUS). CCUS refers to technological solutions aimed at capturing carbon from the atmosphere and storing for long timescales (i.e. thousands of years) to prevent it from acting as a greenhouse and further increase global temperature.

CCUS is one of the principal means considered necessary to achieve the carbon emission abatements targets The important upfront costs necessary for the introduction and scaling of CCUS require the deployment of public support mechanisms, important financial resources, and the emergence of collaborative frameworks. Partnerships in particular are necessary to achieve economies of scale and to benefit from industrial synergies.

The economic viability of CCUS depends on the scale of operations and the ability to capture and store large quantities of CO_2. The development of hubs in regions of large industrial activities is necessary to achieve this aim. However, no single industrial company could fund the transport and storage infrastructure to achieve the development of upstream and downstream processes. The formation of partnerships between several MNEs and local companies located in a hub to co-own and co-invest in this infrastructure is critical to achieve required scales of operations. For instance, Total, a major oil and gas MNE, recently partnered with AirLiquide, an MNE specialised in liquified gases manufacturing and transport, to develop capture, transport and storage large-scale industrial facilities in Northwest France (Total, 2021). In the US, another example is the collaboration between Carbon Engineering and Occidental Petroleum to launch a pilot facility using direct air capture of carbon (IEA, 2020).

The upscaling and diffusion of CCUS is dependent on the regulatory environment that regulates the long-term mobilization of private finance (van Ewijk & McDowall, 2020). The development of a common regulatory framework on ownership and liabilities linked to carbon stored is a necessary condition to ensure financial viability. Furthermore, the development of risk-sharing mechanisms between government and CCUS MNEs is considered key. For instance, the development of the joint liability ownership of stored carbon dioxide following the termination of projects could provide a solution (IEA, 2020).

Sharing know-how and informing regulation

Given the shared interests of oil and gas MNEs, collaborative frameworks have emerged. An alliance of 12 of the world's largest hydrocarbon MNEs founded the Oil and Gas Climate Initiative (OGCI) that recently jointly invested in technological development to develop methane capture (Ahmad, 2019). During the 2022 COP meeting in Glasgow, OGCI advocated in favour of reducing targets for methane emissions, the second most important anthropogenic contributor after CO_2.

The 12 members expect to produce nearly zero methane emissions by 2030 and they have established a zero-methane emissions alliance involving another 70 smaller companies in the oil and gas sector. They financed and technically supported a pilot program in Iraq for the development of a satellite technology to measure upstream methane emissions from oil and gas. The program is now being scaled to multiple oil fields in Kazakhstan, Nigeria and Egypt. Therefore, they have been effective and influential at tackling these short-lived emissions which are responsible for a significant share of current global warming (estimates range from 10 to 30%).

Access to Capital

MNEs' superior access to capital

Given their presence in multiple countries, MNEs have access to multiple external capital markets and thus have a greater pool of sources for financing, which they can access at a lower cost (Erel et al., 2020). MNEs have superior access to external financing, through equity and debt markets, and have also developed efficient internal capital markets within their own organizational structure, which enable them to transfer capital resources across borders (Fisch & Schmeisser, 2020).

Internal capital markets that allow MNEs to effectively redistribute financial resources within the organization are particularly important when MNEs face segmented international capital markets or market imperfections (Mudambi, 1999; Scharfstein & Stein, 2000). These markets are used to alleviate the financial constraints of foreign subsidiaries operating in countries with underdeveloped or even absent external capital markets, where the supply of capital is short and/or the cost at which such capital can be accessed is high (Boutin et al., 2013; Desai et al., 2004). For these subsidiaries, internal capital markets can substitute for external financing (Gertner et al., 1994), especially when financing costs in external markets are high (Yan, 2006), and have the effect of improving subsidiary performance (Nguyen & Rugman, 2015). Thus, MNEs have a competitive advantage in countries where financing for local firms is expensive (Desai, 2008), such as developing countries, which allows their developing country subsidiaries to take advantage of the high growth opportunities that are inherent in such countries (Love, 2003).

Channeling capital to developing markets

The implications of such resources in the context of climate challenge is that MNEs are able to raise substantial funds at favorable rates in the global capital markets, and use such funds to finance renewable energy projects, sustainable infrastructure, and other climate related initiatives in developing nations. The idea that MNEs superior access to capital has not only supported their R&D and innovation capabilities but has also allowed them to diffuse and implement technological innovations in developing countries is illustrated by the following examples.

The Italian multinational energy company Enel, the European Investment Bank (EIB) and the Italian export credit agency SACE joined forces to support the development of renewable energy and energy efficiency programs in Latin America i.e., Peru, Brazil and Colombia (Enel, 2022). Specifically, EIB has provided Enel with a sustainability-linked financing framework which foresees a multi-country, multi-business and multi-currency facility of up to EUR 600 million euros (USD 650 million), backed by a guarantee from SACE. The financing facility is linked to Enel's ability to achieve its target of reducing its direct (Scope 1) GHG emissions and is structured such that the interest rate increases if Enel fails to achieve its target and decreases otherwise i.e. it embeds contingent step-up/step-down mechanism.

