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PERSPECTIVE

Leveraging the capabilities of multinational firms to address climate change: a finance perspective

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Abstract
Climate change and the associated issue of curbing carbon emissions have 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 intergovernmental transfers needed to finance the transition of developing economies have proven hard to raise. Recently, there have been considerable responses to climate change from the private sector, with stakeholders placing more pressure on firms, and financial markets mobilizing increasingly more capital towards the reduction of negative externalities. We argue that although multinational enterprises (MNEs) have been a major 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, which enable them to circumvent country-specific frictions to climate action such as heterogeneous regulation, corruption, and the lack of technology. We analyze how different public and private incentive mechanisms could be designed to leverage MNEs' unique features, realign their incentives, and engage their potential to play a role in decarbonizing the economy. Lastly, we discuss challenges, opportunities, and future research.

Keywords Climate change · Multinational enterprises · Financing · Energy transition · Just transition

Introduction

While historically greenhouse gas (GHG) emissions underpinning anthropogenic climate change have originated from developed countries, their geographical distribution has radically changed, and currently, it is emerging economies that are major emitters (see Table 1 and Fig. 2 in the "Appendix"). The ensuing global equity issues related to the fact that countries that have contributed the least to climate change are affected the most and are also the ones with the least resources to invest in adaptation and mitigation have contributed to making the implementation of harmonized regulation very difficult. Another 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.[1] There is no doubt that the financial resources that need to be mobilized are significant and beyond most countries' fiscal capacity.[2] Furthermore, the attempts by developed countries to jointly mobilize and transfer capital towards helping developing countries manage climate change have had limited success,[3]

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[1] 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 industrialization should be responsible for bearing most of the costs of their transition.

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

[3] Specifically, at the 2009 COP15 meeting in Copenhagen developed countries committed to jointly mobilize US $100 billion a year by 2020 to help developing countries adapt to climate change. The funds, mobilized through the so-called Green Climate Fund (GCF), were still about US $17 billion short as of 2020 (OECD, 2022).

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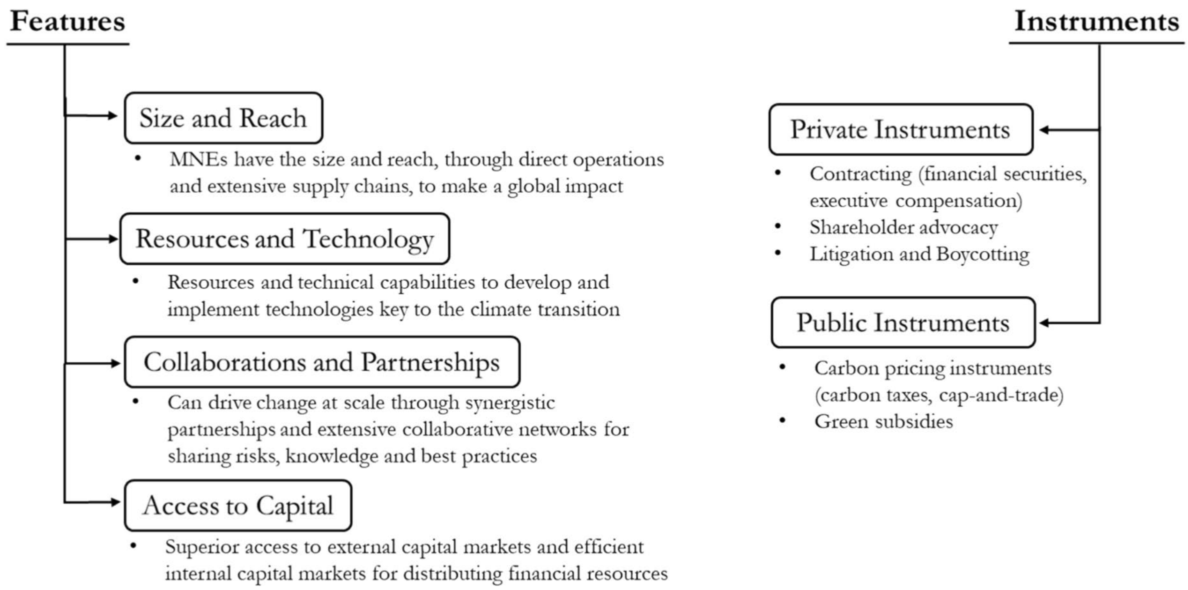

Fig. 1 MNE key features and instruments to leverage these features towards combating climate change. MNEs have traditionally leveraged their key features to pursue the objective of maximizing profits. Various private instruments can be used to incentivize the pursuit of an alternative objective, that of combating climate change. Through their global operations, MNEs can also help disseminate public policies and regulations across borders

and only worsened the tensions between the Global North and Global South countries.

Against the background of fragmented and largely missing public regulatory action, the last years have seen considerable responses to climate change from the private sector, with the debt market alone mobilizing funds that are orders of magnitude larger than the inter-governmental transfers attempted so far.[4] Furthermore, financing agreements can be designed to make the provision of funds at favorable or concessional rates, conditional on the borrower reducing carbon emissions, a type of financial innovation that can be equivalent to a carbon tax by providing similar carbon reduction incentives (Allen et al., 2023). The capital needed to finance the climate transition could therefore be available. Another advantage of this type of financing is that it may be possible to substitute politically difficult regulation with a market solution. However, simply transferring the resources necessary from developed to developing economies to finance the changes needed is fraught with significant concerns regarding corruption, lack of transparency, and the extent to which emerging economies have the technical capabilities to implement the changes needed.

In this paper, we argue that multinational enterprises (MNEs) can act as conduits for transferring the resources necessary to finance the climate transition and implement the actions needed. MNEs are not only major contributors of global emissions,[5] they are also in a position to become significant actors for decarbonization. We go beyond the idea that MNEs are solely culprits and aim to emphasize the important effect that engaging these companies positively would have. First, we identify four key features that place MNEs in a unique position to support the climate transition. Then, we discuss the instruments that can be used to incentivize MNEs to pursue the objective of combating climate change, and thus leverage these features for the common good. Figure 1 provides an overview of the paper, briefly outlining the features and instruments we discuss.

Addressing the climate change challenge – an objective that is global, which requires significant resources and the collaborative efforts of large networks of agents – is something that MNEs are particularly well positioned to do. First, MNEs have the size and reach, directly through their own operations and/or indirectly through their extensive supply chain networks, to make an impact. Through their

[4] As of 2023, debt markets alone have mobilized cumulatively over US $7.5 trillion to finance sustainability-related projects, which is orders of magnitude larger than the 2009 COP15 pledge to developing countries.

[5] GHG 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%).

internal governance markets, MNEs can potentially coordinate actions better than governments, and can also act as institutional carriers that diffuse best practices and corporate governance standards across countries. Second, MNEs have the resources and dynamic capabilities to develop and bring to scale innovative technologies that are key to the climate transition, as well as the technical ability to implement and accelerate the adoption of such technologies in emerging markets. Third, MNEs have extensive collaborative networks – with industry peers, international organizations, think tanks, and governments – which enable them to drive change at scale. Through collaborations and partnerships, they can share risks and ensure the economic viability of technologies requiring economies of scale, leverage synergies in firm-specific advantages (FSAs) to advance innovation, and share know-how and best practices to enhance knowledge. Finally, MNEs have superior access to external capital and efficient internal capital markets that enable them to transfer financial resources effectively across borders. They have been at the forefront of climate-related financial innovation, and have leveraged their credibility and relationships with international and supranational finance institutions to access and channel capital towards developing renewable projects in emerging markets.

