

POLICY BRIEF

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Intellectual property and the green technology divide: barriers, policy spaces and collective options for developing countries

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ABSTRACT

Developing countries are expected to industrialise, decarbonise, and adapt to climate change simultaneously. Yet, many crucial climate technologies remain inaccessible because key knowledge is protected by patents and trade secrets held by multinational companies in a few countries. Drawing on the intellectual property (IP) and climate literature, the paper maps this green technology IP landscape and synthesises four interacting barrier clusters – access costs, transaction costs, legal and institutional constraints (including TRIPS and “TRIPS plus”), and information and absorptive capacity gaps – that hinder diffusion and reinforce dependence. It concludes that closing the green technology divide requires a combined strategy: using and defending TRIPS flexibilities (e.g., compulsory licensing and tighter patentability standards), building collective licensing and transparency mechanisms (such as patent pools), mobilising finance, and investing in domestic capability and competition policy so access translates into real deployment and learning.

KEYWORDS: Intellectual Property, Green Technology, Green Technology Divide, Policy Space, TRIPS Flexibilities

Les pays en développement sont appelés à s'industrialiser, à décarboniser et à s'adapter au changement climatique simultanément. Or, de nombreuses technologies climatiques essentielles restent inaccessibles, car les connaissances clés sont protégées par des brevets et des secrets d'affaires détenus par des multinationales implantées dans un petit nombre de pays. S'appuyant sur la littérature relative à la propriété intellectuelle (PI) et au climat, cet article dresse un état des lieux de la propriété intellectuelle dans le domaine des technologies vertes et synthétise quatre groupes d'obstacles interdépendants – les coûts d'accès, les coûts de transaction, les contraintes juridiques et institutionnelles (notamment les ADPIC et les « ADPIC plus »), ainsi que les déficits en matière d'information et de capacité d'absorption – qui entravent la diffusion de ces technologies et renforcent la dépendance. Il conclut que pour combler le fossé en matière de technologies vertes, une stratégie combinée s'impose : utiliser et défendre les flexibilités de l'accord ADPIC (par exemple, les licences obligatoires et des normes de brevetabilité plus strictes), mettre en place des mécanismes collectifs de licence et de transparence (tels que des pools de brevets), mobiliser des financements et investir dans les capacités nationales ainsi que dans la politique de concurrence, afin que l'accès se traduise par un déploiement concret et une véritable acquisition de connaissances.

MOTS-CLÉS: Propriété intellectuelle, technologies vertes, fracture technologique verte, marge de manœuvre politique, flexibilités prévues par l'Accord sur les ADPIC

KEY MESSAGES

- Ownership of green technology is concentrated to a degree that makes market access a structural, not a commercial, problem.
- IP-related barriers operate as a system, and single-instrument remedies therefore fail.
- Closing the divide requires combining legal flexibilities, collective mechanisms, finance and domestic capability – and using them collectively rather than country by country.

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Se espera que los países en desarrollo se industrialicen, se descarbonicen y se adapten al cambio climático de manera simultánea. Sin embargo, muchas tecnologías climáticas cruciales siguen siendo inaccesibles porque el conocimiento clave está protegido por patentes y secretos comerciales en manos de empresas multinacionales en unos pocos países. Basándose en la literatura sobre propiedad intelectual (PI) y clima, el artículo mapea este panorama de PI de tecnologías verdes y sintetiza cuatro conjuntos de barreras interrelacionadas —costes de acceso, costes de transacción, restricciones legales e institucionales (incluidos los TRIPS y los “TRIPS plus”), y brechas de información y de capacidad de absorción— que dificultan la difusión y refuerzan la dependencia. Concluye que cerrar la brecha tecnológica verde requiere una estrategia combinada: utilizar y defender las flexibilidades de los TRIPS (p. ej., licencias obligatorias y criterios más estrictos de patentabilidad), crear mecanismos colectivos de concesión de licencias y de transparencia (como los “pools” de patentes), movilizar financiación e invertir en capacidades nacionales y en política de competencia para que el acceso se traduzca en un despliegue real y en aprendizaje.

PALABRAS CLAVES: Propiedad intelectual, tecnología verde, brecha tecnológica verde, margen de maniobra política, flexibilidades del Acuerdo sobre los ADPIC

发展中国家被期望同时实现工业化、脱碳和适应气候变化。然而，由于关键知识受到少数几个国家跨国公司所持有的专利和商业秘密的保护，许多至关重要的气候技术仍然无法获得。本文借鉴知识产权 (IP) 和气候变化领域的文献，梳理了绿色技术知识产权格局，并归纳出四个相互关联的壁垒集群——获取成本、交易成本、法律和制度约束（包括《与贸易有关的知识产权协定》(TRIPS) 及“TRIPS+”条款），以及信息和吸收能力缺口——这些壁垒阻碍了绿色技术的扩散并加剧了依赖性。文章得出结论：要弥合绿色技术鸿沟，需要采取综合策略：利用并捍卫《与贸易有关的知识产权协定》的灵活性（例如强制许可和更严格的专利性标准），建立集体许可和透明度机制（如专利池），调动资金，并投资于本土能力建设和竞争政策，从而使技术获取转化为实际应用和学习。