Another examples is the initiative by Iberdrola, the Spanish electric utility MNE, that joined forces with the World Bank Group (WBG) to boost energy transition in emerging countries (Iberdrola, 2023). The private sector investment arm of the WBG, the International Finance Corporation (IFC), and Iberdrola launched a partnership involving a green loan linked to sustainability targets of USD 150 million to finance digitalization and energy efficiency improvements in the electricity distribution networks in Brazil. This is part of a broader global partnership between Iberdrola and IFC that will promote the energy transition and the development of renewable energy projects in countries such as Poland, Morocco and Vietnam.

MNEs' superior access to capital does not only enable them to develop innovative technologies in house, but MNEs also provide funding to startups, which can play an important role in climate change related innovation. An example is thermal battery technology developed by start-up Rondo Energy, which converts renewable electricity into industrial-grade heat. This technology, which involves heating solid carbon blocks to industrial temperatures which can preserve the heat energy for days with minimal daily loss rates of just 1%, was funded by hefty industrial carbon emitters like Rio Tinto, Saudi Aramco, Titan and Siam Cement Group. It is estimated that thermal batteries could in theory displace about 75% of fossil fuel usage for US industrial energy (EnergyInnovation, 2023) and has the potential to address the intermittency of solar and wind energy.

EXPLORING INSTRUMENTS OF ALIGNMENT WITH SOCIETAL PRIORITIES

We have so far highlighted the potential that MNEs have for addressing the climate crisis but we must acknowledge that their past behavior has often steered away from advancing societal goals (Yu et al., 2023). However, with the climate crisis speeding towards a catastrophe (IPCC, 2023), the academic community is now being challenged to redefine operational concepts such as country specific advantages (CSAs) and firm specific advantages (FSAs) around the resolution of "grand challenges" such as climate change (Buckley et al., 2017).

A crucial first step is to set incentives right, so that MNEs' objectives are aligned with societal priorities. So far, incentives or drivers of MNEs' actions have been analysed in macro contexts such as economic, social, technological and regulatory (Bass & Grøgaard, 2021; Ivanaj et al., 2017). We complement this analysis by taking a corporate finance perspective, and highlight how incentives can be provided through market solutions that operate through corporate governance and financing. We also discuss the role of public incentives such as regulation, and the interaction between public and private levers.

Public Instruments

Policymakers worldwide need to incentivize firms to decarbonize their own operations, but also facilitate technology transfers towards countries with the greatest decarbonization potential. This would require a combination of global carbon pricing policies and localized subsidies for green technologies. However, political frictions have resulted in highly fragmented carbon prices and a competitive approach to green subsidies.

In such an inefficient regulatory framework, MNEs have two strategic choices: shift operations to countries with relatively lax norms (i.e., "race to the bottom" and ensuing "pollution havens") or translate higher external requirements into FSAs (i.e., "race to the top"). MNEs may opt for one of the other strategy depending on firm-level capabilities as well as on the institutional context in which they operate (Bu & Wagner, 2016; Dong et al., 2012; Singhania & Saini, 2021). In shaping MNEs' response, an important role is played by governments and whether they directly address cross-country arbitrage opportunities through regulatory instruments.

Below, we discuss carbon pricing regulation and green subsidies, and note here that the effectiveness of each and their interaction depends on many factors, the relevance and importance of which remain to be fully understood (see, for example, Blanchard et al. (2023)). Carbon pricing schemes are subject to political frictions and typically face pushback given their implications for macro-economic and financial stability. Subsidies are more popular instruments which can complement carbon pricing schemes in the short term, yet they are not sustainable in the long term because of the significant strain on the regulators' budgets.

Carbon Pricing Policies

Popular forms of public instruments for reducing emissions are carbon taxes, which involve putting a price on each ton of CO_2 equivalent emitted, or cap-and-trade schemes, which involve issuing or auctioning emission allowances to firms which they can subsequently trade among each other at market-determined prices. The choice of whether to regulate prices (through taxes) or quantities (through cap-and-trade) has been centered around the economic dimension of mitigating the uncertainties about the societal cost of carbon and the elasticity of energy demand to prices (Weitzman, 2017), and the political dimension of which public instrument is practically enforceable (Gollier et al., 2017). Although in principle consensus exists regarding the need to implement a carbon pricing regulation, currently the global regulatory framework is highly heterogeneous and overall insufficient in ambition.