We discuss incentive tools and instruments that can be employed to engage MNEs' potential to play a role in decarbonizing the economy, making a distinction between private and public instruments. The private instruments we discuss are essentially contracting solutions powered through financial markets, such as conditional financing, the exercise of corporate governance through equity holdings, executive compensation, and litigation. The public instruments we discuss are carbon pricing regulations, namely carbon taxes and cap-and-trade systems, which incentivize the reduction of GHG, as well as green subsidies, which incentivize the development of technologies that enable decarbonization. MNEs' global operations allow them to act as institutional carriers that can diffuse such public instruments and regulations across countries. Our contribution is to bring together the international business (IB) literature – which has focused on analyzing the specific features of MNEs and placed their multi-location presence at its core – and the corporate finance literature – which has focused on designing incentive mechanisms to steer the actions of firms towards various objectives, through channels such as financing and capital structure, executive compensation, and corporate governance. We believe fruitful areas for future research can be found at the intersections of these fields, which we discuss in the last section, with implications that are of great importance given the worsening climate crisis.

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 analyze how different public and private mechanisms could be designed to leverage MNEs' unique features and incentivize them to act toward the objective of combating climate change. Finally, we discuss opportunities, challenges, and open questions.

Literature review

The global challenge posed by climate change has brought to the fore the fundamental question of what the objective function of the firm should be. 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 the diversity of their risk exposure positions them to better internalize the global-level negative externality of global warming, similarly to a social planner. Some argue that it is not a matter of self-interest, but firms should go beyond their traditional profit maximization objective, and aim to improve social welfare by catering to a wide range of stakeholders. Debates about the nature of MNEs' objective function still exist. We do not aim to settle such debates. Instead, we take as given the objective of combating climate change and discuss a set of private and public instruments that can be used to engage MNEs in its pursuit.

Understanding the role of MNEs in the climate change debate cannot be done without drawing on the foundational IB theories that explain the existence and operation of MNEs. Hymer (1960) laid the groundwork for understanding why firms become multinational and invest in cross-border subsidiaries by emphasizing the role of firm-specific advantages (FSAs). FSAs are key for subsidiaries to confront the "liability of foreignness" (LOF) faced when operating in foreign markets that are distant in cultural, economic, or institutional terms. Building on this, the Uppsala model (Johanson & Vahlne, 1977) of international expansion explains the different stages of internationalization in terms of balancing the costs of overcoming the LOF and the benefits of exploiting FSAs abroad. More realistic representations of FSAs have been developed, such as the distinction between Location-Bound (LB) FSAs that can be exploited by MNEs only in specific environments as opposed to Non-Location Bound (NLB) FSAs such as transferable technological innovation that can build competitive advantage across boundaries (Rugman & Verbeke, 1992).

Another important theory used to explain Foreign Direct Investment (FDI) and the existence of MNEs is internalization theory (Buckley & Casson, 1976). At its core is the idea that in the face of various market imperfections, it is optimal for MNEs to internalize their intermediate markets across national borders. Indeed, MNEs' ability to overcome imperfections in various external markets by creating internal markets (Rugman, 1981) and to organize inter-dependencies between economic actors located in different countries more efficiently than markets (Hennart, 1982), are key to understanding the role that MNEs can have in tackling climate change.

The eclectic paradigm of Dunning (1977) integrates several theory streams by considering different country- and firm-level advantages that explain FDI. Specifically, the OLI paradigm considers the following three dimensions: (1) ownership advantages referring to the ownership of tangible and intangible assets, as well as transactional advantages such as the ability to coordinate a network of geographically dispersed affiliates, (2) location advantages referring to the country-specific advantages (CSAs) that some foreign countries have relative to others, (3) internalization advantages referring to the benefits of creating and exploiting FSAs internally using internal markets instead of relying on contractual arrangements with outside third parties.

The classic framework for IB theory relies on the country-specific advantage (CSA) and firm-specific advantage (FSA) matrix proposed by Rugman (1981), which allows analyzing MNE actions as a function of various CSAs and FSAs interactions and recombinations. Throughout the paper, we will discuss concrete examples illustrating how MNEs respond to CSAs to develop FSAs, how FSAs contribute to the emergence and/or consolidation of 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.

Although the relevant unit of analysis for most IB theory remains the MNE as a whole, since most key decisions are taken at that level, network-based theories have taken more seriously the agency of the subsidiary, and in particular the notion that subsidiary managers can develop FSAs through "subsidiary initiatives" (Birkinshaw, 1996). Subsidiary initiatives refer to the ability of subsidiaries to develop FSAs through the recombination of CSAs from the home and host countries together with FSAs held by various MNE units, dispersed across borders, which can then be used in resource recombination efforts through the MNE network.

We will refer, implicitly or explicitly, to these foundational theories and concepts throughout our exposition, especially when discussing the MNE features that are key to enabling climate action.

Four key features of multinational firms

We identify four MNE features that enable them to play an important role in responding to the climate change crisis and illustrate using examples how these capabilities have been successfully employed. First, we discuss how the size and reach of MNEs can enable them to achieve impact at scale. Second, we discuss how MNEs' superior resources enabled them not only to develop new technologies relevant to the climate crisis but also to deploy technologies to emerging markets lacking such capabilities and resources. Third, we discuss how the collaborations and partnerships that MNEs engage in have been used to develop and disseminate innovative mitigation and adaptation. Finally, we discuss how their superior access to capital and efficient internal capital markets allows them to transfer capital across borders and finance climate-related initiatives in developing markets.

Size and reach

MNEs' large scale of operations and their global supply chains have been studied and linked to their ability to acquire important economic and political influence (Sun et al., 2021), but their size and reach can also be instrumental in addressing 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 the climate processes influencing the global temperature–carbon dynamics. Furthermore, MNEs' global operations allow them to act as institutional carriers that can diffuse regulation and practices globally.

Significant direct impact through own operations

MNEs are large, the value of many exceeding the GDP of entire countries, and have a wide-ranging impact through their direct operations. Their size is generally associated with commensurately high environmental footprints. Thus, changes in their behavior can contribute substantially to global-level mitigation efforts. For instance, the carbon footprint of Mars is equivalent to that of a country the size of Finland, with more than 80% of total emissions embedded in the goods and services that Mars buys (Mars, 2023). In 2023, Mars has pledged US $1 billion to halve its emissions by 2030. These resources will be focused on the transition to 100% renewable energy, improving supply chain traceability, scaling up climate-smart agriculture, changing recipes, and improving logistics. Mars operates in 100 countries worldwide, so these initiatives will likely have an extensive impact, illustrating how the operations of a single MNE can be consequential.

Another example of how the operations of a small number of MNEs' could be instrumental in tackling a global-level challenge is the loss of resilience of the Amazonian rainforest. The Amazonian rain forest is one the largest global land carbon sinks – providing 15% of global terrestrial photosynthesis – and a central driver of the Earth's climate system dynamics (Malhi et al., 2008). Recent estimates indicate that approximately 15% of the original Amazonian rainforest surface has been damaged through mining and agricultural activity (Albert et al., 2023). The ongoing degradation is contributing to a loss of resilience of the Amazon that could lead to its tipping towards a Savannah-like ecosystem.

With only five commodity-trading groups (Cargill, Bunge, ADM, Louis Dreyfus, COFCO) purchasing most of Brazil's soybean exports, and only 13% of municipalities growing soybean being responsible for 95% of deforestation (Reis & Moro, 2022), MNEs could play a central role in drastically reducing deforestation and averting a catastrophic decrease of carbon sequestration. First, given this concentration, MNEs can help reduce deforestation by eliminating purchases of agricultural commodities grown in non-authorized forested areas. Indeed, the Amazon Soy Moratorium agreement reached between the six largest commodity-trading MNEs in Brazil aims to ban the purchase of crops grown in deforested land and illustrates the potential that joint MNE action can achieve (Heilmayr et al., 2020). Second, they can adopt and deploy remote sensing technologies for traceability in supply chains, such as the satellite-based system for "Real-Time Detection of Deforestation", which has proven effective in reducing deforestation through better enforcement by the government (Assuncao et al., 2023). Provided that incentives or effective regulations are in place, MNEs can internalize (Buckley & Casson, 1976) such technological advances in the detection and measurement of deforestation, and develop new purpose-made FSAs which would help them curtail the risk of further degradation by ensuring that they source from deforestation-free areas.

Indirect impact through supply chains and procurement

In addition to their size and extensive reach through direct operations, MNEs have vast supply chains spanning multiple countries. They can leverage their influence and transactional ownership advantages (Dunning, 1977) to promote the adoption of sustainable practices and technologies throughout the value chain. MNEs can also drive change by acting as institutional carriers that diffuse practices and regulations globally, through their extensive networks of subsidiaries (Birkinshaw, 1996).

The global cocoa value chain illustrates the potential role of MNEs in supporting adaptation to climate change. Over 70% of the world's cocoa supply originates from West Africa, and climate projections indicate that over half of the current production area will become unsustainable (Schroth et al., 2016). For Nestlé, one of the world's major cocoa buyers, this represents an important risk that requires large-scale investments and the implementation of climate adaptation strategies to ensure the viability of production in a changed climate. In 2020, Nestlé piloted an "Income Accelerator" program for cocoa farmers in Ghana and the Côte d'Ivoire, offering cash incentives and agricultural extension services. The program was highly successful in increasing farmers' crop yields and reducing the risk of pests and diseases, ultimately enabling better adaptation to changing weather patterns. Nestlé helped 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 Côte d'Ivoire. These MNEs agreed to pay a country premium which will enable cocoa regulators to set a floor price for cocoa, with 70% retained by farmers.

Given their cross-country operations, MNEs can act 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. By adhering to stringent regulations in some countries, such as the FDA's Final Rule in the US or the European Digital Product Passport (DPP) in the EU, MNEs diffuse these standards across their international operations. For instance, the FDA's Final Rule requires comprehensive record-keeping for certain foods, establishing a framework for end-to-end traceability throughout the food industry (Suominen, 2023). Similarly, the EU's DPP mandates that products sold in the EU carry a digital 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 it is aimed at promoting environmental sustainability and recyclability of goods. These regulations have extraterritorial implications, influencing the operations of businesses worldwide. For example, the 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

MNEs routinely leverage their superior resources and dynamic capabilities to accelerate the process of technological innovation and gain a competitive advantage in new markets by investing in subsidiaries or acquiring local firms (Hymer, 1960). Given that MNEs are multi-locational firms embedded within different business systems, they can take advantage of favorable regulatory and institutional environments, adapt and respond to local and subsequently more distant market needs (Johanson & Vahlne, 1977), and contribute to the development and diffusion of key technologies. Importantly, they have played a key role in accelerating the expansion of low-carbon energy technologies in emerging markets, as we discuss below.

The rise of renewable energy

Vestas, a leading Danish wind turbine manufacturer with a 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. Vestas installed its first wind turbines in China in 1986 in Shandong and Hainan Island, and built its first turbine assembly factory in the port city of Tianjin in 2007 (Vestas, 2023). Since the early 2000s, the Chinese government provided a wide-ranging policy package to support the wind turbine industry, which included important direct and indirect subsidies, preferential feed-in tariffs as well as localization requirements. This made China an attractive market with great potential, a prerequisite for MNEs to engage in localization and technology transfer (Lewis & Wiser, 2007). Vestas' ability to adapt to the local market needs through innovation,[6] and the establishment of R&D facilities played an important role in securing domestic market demand, and in the subsequent expansion of wind turbine manufacturing capacity. Through localization requirements and technology transfers, a domestic Chinese value chain developed, with over 90% of turbines' components sourced domestically by 2010 (Perrot & Filippov, 2010). The initial attractiveness of the market can partly be explained by the fact that the Chinese government placed technology transfer at the center of its strategy to achieve an end-to-end harnessing of supply chain know-how. China is now the largest wind turbine manufacturer and the largest exporter of wind turbines globally, producing close to 50% more wind energy power than second-placed Europe (Reuters, 2023a).

Technology transfer by Vestas has played a key role in China becoming the world leader in manufacturing wind turbines. This a cogent example that MNEs do not only leverage FSAs (i.e., superior technology) to offset their LOF (Hymer, 1960) and exploit CSA but eventually, through innovation and technology transfers, MNEs can contribute to the further development of CSAs and shift the international competitive landscape. Vestas provides a telling illustration of the Uppsala Model of internationalization of MNEs (Johanson & Vahlne, 1977). After initially developing its core technologies and deploying its initial industrial-level testing and introduction in its home market of Denmark, Vestas expanded its operations in neighboring European countries to develop further large-scale wind energy plants. It is after acquiring this knowledge that Vestas expanded to more distant, challenging, but also high-growth markets like China.

Decarbonizing carbon-intensive industries

Large MNEs are not only large polluters but they also have the resources to invest in R&D and drive innovation. This is especially the case in hard-to-decarbonize sectors facing high transition risk, which have high incentives to develop technologies to mitigate emissions. For instance, the Danish shipping group Maersk has formed a start-up aiming to develop and increase the supply of affordable green methanol, viewed 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 meter-high sails (Reuters, 2023b). In developing and testing this novel proof-of-concept technology, Cargill is taking considerable risk on behalf of the entire industry, and may struggle to profit from its initial investment in the wind-powered vessel. Thus, MNEs possess the capabilities and resources to take on the risk of developing novel decarbonization solutions that have the potential to significantly shape industries.

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 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 mold, 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, 2021). Thus, Holcim was able to leverage its NLB FSAs (Rugman & Verbeke, 1992), invested in the development of innovative technologies and new FSAs in response to market conditions, and capitalized on them to bring changes to developing countries.

Collaboration and partnerships

MNEs often have strong relationships with various stakeholders, including governments, NGOs, consumers,

[6] An innovation 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.

communities, investors, and academic institutions. They can leverage these relationships to share risks, resources and knowledge, as well as advocate for climate-friendly policies and raise awareness about climate-related issues. As we discuss below, collaboration is essential in achieving critical mass and economic viability of decarbonization technologies requiring economies of scale, such as carbon capture.