Cap-and-trade schemes. The implementation of cap-and-trade schemes have generally been met with less political resistance and to this date, cap-and-trade schemes have a broader coverage than carbon taxes i.e. approx. 8.91Gt CO_2 equivalent of global emissions covered against 2.76Gt CO_2 for carbon taxes.[4] The most ambitious cap-and-trade scheme to date is the EU Emissions Trading Scheme (ETS), active since 2005. When subject to a cap-and-trade scheme, MNEs have

[4]Updated data can be found on the World Bank Carbon Pricing dashboard at this link.

an incentive to leverage their greater resources and outperform domestic firms because by doing so they can make profits by selling unused carbon allowances. MNEs can also capitalize on their improved environmental standards by transferring clean technologies to subsidiaries in less regulated countries. Such actions fall under the "race to top" view that MNEs' features make them react more positively to environmental regulation than domestic firms, dating back to Porter (1991) and Porter and van der Claas (1995). Anecdotal evidence of this type of behavior comes from European multinational utilities such as Enel and Iberdrola, which leveraged the regulatory pressure imposed by the EU ETS to become market leaders in renewable energy generation. Nippa et al. (2021) show that MNEs covered under the EU ETS maintain consistent carbon reductions across institutional contexts, and an overall carbon performance edge over domestic firms.

A competing view is that MNEs react less to local carbon regulation as they can shift operations to countries with relatively lax norms. This "pollution haven" hypothesis, also referred to as "carbon leakage", has been documented in a variety of countries (e.g., Shahbaz et al. (2019) for Vietnam, Sapkota and Bastola (2017) for Latin American countries, Nasir et al. (2019) for emerging Asian economies, and Li and Zhou (2017) for the US). In contrast, carbon leakage has not been detected in relation to the EU ETS (Dechezleprêtre et al., 2022). If the EU has succeeded in limiting carbon leakage, this can be attributed to the adoption of complementary instruments that alleviate the frictions generated by unilateral carbon policies. The EU has been working since 2016 on a universal taxonomy for sustainable activities. The taxonomy has been a cornerstone of the corporate sustainability reporting directive (CSRD), enforced in January 2023, which mandates the public release of environmental reports for all large firms headquartered or operating in the EU with over EUR 750 million in global revenue. Evidence suggests that disclosure requirements have had an impact on decarbonization (Bolton & Kacperczyk, 2021; Downar et al., 2021; Yang et al., 2021). Importantly, in October 2023 the EU has also implemented the Carbon Border Adjustment Mechanism (CBAM) in a transitional phase. The CBAM is carbon tariff on carbon intensive products imported in the EU aimed to eliminate carbon leakage and to encourage cleaner industrial production in non-EU countries. The CBAM is meant to ensure the carbon price of imports is equivalent to the that of domestic production, and that the EU's climate objectives are not undermined.

Carbon taxes. Carbon taxes are the politically unpopular alternative to cap-and-trade schemes. Although over 30 carbon tax schemes are in operation in various countries, the average price of emissions worldwide is only USD 2 per ton of CO_2 equivalent — an insignificant fraction of the USD 190 per ton needed to reach the Paris Agreement goals (Prest et al., 2023). Some developped countries such as Canada, Sweden and the UK have succeeded in implementing a nation-wide carbon tax. In Canada, the federal government imposed a carbon price beginning at USD 20 per ton in 2019 and rising to USD 65 per ton as of April 2023. However, generous exemptions were made, and, on average, companies ended up paying for only a fraction of the carbon actually produced. Suncor, for example, the oil and gas sector's largest emitter, estimates that it paid in 2020 an average carbon cost of USD 2.10 per ton. Despite these discouraging facts, evidence from the Carbon Disclosure Project (CDP) shows that the largest emitters are organizing their business operations anticipating governments' requirements to pay carbon taxes of USD 60 per ton or higher (Ramadorai & Zeni, 2023), suggesting that raising taxes may not come at a high cost for these firms. In fact, MNE-level carbon taxes could be seriously considered as a simple regulatory tool to control the firms' operations as a whole. We will return to discussing this issue in the next section.

Green Subsidies

Green subsidies are a public instrument particularly important to support the early stages of development of green technologies, when investments are prohibitively expensive, time horizons are long, and risks are high. When used in conjunction with carbon pricing schemes, subsidies ensure that the decarbonization incentives translate into an adoption of green technologies rather than a reduction in production capacity (Lafforgue, 2011). However, we have seen governments implementing subsidies alone with the goal to enhance the country's competitive advantage over a certain technology. Timing has been crucial to determine these policies' success along with the international context in which MNEs have often played a role.

For instance, green subsidies have contributed to the rise and change in global dominance of MNEs in the solar photovoltaic energy (PV) industry (Binz et al., 2017). In the mid 2000s, the EU was a leader in the PV market and the single largest contributor to renewable technologies worldwide.[5] Today, however, China has over 80% of the global PV market and manufacturing, with some key elements of its supply chain being almost exclusively reliant on Chinese production (IEA, 2022). The shift in dominance of the industry's supply chain from the EU to China was triggered by a policy change in Germany. In the early 2000s, the innovative launch of feed-in tariffs in Germany provided an effective mechanism to support the growth of German MNEs such as SolarWorld by de-risking capital intensive PV investments (Quitzow, 2015). However in 2013, Germany's government cut feed-in tariffs for PVs, suddenly decreasing domestic producers competitiveness compared to Chinese competitors (Winter & Schlesewsky, 2019). The policy change provided the basis for market expansion of rising Chinese solar PV companies who benefited from it to increase sales in the German market as they also received direct governmental subsidies (Zhang & He, 2013) to build production facilities in China (DerSpiegel, 2011). Over time, European manufacturers have been replaced by Chinese ones. In addition, the hiring of skilled Chinese diaspora working in leading German and US solar PV MNEs served as an effective means to quickly transfer technology (de la Tour et al., 2011). Importantly, although the shift in market dominance was triggered by a policy change, MNEs' abilities to reallocate resources across countries (e.g., skilled workforce) contributed significantly to the rapid collapse of the German market. This suggests that MNEs' role should be accounted for when evaluating the impact of policy changes.

The Chinese governments' subsidies were also crucial in the development of EVs. China has become a world leader in making and buying EVs and is now the main player in battery and EV component trade. In 2022, 35% of exported electric cars came from China, compared with 25% in 2021 (IEA, 2023). China's current dominance success is down to a multi-decade government-planned effort involving generous government subsidies, tax breaks, procurement contracts, and other policy incentives. In the early 2000s, China recognized it could not compete with US and German legacy manufacturers of traditional combustion engine cars, and Japan was leading in hybrid vehicle research. In 2001 the EV technology was introduced as a priority science research project in China's Five-Year Plan, the country's highest-level economic blueprint. Starting in 2009, the country began handing out financial subsidies to EV companies for producing buses, taxis, or cars for individual consumers. From 2009 to 2022, the government poured over RMB 200 billion (USD 29 billion) into relevant subsidies and tax breaks. The government also helped domestic EV companies stay afloat in their early years by handing out procurement contracts. Importantly, the Chinese government did not limit subsidies to domestic companies, but to domestically produced EVs. Foreign manufacturers could produce an electric car at a subsidized rate in China provided they formed a joint venture with a Chinese manufacturer and thus transferred crucial technology

[5]To this date, subsidies to renewable energy in the EU27 total roughly EUR 70 billion a year against the annual EUR 17 billion cost of the EU ETS.

to the local company. The policy was therefore designed to stimulate technology growth within the country but also facilitate technological transfers from foreign companies. It stimulated investments from international MNEs such as Tesla, Ford, Nissan and Hyundai.

Private Instruments

We refer to private instruments as the set of actions or initiatives that investors, consumers, and other stakeholders worldwide can take, or the contracts they can enter to reform MNEs' actions in relation to climate change. When it comes to MNEs, private instruments can be particularly effective as they are not tied to local jurisdictions but can have a global reach through the cross-border operations of MNEs. As discussed in this section, MNEs have often played the role of innovators in the development of such private instruments.

Capital Markets

Investors concerned about climate change have used equity and debt markets to induce or incentivize large publicly listed companies to take climate action. An important channel through which investments can change incentives is the so-called cost of capital channel. Specifically, by allocating capital towards environmentally responsible companies and away from socially harmful ones, investors can decrease (increase) the cost of capital of firms that contribute the most positively (negatively) to society. Thus, markets can steer future investments towards projects that have a positive impact and away from those that generate harmful externalities.

Equity investments based on environmental, social and governance (ESG) or sustainable criteria have increased in popularity considerably in recent years. Common investment strategies such as divestment or tilting involve providing no/less capital to green firms while subsidizing the operations of green firms. This is meant to incentivize brown firms to become greener (Heinkel et al., 2001; Pástor et al., 2021). However, to the extent that capital is substitutable, such strategies are unlikely to have an impact on the cost of capital in equilibrium (Berk & van Binsbergen, 2021). Even if it did, increasing the cost of capital for brown firms makes them even less able to undertake investments in green technologies, while subsidising already green firms will have little to no impact (Hartzmark & Shue, 2023).

Debt markets are an alternative platform for allocating capital to socially desirable projects and firms. The market for sustainable debt, including instruments with an environmental, social or sustainable purpose, has increased significantly in recent years to a cumulative total of over USD 6 trillion in 2022. Despite the proliferation of securities, sustainable debt contracts can be divided into two broad categories, project-based and outcome-based contracts. Whereas project-based are centered around specifying ex-ante the projects to which the proceeds from issuance are going to be allocated to, outcome-based contracts do not impose restrictions on the use of proceeds but instead embed contractual mechanisms that ensure commitment to outcomes (Barbalau & Zeni, 2022).