Economies of scale and risk-sharing

Collaboration between large MNEs presents important advantages when it comes to the challenge of managing the climate transition, such as cost efficiency and risk sharing. These have likely driven some of the most influential MNE partnerships in the energy and utilities sectors, such as those for the development of Carbon Capture Usage and Storage (CCUS) technologies. CCUS refers to technological solutions aimed at capturing carbon from the atmosphere and storing it for long timescales to prevent it from acting as a greenhouse and further increase global temperature. CCUS, one of the principal means considered necessary to achieve decarbonization targets, requires sizeable upfront costs and its economic viability depends on the ability to capture and store large quantities of CO_2. The formation of partnerships between MNEs and local companies located in an industrial hub is critical to achieve the required economies of scale and to benefit from industrial synergies. For instance, Total, a major oil and gas MNE, partnered with AirLiquide, an MNE specialized in supplying industrial gases and services to various industries, to develop large-scale carbon capture in France, and Carbon Engineering, a US carbon capture technology solutions company, teamed up with Occidental Petroleum in the US to upscale direct air carbon capture (IEA, 2020). Thus, partnerships allow leveraging complementarities between MNEs to achieve otherwise unachievable targets, as evidenced by the synergistic combination of LB FSAs specific to oil refineries with NLB FSAs specific to gas specialists such as Carbon Engineering, which has enabled progress in carbon capture to be achieved and scaled.

Sharing know-how and raising awareness

Collaborative frameworks, like the Oil and Gas Climate Initiative (OGCI) of 12 major hydrocarbon MNEs, have also emerged to advance the development of methane mitigation technologies. Methane is the second most important anthropogenic greenhouse gas effect contributor after CO_2. The reduction of this short-lived gas could be the most effective way of reducing near-term global warming, albeit not a substitute to abating long-lived CO_2 emissions.

The 12 members expect to reduce methane emissions to zero by 2030 and have established a zero-methane emissions alliance involving over 70 smaller companies in the oil and gas sector. By sharing know-how and best practices, the alliance members have developed and made available numerous resources and materials for tackling methane emissions from oil and gas operations, including standards for reporting, measurement, and verification (Aiming for Zero Methane Emissions Initiative, 2024). In addition to collaborating with industry peers, OCGI has actively engaged in collaborations with international institutions, think tanks, and other organizations, which have led to the development of programs and tools for monitoring methane emissions, detecting methane leaks, and identifying abatement potential. For instance, the OGCI jointly 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, which has been successfully scaled to multiple oil fields in Kazakhstan, Nigeria, and Egypt. OGCI has also been active in engaging with regulators and advocating for the implementation of regulations to reduce methane emissions. During the 2022 COP meeting in Glasgow, the OGCI advocated in favor of reducing methane emissions, demonstrating that MNEs can exert also influence towards increasing the stringency of regulation, rather than relaxing it as is usually assumed when it comes to lobbying.

Collaborative efforts integrating MNEs, smaller firms, and public institutions across countries such as the example of the OGCI methane emissions reduction initiative illustrate the importance of leveraging FSA complementarities and sharing know-how to tackle climate change at scale and can make a big difference for countries or other institutions lagging in technical expertise or with poor access to capital and human resources.

Access to capital

Given their presence in multiple countries, MNEs have access to diverse capital markets and thus have a greater pool of sources for financing, which they can access at a lower cost (Erel et al., 2020). Not only do MNEs have superior access to external financing, through equity and debt markets, but they also have efficient internal capital markets within their own organizational structure, which enable them to redistribute and transfer financial resources efficiently across borders. Internal capital markets can effectively substitute for external financing (Gertner et al., 1994) and by doing so 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 at a comparatively high cost (Desai et al., 2004). Thus, MNEs have a competitive advantage in countries where financing for local firms is expensive, such as developing countries, which allows them to take advantage of the high-growth opportunities inherent in such countries.

Channeling capital to developing markets

The implications of MNEs' superior access to capital in the context of the climate challenge are significant. MNEs are able to raise substantial funds at favorable rates in global capital markets and use such funds to finance renewable energy projects, sustainable infrastructure, and other climate-related initiatives in developing nations. For example, 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 that foresees a multi-country, multi-business and multi-currency facility of up to US $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. Another example is the initiative by Iberdrola, the Spanish electric utility MNE, that joined forces with the World Bank Group to promote the energy transition and development of renewable energy projects in emerging countries. In 2023, it took on a US $150 million green and sustainability-linked loan to finance digitalization and energy efficiency improvements in the electricity distribution networks in Brazil (Iberdrola, 2023).

Additionally, MNEs' superior access to capital enables them to directly fund innovative startups, fostering innovation in low-carbon technologies. An example is the thermal battery technology developed by startup Rondo Energy, which converts renewable electricity into industrial-grade heat. This technology, which involves heating solid carbon blocks to industrial temperatures that can preserve the heat energy for days, was funded by significant industrial carbon emitters like Rio Tinto and Saudi Aramco. It is estimated that thermal battery technology could displace about 75% of fossil fuel usage for US industrial energy (Energy Innovation, 2023) and can address the intermittency of solar and wind energy.

In sum, superior access to capital has not only supported MNEs' R&D and innovation capabilities but has also allowed them to diffuse and implement technological innovations in developing countries, with important societal welfare implications. They have successfully leveraged their local expertise (LB FSA) and credibility and relational capital (NLB FSA) to form partnerships with multinational organizations that would otherwise face significant frictions to funding and implementing low-carbon technologies in emerging markets.

Instruments for incentivizing MNES to combat climate change

Despite the potential of MNEs to tackle and respond to the climate change mitigation and adaptation challenge, we must acknowledge their behavior has often steered away from advancing societal goals (Yu et al., 2023). Addressing the climate change challenge – an objective that is global, and which requires significant resources and the collaborative efforts of large networks of counterparts – is something that MNEs are particularly well positioned to do given their global size and reach, extensive networks of stakeholders and significant resources and capabilities to develop and disseminate technologies that are key to the climate transition. We also 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. However, a crucial step is to set incentives right, so that MNEs' objective is to combat climate change and thus avoid the welfare losses associated with the worsening climate crisis.

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.

Carbon Pricing Policies

The main type 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 that 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) is subject to many trade-offs, with a key role being played by the political dimension of which public instrument is practically enforceable. Although, in principle, consensus exists regarding the need to implement a form of carbon pricing regulation, currently the global regulatory framework is highly heterogeneous and overall insufficient in ambition.

Carbon taxes are a carbon pricing instrument the implementation of which has typically faced considerable political resistance. Although over 30 carbon tax schemes are in operation in various countries, the average price of emissions worldwide is only US $2/ton of CO_2 equivalent – an insignificant fraction of the US $190/ton needed to reach the Paris Agreement goals (Prest et al., 2023). Some developed 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 starting at US $15/ton in 2019 and rising to US $39/ton as of 2022. However, generous exemptions were made, and, on average, companies ended up paying for only a fraction of the carbon emitted. For example, the oil and gas MNE Suncor is estimated to have paid an average price of US $2.10/ton of carbon in 2020. 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 US $60/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 firms' operations as a whole. We will return to discussing this issue and the associated areas for future research in the next section.