Project-based debt contracts, such as green bonds and loans, are otherwise equivalent to conventional bonds, except for a use-of-proceeds constraint that restricts using the capital to finance pre-specified green projects only. The rate of interest on the contracts is in principle lower than that associated with their conventional counterparts (giving rise to the so called *green premium*), so these contracts change incentives through the cost of capital channel. The market for project-based debt contracts started in 2007 with the issuance of the world's first green bond by the European Investment Bank, and large MNEs soon followed. Green bonds issued by MNEs have played an important role in facilitating the transfer of resources and technologies from developed to emerging countries. In 2018, the first green loan signed by Iberdrola together with 10 other local banks has allowed the development of wind farm projects in Latin America. In 2020, Coca Cola issued the first green bond for greening the operations of its subsidiary in Mexico, including financing reforestation projects to replenish 100% of the company water usage and the construction of solar, wind, geothermal and hydropower facilities. Despite their rising popularity, some skepticism exists among investors and policymakers, and the empirical evidence around the existence and magnitude of the green premium is mixed.[6] Concerns exist that these projects would have been financed anyway, i.e. additionality, and the focus on projects does not warrant a change in overall corporate behavior. This has been the case of the Korea Electric Power Corporation (KEPCO), which issued green bonds in 2022 while investing in new coal-fired power plants in Southeast Asia.

Outcome-based debt contracts, such as sustainability-liked loans and bonds, do not impose restrictions on the use of proceeds but instead link the contracts' interest rate to the achievement of company-wide sustainable targets, most often represented by carbon emission reductions. Achieving the targets allows the issuing firm to borrow at a subsidized lending rate, where missing the target increases the interest rate on the contract i.e., the cost of capital channel. In a frictionless world, contracting on outcomes rather than projects is strictly optimal (Barbalau & Zeni, 2022). Furthermore, contract targetting emission reductions are, under plausible conditions, equivalent to a carbon taxes (Allen et al., 2023). This is an important result suggesting these contracts can substitute regulations by providing an alternative carbon pricing incentive that is not tied to local jurisdictions and subject to political constraints. Institutions such as the World Bank Group are considering sovereign sustainability-linked bonds as potential instruments to enable cross-country transfers of resources (Wang et al., 2023).

The market for outcome-based debt started with the sustainability-linked loan issued by the multinational company Phillips in 2017. Also worth noting is that the suppliers of capital have been large multinational banks rather than public entities. Therefore, it is MNEs that can be credited with having started a market that, if properly implemented, can have a significant impact. Importantly though, the efficiency of outcome-based contracting depends importantly on the ability to accurately and reliably measure outcome such as carbon emissions (Barbalau & Zeni, 2022). In practice, more regulation is needed to support the market development as evidence points to some adverse selection mechanisms around the definition and monitoring of sustainable metrics (Ul Haq & Doumbia, 2022).

Corporate Governance

In addition to the cost of capital channel, investors can directly engage with companies by acquiring an equity stake in these firms. Financial securities are contracts, and equity securities grant voting rights on every resolution related to the company in proportion to the owned equity share capital of the company. Therefore, increasing equity ownership in a green or brown firm implies having more say on the firm's corporate policies. This is what we call the corporate governance channel.

In the last few years there has been considerable increase in shareholders' engagement on environmental and social issues (Hart & Zingales, 2022). Shareholders' activism usually targets large, visible firms with low ESG ratings and high financial performance (Barko et al., 2021).[7] Broccardo et al. (2022) argue that shareholders' engagement through the exercise of voting rights (i.e., the corporate governance channel) is relatively more effective than divestment (i.e., the cost of capital channel) in promoting socially desirable outcomes. Whereas divesting has an impact only to the

[6]See MacAskill et al. (2021) for a systematic literature review.

[7]Activism by shareholders is exercised through voting on companies' resolutions and differs from other types of activism such as boycotts, petitions and social media campaigns, which can be exercised by any stakeholder. The latter are discussed in the next section.

extent that all investors are significantly socially responsible, voting can achieve positive outcomes provided the majority is at least slightly socially responsible. In practice though, a majority is not always required (and anticipatory effects play an important role). A prominent example is the activist hedge fund Engine No. 1, which despite its very small ownership share in ExxonMobil of 0.02%, managed to bring about change to its board and replace three board members. This was possible because the fund received support from some of the Exxon's biggest institutional investors such as BlackRock, Vanguard and State Street, which voted against Exxon's leadership.

Another powerful instrument which can be used to shape corporate governance in a robust manner is that of tying executive compensation to a sought-after outcome. So called ESG-linked compensations were first introduced by the US multinational company Alcoa, a market leader in the production of aluminium. In 2013, the company announced that 20% of executive compensations was tied to environmental and safety goals. Since the Alcoa initiative, roughly 40% of the large companies listed in the S&P 500 index have introduced ESG factors in their executives' bonuses. As executive pay surged relative to pre-pandemic levels, linking even small percentages of the total bonuses to ESG factors can significantly alter CEOs' incentives. A recent study by Homroy et al. (2022) has shown that these instruments increase the firm's ESG performance if the firm has good governance ex-ante. ESG-linked compensations on the other hand do not have an effect on profits, suggesting that profits and ESG goals are competing and ESG achievements may not be produced without these incentives.

Boycotts and Litigations

Consumers who do not access capital markets can use boycotts as a way to express their environmental and demand more sustainable practices. Boycotts for climate change are a form of collective action in which individuals abstain from consuming the products or services of companies that are perceived to contribute to environmental harm or which are failing to combat climate change. Energy companies such as Shell and ExxonMobil have been the target of various boycott campaigns in addition to being the targets of shareholders' activism. Outside the energy sector, Monsanto, a multinational agrochemical and agricultural biotechnology corporation, has recently been faced with boycotts and protests for its production of genetically modified organisms (GMOs) and herbicides which are linked to environmental and health concerns. Given the debatable effectiveness of boycotts and protests, litigation is an alternative that albeit more enforceable if successful, is also more difficult and costly.

Litigation against large MNEs has been notoriously hard[8], yet recently there has been an increasing number of litigations for environmental issues and the emergence of market-based mechanisms that support it. For example, the impact investment firm Aristata Capital is deploying funds to finance community lawsuits against companies over environmental and social problems. With nearly GBP 52 million in capital from impact funds, foundations and wealthy individuals, Aristata will cover the costs of lawsuits in exchange for a share of the plaintiffs' damage awards. In contrast with peer funds that focus largely on financing lucrative disputes between companies, Aristata is the first to focus on cases aimed at social and environmental impact.

Environmental lawsuits are becoming material risks for large firms, as illustrated by the successful class action lawsuit against Royal Dutch Shell, a major oil and gas MNE, which was ordered by a Dutch court to reduce its emissions (Bloomberg, 2021). Because of litigation risk, large firms are pulling back from voluntary environmental disclosures initiatives such as CDP. The implications of litigation risk on environmental disclosure are well documented in a recent paper by Robinson et al.

[8]Taking corporations to court is especially hard in the case of common law countries, such as the UK or Australia, where unsuccessful plaintiffs must pay the defendants' legal costs as well as their own.

(2023). The paper finds that firms prefer to disclose forward-looking information such as environmental risks and targets rather than historical emissions, whose disclosure is becoming mandatory in Europe and the USA, because the latter comes with higher litigation risk.

Public-Private Partnerships

Despite considerable developments from the private sector, the difficult task of tackling climate should not be delegated to the private sector alone, and regulators should still act. Research indicates that markets for sustainable investing fail to internalize aggregate welfare implications and can misallocate resources (Green & Roth, 2021; Hartzmark & Shue, 2023; Oehmke & Opp, 2022), distort market power and product market competition (Bisceglia et al., 2022), and can delay reform (Gupta et al., 2022; S. Huang & Kopytov, 2022). However, implementing regulation can be challenging as it can pose financial stability risks due to financial constraints and leverage (Döttling & Rola-Janicka, 2022; Heider & Inderst, 2021). Developing countries' budgets are already overstretched (Caseloads, 2022) and cannot support subsidy schemes nor afford to tax domestic firms. For these countries, reliance on foreign investments is essential.

Attracting foreign investments, and private finance in particular, requires closing the financial viability gap. Private investors face prohibitive risks when funding green infrastructure projects in regions that lack electricity and transport infrastructure in the first place. In the past, official sector entities such as multilateral development banks (MDBs) have played a useful catalytic role, helping to share risks with private investors to enhance the viability of investments. MBDs have a long-term perspective, a cross-country experience, a strong financial position, and well-understood standards in project design (Chelsky et al., 2013). The development of climate-change focused public-private partnerships is still in the nascent phase (Fouad, 2021). Recently, we have seen some successful collaborations in the Asia Pacific and Africa regions. These refer to the Just Energy Transition Partnerships (JEPTs), funded in 2021 at the COP26 in Glasgow. JETPs are among the most high-profile public-private financing mechanisms designed to transfer funds from wealthy economies to developing ones for the purpose of weaning off fossil fuels. South Africa, Indonesia, and Vietnam are the first three developing countries to receive funding through these parterships. In essence, JEPT consists of grants, loans, or investments to coal-dependent developing nations to support the country's own path to phase-out coal and transition towards clean energy while addressing the social consequences. JEPTs funding is provided by wealthy nations (the International Partners Group) together with MBDs and finance multinationals (the Glasgow Financial Alliance for Net Zero Working Group). To this date, the donor pool includes multinationals such as HSBC and Citigroup.

OPPORTUNITIES, CHALLENGES AND OPEN QUESTIONS

We have first discussed how different key features of MNEs provide meaningful channels to tackle the challenge of mitigation and adaptation to climate change. Subsequently, we analysed the way in which different instruments could be used to restructure the incentives of MNEs to be aligned with the objectives of collective economic stability and preserving the environment. We now turn to discussing opportunities, challenges and open research questions that emerge from our analysis.