Cap-and-trade schemes are the politically more popular alternative to carbon taxes. To this date, cap-and-trade schemes have a broader coverage than carbon taxes, i.e., approximately 8.91Gt CO_2 equivalent of global emissions covered against 2.76 Gt CO_2 for carbon taxes.[7] 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 an incentive to leverage their greater resources and outperform domestic firms because by doing so they can profit from 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 the top" view that MNEs' features make them react more positively to environmental regulation than domestic firms (Porter, 1991). Indeed, Nippa, Patnaik and Taussig (2021) provide evidence 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 engage in a "race to the bottom" and react negatively to local carbon regulation by shifting operations to countries with relatively lax norms. The ensuing "carbon leakage" phenomenon has been documented in a variety of markets such as Latin American countries (Sapkota & Bastola, 2017). 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, such as disclosure mandates and the landmark Carbon Border Adjustment Mechanism (CBAM). CBAM is a 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 by ensuring that the carbon price of imports is equivalent to that of domestic production.

Clearly, in the face of fragmented and heterogeneous regulation, complementary measures are needed to ensure that a jurisdiction's climate objectives are not undermined. In such a context, MNEs' response – in particular, whether they engage in a "race to the bottom" by shifting their operations to countries with relatively lax norms or a "race to the top" by turning stringent regulatory requirements into FSAs – is crucially important.

Green subsidies

Green subsidies are a public instrument particularly important for supporting the development of new green technologies, characterized by high upfront costs, long time horizons and uncertain outcomes. When used in conjunction with carbon pricing schemes, subsidies ensure that decarbonization incentives translate into the adoption of green technologies rather than a reduction in production capacity (Lafforgue, 2011). However, we have seen governments implementing subsidies alone with the goal of enhancing the country's competitive advantage in the production of technologies that play a key role in the energy transition.

For instance, green subsidies have contributed to the rise and change in global dominance of players 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. Today, however, China controls over 80% of global PV manufacturing, with some key elements of its supply chain being almost exclusively reliant on Chinese production (IEA, 2022). The shift in the 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.

[7] Updated data can be obtained from the World Bank Carbon Pricing Dashboard.

However, in 2013, Germany's government cut feed-in tariffs for PVs, decreasing domestic producers' competitiveness compared to Chinese MNEs (Winter & Schlesewsky, 2019). For Chinese PV companies, which were themselves the beneficiaries of domestic subsidies, the policy change provided the basis for market expansion, allowing them to increase sales in Germany. Over time, European manufacturers have been replaced by Chinese ones, with important geopolitical and competitiveness implications.

The Chinese government's subsidies were also crucial in the development of electric vehicles (EVs). China has become a world leader in making and buying EVs and is now the main player in battery and EV component trade. China's current dominance can be attributed to a multi-decade government-planned effort involving generous government subsidies, tax breaks, procurement contracts, and other policy incentives (Ezell, 2024). 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. The EV technology was introduced as a priority science research project in China's Five-Year Plan, the country's highest-level economic blueprint (Yang, 2023). In 2009 the government started subsidizing the production of electric buses, taxis, and cars for individual consumers, and also helped domestic EV companies stay afloat in their early years by handing out procurement contracts. Between 2009 and 2023, the government poured over US $230.9 billion into subsidies and other support to the EV sector (see Table 2 in the "Appendix"). Importantly, the Chinese government did not limit subsidies to domestic companies, but to domestically produced EVs. Foreign manufacturers could produce an EV at a subsidized rate in China provided they formed a joint venture with a Chinese manufacturer and transferred crucial technology to it. The policy was therefore designed to stimulate technology growth within the country and to facilitate technological transfers from foreign companies. It stimulated investments from MNEs such as Tesla, Ford, and BMW, which took advantage of the low costs and supportive regulatory environment but are currently finding it hard to compete with Chinese manufacturers.

These examples clearly illustrate that the role of MNEs, given their intrinsic ability to arbitrage across favorable regulatory environments, needs to be carefully considered when designing regulatory policies as well as when evaluating the impact of policy changes. Carbon pricing schemes are subject to political frictions and typically face public resistance. Subsidies are politically more popular alternatives to incentivizing climate action, yet they may not be sustainable in the long term because of the significant strain on regulators' budgets. However, governments can use subsidies strategically to spur MNE activity and thus capitalize on their FSAs, which can ultimately lead to the development of CSAs. Given the limited reach of regulation and MNEs' ability to engage in cross-country regulatory arbitrage, we now turn to market-based instruments that can in principle have a global reach.

Private instruments

We refer to private instruments as the set of actions, initiatives or contracts that investors, consumers, and other stakeholders worldwide can employ to reform MNEs' actions. 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. Furthermore, 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 incentivize publicly listed companies to take climate action. An important channel through which investments can change incentives is the so-called cost of capital channel. The idea is that 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 and by doing so steer future investments towards projects that have a positive impact.

Equity investments based on environmental, social, and governance (ESG) or sustainable criteria have increased in popularity considerably in recent years, reaching over US $30 trillion in assets under management (AUM) as of 2022, and expected to exceed US $40 trillion by 2030 (Bloomberg, 2024). There is no single or mutually exclusive classification of investment strategies, which include screening, thematic, best-in-class, or impact investing strategies, to name a few.[8] However, a broad distinction can be made between screening strategies that involve applying various criteria to determine whether an investment is permissible and, at the other end of the spectrum, impact strategies that aim to bring about some form of positive societal impact by engaging with the invested companies. The idea behind screening strategies, which essentially involve providing less capital to or divesting from brown firms while effectively subsidizing the operations of green firms, is to incentivize brown firms to become greener by changing their cost of capital. However, to the extent that capital is substitutable, it is debatable

[8] For instance, MSCI offers over 3900 equity and fixed-income ESG indexes that integrate ESG or climate considerations into the investment process and portfolios.

whether they have an impact on the cost of capital in equilibrium (Berk & van Binsbergen, 2021), and even if they did, this can be counterproductive because increasing the cost of capital for brown firms makes them even less able to undertake investments in green technologies, whereas subsidizing already green firms will have little to no impact (Hartzmark & Shue, 2023). Importantly, as of 2022 the market capitalization of 157 MNEs estimated by Steenbergen and Saurav (2023) to account for 60% of global emissions was only US $9.75 trillion[9], whereas the AUM of ESG funds was US $30 trillion, so there is sufficient capital for such funds to adopt an impact mandate, acquire controlling shares in these big polluters and help reform them.

Debt markets are an alternative platform for allocating capital to socially desirable projects and firms. The market for sustainable debt has increased significantly in recent years to a cumulative total of over US $7.5 trillion as of 2023.[10] Despite the proliferation of securities, sustainable debt contracts can be divided into two broad categories, namely project-based contracts focusing on the projects that the funds are allocated to, and outcome-based contracts focusing on the outcomes that will be achieved using the funds (Barbalau & Zeni, 2022).

Project-based debt contracts, such as green bonds and loans, are otherwise equivalent to conventional bonds and loans, except for a use-of-proceeds constraint that restricts using the capital to finance pre-specified green projects only. By pledging the proceeds to specific green projects, borrowers benefit, in principle, from a so-called green premium, meaning that the rate of interest on these contracts is lower than that associated with their conventional counterparts. 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 green loan signed by Iberdrola together with ten banks has allowed the development of wind farm projects in Latin America. In 2020, Coca-Cola issued its first green bond for greening the operations of its subsidiary in Mexico, including financing reforestation projects 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 (MacAskill et al., 2021). Concerns exist about additionality, that is, whether these projects would have been financed anyway, and the focus on projects does not warrant a change in overall corporate behavior. For instance, the Korea Electric Power Corporation, issued green bonds in 2022 while still 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 cost of debt to the achievement of company-wide sustainability targets, most often carbon emission reduction targets. Achieving such targets allows the issuing firm to borrow at a lower lending rate, whereas missing the target increases the interest rate on the contract – so they embed pricing mechanisms that ensure commitment to outcomes. If outcomes are perfectly observable, contracting on outcomes rather than projects is strictly optimal (Barbalau & Zeni, 2022). Furthermore, contracts targeting emission reductions are, under plausible conditions, equivalent to a carbon tax (Allen et al., 2023). This is an important result suggesting these contracts can substitute regulation by providing an alternative carbon pricing incentive that is not tied to local jurisdictions nor subject to political constraints. 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 this kind of capital have been large multinational banks rather than public entities. Therefore, MNEs have played a critical role in driving financial innovation and can be credited with having started a market that, if properly implemented, can have a significant impact.