The objective function of the firm

The global challenge posed by climate change has led to the rise of stakeholder capitalism or corporate welfarism, and brought to the fore the fundamental question of what should be the objective function of the firm. The universal ownership argument (Hansen & Lott, 1996) supports a rationale of self-interested drivers for MNEs to act for the collective good. Specifically, the multi-locality of MNEs and diversity of their risk exposure, positions them to better internalize the global-level negative externality of global warming, similar to a social planner. Even when companies' objectives do not resemble that of a social planner but reflect instead shareholders' interests, if externalities are important and at least some investors are prosocial, companies should pursue shareholder welfare maximization not value maximization (Hart & Zingales, 2022).

Debates focused on the nature of MNE's objective function still exist. Some argue that firms should go beyond the pursuit of profit to cater to a wide range of stakeholders and improve social welfare. We do not aim to settle this debate. Instead, we have centered our discussion on the ability of private and public levers for engaging MNEs in playing a role in enhancing social welfare and thus influencing the MNEs' objective function. Can public levers be specifically designed to shape MNEs' incentives? How do public and private levers interact and how can they be optimally combined to engage MNEs in addressing the climate change challenge?

Corporate responsibility

An issue with expanding the scope of corporate responsibility is that the set of issues that corporations are expected to can act on becomes unbounded. What principles can we devise and use in determining the scope of corporate responsibility? Hart and Zingales (2022) posit that corporate engagement should be limited in the case where a firm's damage-inducing (or benefit-generating) activities are inseparable from its production activities and outsiders cannot easily replicate (or undo) the firm's decisions. In other words, responsibility should be limited to when a firm has a comparative advantage in achieving a prosocial goal, which cannot easily be replicated and reversed. Yet, determining this in practice is difficult, dependant on many trade-offs and there are important temporal and spatial dimensions that need to be considered.

IB scholarship places location and borders at its core (Beugelsdijk, 2022) but climate change could fundamentally change the notion of corporate responsibility. Particularly, it could expand the borders of corporate responsibility beyond the borders of the countries where MNEs operate. Recent landmark lawsuits illustrate this. For instance, a Peruvian farmer sued the German utility company RWE for its role in risking its hometown to be flooded by melting glaciers because the cumulative emissions over its 124-year history contributed to global warming and thus to increasing this risk. RWE has never operated in Peru but was estimated to have contributed 0.47% to global emission. The lawsuit aims to make RWE pay for 0.47% of the costs of building defenses against the melting glacier, amounting to USD 20,000 (The Guardian, 2022). A similar case has been brought by Indonesian residents against Holcim, a major cement manufacturer MNE (Financial Times, 2023a). Holcim has emitted 0.42% of global emissions and is now held responsible as a material contributor in proportion to this for contributing to the existential risk of sea level rise. If successful, the implications of these lawsuits cannot be overstated and are certainly not well understood. Different questions arise. What would the implications of the lawsuits be, if successful? Would this mean that MNEs will have to pay for global damages in proportion to their historical emissions? Will MNEs located in jurisdictions that provide a legal basis for such litigation move? Are there anticipatory strategies for MNEs to move to legal safe heavens? Will this also create a precedent that extends at the country level and that would thus provide a legal basis for the loss and damage debates underpinning most of the recent COP meetings?

Regulation and MNEs

MNEs can play an important role in "exporting" local environmental standards, as evidenced by regulation on supply chain traceability and reporting. However, local regulation can also generate carbon-leakage towards pollution havens. Complementary measures such as the CABM introduced by the EU are meant to address the disadvantage that firms operating in the EU might be faced with and prevent them from shifting production abroad. However, these measures have complex designs and are often deemed incompatible with the international trade commitments under the World Trade Organization (WTO).

The issue of carbon-leakage has always been approached from a country-level perspective. However, there is an opportunity for IB research to tailor the debate around MNEs-specific policy designs aimed at correcting carbon-leakage effects and instead generate positive externalities. MNE-level carbon taxes hold potential as a simple and effective tool to regulate the firms' emissions as a whole. The European Business Tax Forum (EBTF) has recently raised this point and challenged MNEs themselves to pay greater attention to carbon taxation and ways in which the business community can shape nascent carbon tax regimes. So far, the attention of governments on MNEs taxation has been centered around corporate income taxes. In the US, for example, MNEs typically structure their foreign operations through controlled foreign corporations (CFCs). These CFCs pay foreign taxes, and their US parent companies pay residual taxes domestically. The regulatory infrastructure for foreign corporate income taxation is well developed and could be easily extended to other taxes such as employment, social welfare, product taxes and, most importantly, environmental taxes. Can an MNE-level carbon tax be an alternative to carbon border tariffs? Could this be an effective substitute to missing and heterogenous country-level regulation? Can an MNE-level border tariff be designed in such a way as to spur technology transfers towards developing countries? How could MNE-level taxation be optimally designed to combat cross-border arbitrage and effectively reduce emissions while preserving competitiveness?

In addition to carbon-leakage effects, unilateral regulatory policies can have important competitiveness implications. China's massive support for EVs, for example, was a strategic decision to become a market leader in EVs by creating a competitive advantage in this sector. Foreign producers are believed to have been harmed as a result and the EU is now considering imposing anti-subsidy tariffs on grounds that subsidies have already enabled Chinese imports to undercut European EV prices by about 20%. A similar pattern may be generated by the US's Inflation Reduction Act, which will massively subsidise clean energy use and generation using tax incentives, grants, and loan guarantees. The EU is fearing competitiveness losses and trying to match some of these subsidies with its EUR 2 trillion post-Covid recovery fund. At the same time, the EU's CABM will impose a burden on US imports but also on imports from companies in emerging and developing economies. This "race to the top" will end up creating a competitive advantage for firms operating in countries which can afford the energy transition, while increasing the opportunity cost of funding green investment in developing countries. These already budget-constrained countries will face higher financing costs and also have stringent financing needs for adaptation, given their exposure to climate shocks. In such a context, it is important to explore the role of MNEs as potential bridges across countries and promoters of fair trade. How can MNEs exercise the competitive advantage acquired in the home country to increase wealth in host countries? How could "carrot" or "stick" approaches be balanced or complemented to promote decarbonization while also maintain competitiveness of developing countries' firms? What is the role of MNEs in this context?

Measurement and disclosure

In addition to regulation, we have discussed the role of private contracts, in the form of equity, debt securities and employment contracts, that can incentivize MNEs to pursue climate goals. The use of contractual mechanisms that target delivery of non-pecuniary outcomes relies importantly on the ability to measure and quantify these non-pecuniary outcomes, which is notoriously difficult. There is no unified, mandatory framework for carbon measurement and disclosure but these are largely governed by the Greenhouse Gas (GHG) Protocol. Instead various interpretations and implementations of the standards, guidance and tools in the GHG Protocol exist. Direct measurement of GHG emissions by monitoring concentration and flow rate is uncommon. The most common approach for calculating GHG emissions is through the application of documented emission factors, which are calculated ratios relating GHG emissions to a proxy measure of activity at an emissions source. Thus emission disclosures are by no means precise measurements but rely on approximations. The accounting of carbon offsets within the emissions budgets is another source of uncertainty.

The last years have seen a plethora of companies making net-zero pledges, which at least to some degree involve emissions offsetting, because reducing absolute emissions to zero is not possible. Numerous concerns have been raised regarding the integrity of voluntary markets for carbon offsets. The monitoring, reporting and verification techniques involve time consuming manual processes and analogue data capture through in-person auditing of sites. This is often not reliable, consistent or efficient. Recent technological advances in remote sensing and image recognition which permit monitoring and safely storing changes in forest biomass more quickly, reliably, and cheaply can potentially restore confidence in voluntary carbon markets (Burke et al., 2021). Such technologies include high resolution remote sensing satellites such as Sentinel or the NISAR mission due to launch next year, as well as smaller scale LIDAR drone technologies for measuring forest biomass and carbon content. It remains an open question why these have not been already incorporated by carbon offset verification bodies such as Verra and Gold Standard. Given the emergence and availability of new technologies, new opportunities are emerging. Currently, third-party verification organisations have financial incentives to compromise their impartiality and competition in the industry is such that if a project is rejected, the owner can simply seek approval from a rival agency. Several questions arise. What is needed to change the incentives of these players and ensure adaption of technologies that make measurement and monitoring more precise? Can and should regulation complement such technological advances? Government intervention is likely needed to ensure unbiased, reliable verification and ensuring additionality.

CONCLUDING REMARKS

Climate change, a global externality, demands a unified regulatory response. However, coordination across governments has been fraught with political disagreement and overall insufficient ambition. This has led to a shift in focus towards the private sector and in particular the role of "universal owners" such as MNEs. Their size and international presence uniquely position them to internalize the global externality and potentially play an important role in the climate challenge.

MNEs, operating across borders, possess efficient internal markets for governance, financing, and technology which enable them to bypass country-specific obstacles to climate action, such as varying regulations and institutional shortcomings. Through internal governance markets, MNEs can coordinate actions more effectively than governments. Pressure from stakeholders, including shareholders and activists, compels them to extend global governance standards and drive change in challenging environments. MNEs enjoy superior access to capital, which supports R&D efforts, and the diffusion of innovation and technological know-how across countries. Furthermore, through collaborations and partnerships they can bring this technology to scale and accelerate decarbonization in critical emerging markets.

We discuss incentive mechanisms to better align MNEs' objectives with societal goals and engage them in decarbonization efforts. Prominent examples of public regulations, private contracts, and market solutions are scrutinized for their ability to drive this alignment, with a corporate finance perspective playing a key role. We conclude with outlining opportunities, challenges, and open questions that emerge from this discussion, suggesting potential avenues of future research.

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