Corporate governance

Shareholder advocacy is an alternative way of urging MNEs to act more sustainably. Rather than influencing a firm's actions indirectly through the cost of capital channel, investors can get directly involved in the corporate governance of firms by acquiring an equity stake in these firms. Equity securities are contracts that grant shareholders rights to vote on directors and resolutions concerning the firm, with voting power proportional to the amount of equity share capital they own. They underlie the corporate governance channel.

In the last few years, there has been a considerable increase in shareholders' engagement on environmental and social issues. Shareholder activism usually targets large, visible firms with low ESG ratings and high financial performance (Barko et al., 2021). 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 extent that all investors are significantly socially responsible, voting can

[9] This figure is based on our calculations, using data from companiesmarketcap.com.

[10] In line with Bloomberg, the sustainable debt market includes green loans and bonds, social bonds, sustainable bonds and sustainability-linked loans and bonds.

achieve positive outcomes provided the majority is at least slightly socially responsible. In practice though, a majority is not always required, as exemplified by the activist hedge fund Engine No.1, which despite its very small ownership share in ExxonMobil of 0.02%, managed to replace three board members as part of its effort to improve ExxonMobil's climate governance and risk management practices. This was possible because Engine No. 1 was informally backed by some of Exxon's biggest institutional investors, finance MNEs such as BlackRock and Vanguard, illustrating again the key role of MNEs.

Through the ownership of equity securities, shareholders have a contractual right to be involved in corporate governance. Another contracting-based solution to influencing a firm's corporate governance is by tying executive compensation to a sought-after outcome. So-called ESG-linked compensations were first introduced by the US MNE Alcoa, which in 2013 announced that 20% of its executives' compensation 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, and evidence suggests that these instruments are effective in increasing ESG performance for firms with good corporate governance (Homroy et al., 2023). Although the full implications of such contracting solutions have yet to be understood, these represent a useful tool for steering MNEs' actions towards certain desired outcomes.

Litigation and boycotting

Stakeholders that are not actively participating in capital markets can exert pressure on MNEs to advance climate goals through litigation and boycotting. The number of climate change litigation cases has increased exponentially over the past two decades, from less than 50 in 2003 to a total of 2341 as of 2023 (Setzer & Higham, 2023). Litigation against large MNEs has been notoriously hard,[11] and involves significant costs that are disproportionate relative to the resources of the plaintiffs, which are typically NGOs and individuals, often backed by advocacy groups. However, the recent emergence of market-based solutions that provide financial support for bringing large MNEs to court is bound to make litigation an ever more important instrument for urging responsible corporate action. For example, the impact investment firm Aristata Capital is deploying funds to finance community lawsuits against companies over environmental and social problems. Unlike 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 and will cover the costs of lawsuits in exchange for a share of the plaintiffs' damage awards.

The rapidly shifting legal environmental around climate-related corporate responsibility raises important risks for MNEs. Indeed, environmental lawsuits are becoming material risks for firms, as illustrated by the successful class action lawsuit against the major oil and gas MNE Shell, which was ordered by a Dutch court to reduce its carbon emissions (Bloomberg, 2021). Because of litigation risk, large firms are pulling back from voluntary environmental disclosures initiatives such as the CDP, and when disclosing they prefer to focus on forward-looking information such as environmental risks and targets rather than historical emissions, because the latter comes with higher litigation risk (Robinson et al., 2023).

Consumers who do not access capital markets can use boycotts as a way to express their environmental concerns 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 firms that cause environmental harm, or which are failing to take action against climate change. Evidence suggests that consumer boycotts are often effective in driving changes in corporate policies and practices, and this is not necessarily due to the direct impact on a firms's sales but to the negative publicity they generate (King, 2011). The success of boycotts and protests often depends on various factors including media attention, public awareness, and their impact on a firms's public image and reputation (see Roser-Renouf, Atkinson, Maibach, and Leiserowitz (2016) and references therein). This is especially true for environmental issues, where boycotts and protests have led to corporate policy changes such as Shell's decision to halt its Arctic drilling operations, BlackRock's divestment from coal, or Nestle's pledged to stop deforestation for palm oil.

Conclusion and discussions

Climate change, a global externality, demands a unified regulatory response. However, coordination across governments has been fraught with political disagreement and overall insufficient in 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 addressing the climate change challenge. Indeed, an increasing number of MNEs have made net-zero commitments in recent years, as indicated by the firm-level evidence we compile in Fig. 3 in the "Appendix", which shows the adoption and status of achievement of net-zero targets across

[11] 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.

regions and industries. In this paper, we have first discussed how different key features of MNEs could enable them to tackle the challenge of mitigation and adaptation to climate change. Subsequently, we analyzed the way in which different instruments could be used to incentivize MNEs to pursue the objective of environmental preservation. We now turn to discussing opportunities, challenges, and open research questions that emerge from our paper.

Corporate responsibility

A corollary of expanding firms' objective function beyond the maximization of profits is that it expands the scope of corporate responsibility. This is problematic because the set of issues that corporations are expected to act on can become 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 to cases 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 actions. Yet, how can we determine this in practice? What are the relevant trade-offs and the important temporal and spatial dimensions that need to be considered? And if we were to limit corporate responsibility to situations where a firm has a comparative advantage in achieving a prosocial goal or reducing a harm, how does this interact with its FSAs?

The climate change crisis could fundamentally change the scope of corporate responsibility. IB scholarship places location and borders at its core but climate change 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 filed a lawsuit at the District Court Essen against the German utility company RWE for its role in risking his hometown being flooded by melting glaciers. RWE has never operated in Peru but was estimated to have contributed 0.47% to global emissions over its 124-year history. The lawsuit aims to make RWE pay for 0.47% of the costs of building defenses against the melting glacier, amounting to US $20,000 (The Guardian, 2022). A similar case has been brought by four residents of the Indonesian island Pari at the Cantonal Court of Zug in Switzerland against Holcim, which is demanded to cover 0.42% of the costs of building defenses against rising sea level, in proportion to its estimated contribution to global emissions (Financial Times, 2023a). If successful, the implications of these lawsuits cannot be overstated and are certainly not well understood, making this an important area for future research. What is the enforceability of these rulings? Would this set a precedent implying that MNEs have to pay for all global damages in proportion to their historical emissions? How can MNEs respond to this existential threat? Will this also create a precedent that extends to the country level and that would thus provide a legal basis for the loss and damage debates underpinning recent COP meetings?

Regulation and MNEs

As discussed, MNEs can play an important role in exporting local environmental standards. However, local regulation can also generate carbon leakage towards pollution havens. 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 MNE-specific policy designs aimed at correcting carbon-leakage effects and generate positive externalities. MNE-level carbon taxes hold the potential as a simple and effective tool to regulate firms' emissions as a whole. The European Business Tax Forum has recently raised this point and challenged MNEs 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 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 carbon 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 carbon tax be designed so 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 support for EVs, for example, was a strategic decision to become a market leader in EVs by creating a competitive advantage in this sector. In fact, Chinese MNEs now dominate each of the three key sectors for the transition to a low-carbon economy, namely PV, EV, and wind (see Table 4 in the "Appendix"). The US and EU are now imposing anti-subsidy tariffs on Chinese EV imports and have themselves launched subsidy schemes to support their domestic renewables sectors. However, as Table 3 in the "Appendix" illustrates, industrial subsidies are relatively low and have come with a considerable delay relative to the support measures implemented in China. For instance, China started supporting its EV sector in 2009, and in 2023 alone it provided US $45.3 billion in subsidies whereas the Inflation Reduction Act, US's flagship low-carbon economy support policy, has budgeted US $23.4 billion to EV sector subsidies to be disbursed over a 10-year period. Furthermore, the lack of commitment and political uncertainty may make closing the competitiveness gap very difficult. For developed countries, the big question now is how to meet climate targets without jeopardizing geopolitical autonomy and energy security. As discussed in this paper, MNEs have played a key role in transferring technology and shifting the competitive landscape, so it is crucial to account for their responses when implementing regulation and to leverage their FSAs to advance climate goals. Another issue is related to the implications for developing countries of subsidies and measures such as the EU's CBAM, which will end up creating a competitive advantage for firms operating in countries that 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 maintaining the competitiveness of firms in developing countries? What is the role of MNEs in this context?

Public–private partnerships and adaptation

The challenge of mitigating climate change through the reduction of negative externalities is compounded in developing countries, whose budgets are already overstretched 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, as private investors face prohibitive risks when funding green projects in developing countries. Traditionally, official sector entities such as multilateral development banks (MDBs) have played a useful catalytic role, by sharing risks with private investors so as to enhance the viability of such investments. Recently, we have seen some promising public–private partnerships (PPPs) in the Asia Pacific and Africa regions, namely the Just Energy Transition Partnerships (JEPTs) funded in 2021 at the COP26 in Glasgow. These are designed to transfer funds from wealthy economies to developing ones for the purpose of weaning off fossil fuels.[12] South Africa, Indonesia, and Vietnam are the first three developing countries to receive funding through these PPPs, which were funded by wealthy nations (the International Partners Group) together with Multilateral Development Banks (MBDs) and finance MNEs (the Glasgow Financial Alliance for Net Zero Working Group). To this date, the donor pool includes MNEs such as HSBC and Citigroup. However, a number of countries, such as India, have refused to receive funding through JETPs, due to concerns related to the funding conditions (i.e., conditional, costly debt), their need to grow, and their adaptation needs. Understanding these frictions is crucial. How can funding deals be structured to overcome such frictions? Can MNEs play a role in alleviating them?

A challenge to climate change mitigation efforts in developing countries is their higher exposure to climate shocks and consequent adaptation needs. Limited resources imply a trade-off between investing in adaptation (e.g., building sea walls) to reduce the impact of unfolding natural disasters, and investing in mitigating (e.g., reducing GHGs) to eventually reduce the magnitude or occurrence of climate shocks. Given that the benefits of investing in adaptation are local and non-scalable,[13] this is an area where private investors have been less forthcoming compared to mitigation (Buchner et al., 2021), which generates global benefits and/or can lead to the development of technologies that can be scaled and monetized. We believe that given the right incentives, MNEs could play a key role in advancing adaptation. That is because MNEs operating in developing countries exposed to climate shocks stand to benefit from investing in adaptation. However, it is also easier for MNEs to simply relocate to avoid being exposed to these shocks. The key question is how can MNEs be incentivized to stay in climate-exposed countries, capitalize on their interest in maintaining current operations, support adaptation efforts, and, in doing so, enhance the resilience of local communities. Does the answer lie in PPPs or subsidizing their adaptation to changing climate conditions? How should partnerships or subsidy schemes be designed to ensure the benefits to local communities are maximized?

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, which can incentivize MNEs to pursue climate goals. The use of contractual mechanisms that target the 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. Instead, various interpretations and implementations of the standards, guidance and tools in the Greenhouse Gas (GHG) Protocol exist. It is uncommon to directly measure GHG emissions by monitoring concentration and flow rates. The most common approach for calculating GHG

[12] Specifically, JEPTs consist of grants, loans, or investments to coal-dependent developing nations to support their path to phasing out coal and transitioning towards clean energy while addressing the social consequences.

[13] In other words, investing in adaptation is such that only local actors benefit from it.

emissions is through the application of documented emission factors, which are calculated ratios relating GHG emissions to a proxy measure of activity at a source. Thus, emissions are by no means precisely measured but rely mainly on approximations. Furthermore, companies can use carbon offsets when calculating their emissions inventory.

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. However, recent technological advances in remote sensing and image recognition that permit monitoring and storing changes in forest biomass more reliably, consistently or efficiently can potentially restore confidence in voluntary carbon markets. Such technologies include high-resolution remote sensing satellites such as Sentinel or the NISAR mission, or smaller scale LIDAR drone technologies for measuring forest biomass. It remains an open question why these are not already being used by carbon offset verification bodies such as Verra and Gold Standard. Currently, third-party verification organizations have financial incentives to compromise their impartiality in the face of competition because if a project is rejected, the owner can simply seek approval from a rival agency. What is needed to change the incentives of these players and ensure the adoption of precise measurement and monitoring technologies that are already available? Can and should regulation complement such technological advances? What are the possible unintended consequences?

In sum, there is great potential for MNEs to play an important role in fighting climate change, especially if the right incentives are in place. Important research questions remain around the issue of defining the bounds of corporate responsibility, designing regulation around MNEs, financing climate change mitigation and adaptation, and improving the measurement and disclosure of negative externalities.

Appendix

See Tables 1, 2, 3, 4 and Figs. 2, 3.

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

Country	Share of global emission (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 from Mexico to Argentina excluding Caribbean countries

Table 2 Government support for China's EV sector (US $billions). *Source*: CSIS Trustee Chair in Chinese Business and Economics (Kennedy, 2024)

Type of support	2009–2017	2018	2019	2020	2021	2022	2023	Total
Rebate	37.8	4.3	3.3	3.5	7.4	9.2	0	65.7
Sales tax exemption	10.8	7.7	6.4	6.6	16.4	30.3	39.6	117.7
Infrastructure subsidies	2.3	0.2	0.2	0.3	0.3	0.6	0.6	4.5
Research and development	2	3.6	3.4	3.5	4.3	3.9	4.3	25
Government procurement	7.8	1.6	1.4	2.9	1.7	1.8	0.8	18
Total	60.7	17.4	14.8	16.8	30.1	45.8	45.3	230.9
Spending as % of total sales	0.424	0.227	0.233	0.254	0.183	0.151	0.114	0.188
Subsidy per vehicle (US $)	–	13860	12311	12294	8538	6656	4764	–

Table 3 Market share of top 8 MNEs across the three main low-carbon industries. The data were extracted from Enerdata (2024) (wind), Satista (2022) (PV), and Swallow (2023) (EV)

Rank	Electric vehicle industry			Solar PV industry			Wind turbine industry		
	Name	Market share (%)	Country	Name	Market share (%)	Country	Name	Market share (%)	Country
1	BYD	21.1	China	Longji Solar	22.1	China	Goldwind	20.8	China
2	Tesla	16.0	USA	JA Solar	15.3	China	Envision	17.5	China
3	Volks.	6.9	Germ.	Canad. Solar	14.9	Canada	Mingyang	17.0	China
4	GEELY	5.9	China	GCL Solar	14.5	China	Windey	12.3	China
5	GM	4.7	USA	Trina Solar	9.4	China	Vestas	11.2	Denm.
6	Mer.-Benz	4.3	Germ.	Jinko Solar	4.5	China	Sany	9.2	China
7	BMW	4.2	Germ.	Risen	3.4	China	GE	7.8	USA
8	Stellantis	4.0	France	Shunfeng	2.3	China	Siemens	7.7	Germ.

Table 4 Breakdown of industrial support funding in different developed economies in 2019 (US $billions). *Source*: DiPippo et al. (2022)

Country	Direct subsidies	Other tax incentives	R&D tax incentives	Govt support for R&D	Below market credit	State investment funds	China-specific factors	Total
China	87.8	15.2	14.4	92.5	121.9	16.6	57.4	406
United States	1.5	24.3	31.2	23.8	1.6	1.6	0	84
Japan	4.1	5.3	4.2	11.3	0.2	1.7	0	27
Germany	1.6	4	0	6.3	5.4	1.5	0	19
France	0.2	8.5	6.4	0.3	1.2	1.2	0	18
South Korea	0	3.1	3.5	3.9	2.6	1.9	0	15
Brazil	1.4	1.7	0.5	4.6	2.3	0.4	0	11
Taiwan	0	1.7	0.9	0	0.4	1.9	0	5

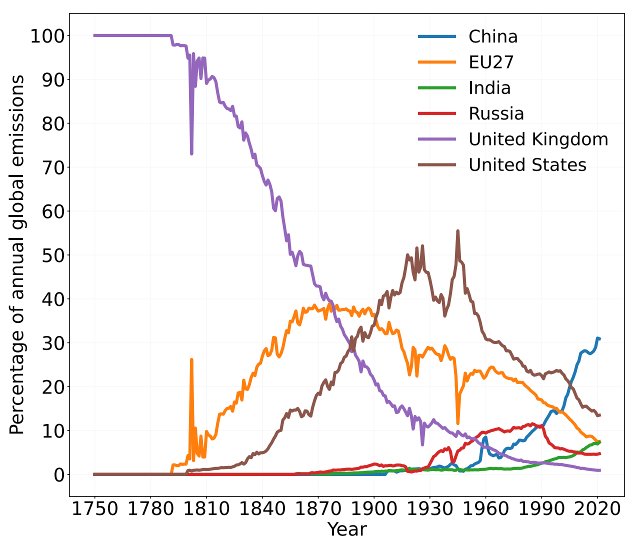

Fig. 2 Percentage of annual global CO_2 emissions for different countries and world regions in 2021. *Source*: Global Carbon Budget (2022) – Friedlingstein et al. (2022)

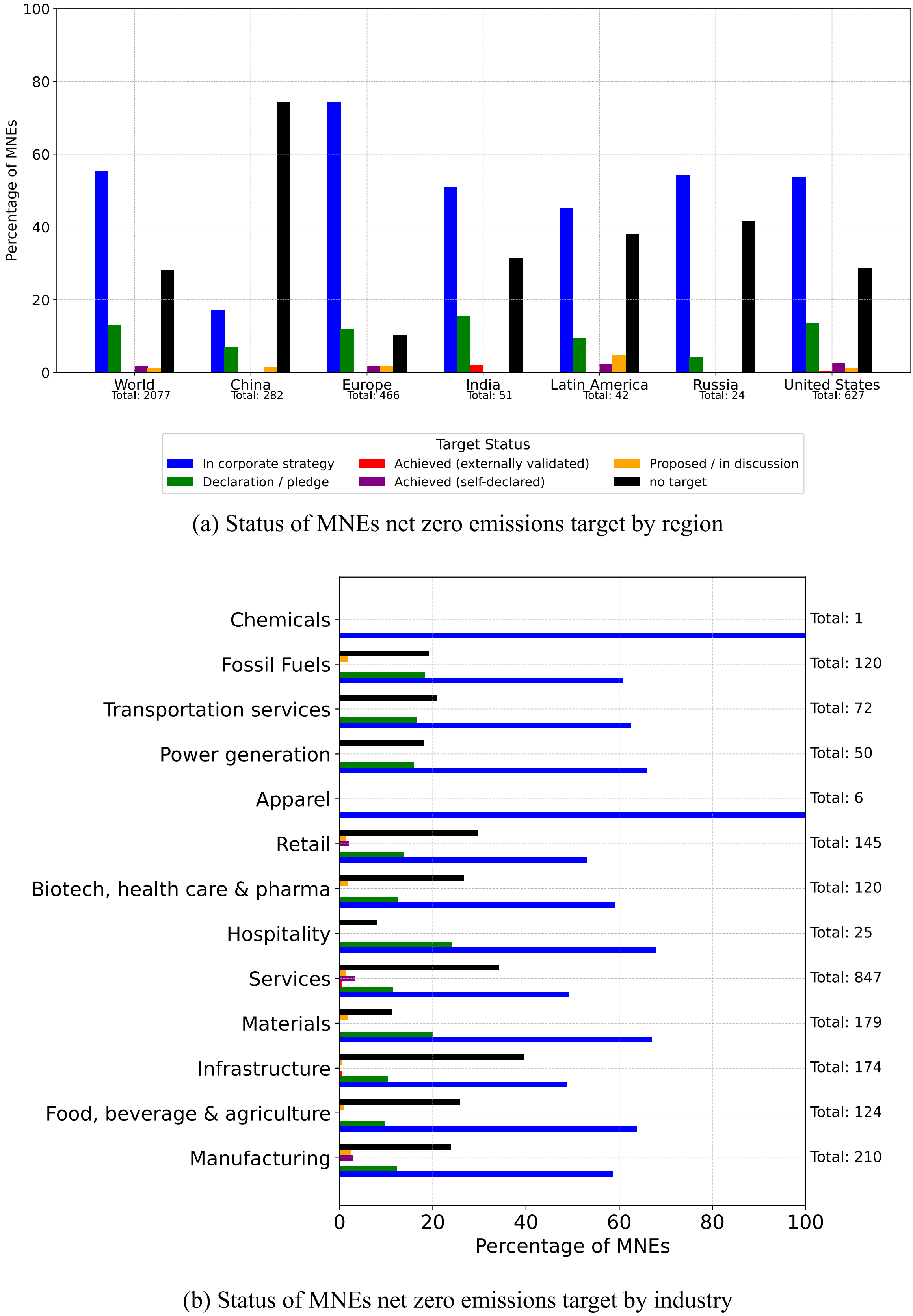

Fig. 3 Status of achievement of net-zero greenhouse gas emissions target of 2000 publicly listed MNEs. The top panel (**a**) presents the percentage of MNEs in different regions of the world while panel (**b**) displays the percentage of MNEs achieving different targets for 13 industry types. The data used were extracted from Net Zero Tracker (2024)

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