关键词：知识产权、绿色技术、绿色技术鸿沟、政策空间、《与贸易有关的知识产权协定》的灵活性

Introduction

Developing countries are expected to industrialise, decarbonise and adapt to climate change simultaneously. In practice, this requires access to a rapidly evolving portfolio of technologies many of which are held under patent or trade-secret protection by multinational firms (Raiser, Naims, and Bruhn 2017; Nathan 2025). This creates a distributional dilemma: the countries most exposed to climate disasters and development constraints often face the steepest barriers to acquiring and using climate-critical knowledge (Abdel-Latif 2015; Glachant and Dechezleprêtre 2017).

This paper surveys existing research on Intellectual Property (IP) Regimes and Green Technology to outline the green technology sector and identify major obstacles and policy strategies to enhance access and promote technology diffusion in developing countries. The literature generally agrees that current IP systems present significant challenges to an equitable green transition. The paper aims to identify and further elaborate on these challenges while also discussing policy alternatives for developing countries.

Green Technology Intellectual Property Landscape

The IP-and-climate debate has remained polarised. Developing countries have argued in negotiations that climate-critical solutions are “out of their reach” because IP protection raises costs and limits access, and they have proposed measures such as patent exemptions or compulsory licences for green technologies (Abdel-Latif 2015). Developed countries and industry actors, by contrast, often insist that strong IP protection is necessary to incentivise innovation and facilitate transfer (Abdel-Latif 2015). The literature emphasises that IP effects are context-specific, varying by technology type, market structure and local absorptive capacity (Glachant and Dechezleprêtre 2017; Rai, Schultz, and Funkhouser 2014). Yet it also identifies common patterns of concentration, dependence and constrained policy space that, if unaddressed, risk deepening global inequalities in the green transition (Lavopa and de las Mercedes Menéndez 2023; UNCTAD 2024b; Nathan 2025).

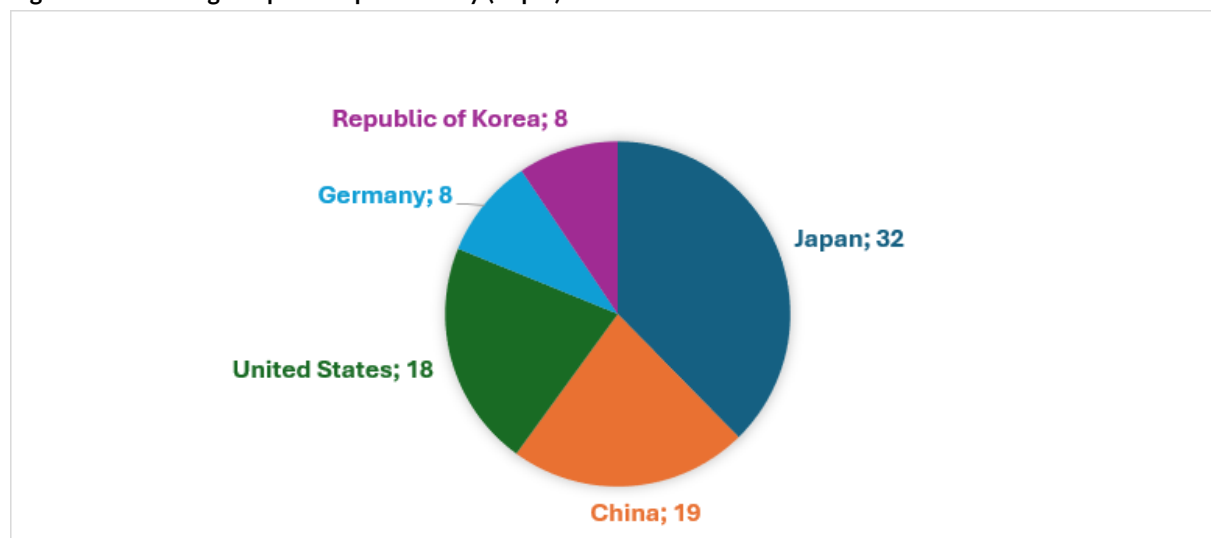
In standard economic theory, patents are supported as a solution to under-investment in invention. The rationale is straightforward: as knowledge is costly to create and easy to copy, a temporary monopoly assures returns on R&D (Nordhaus 1969; Scotchmer 2004). A related argument in the technology-transfer literature is that credible protection can encourage multinationals to license technology or invest abroad by reducing appropriation risks (Mansfield 1994; Javorcik 2004). These claims are often invoked to justify strong protection and enforcement as enablers of technology transfer.

However, as many authors have noted, the multilateralization of IP standards occurs within a political economy where bargaining power matters. The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) was negotiated by developed countries as part of a trade “package deal”, shaped by market access concessions and bilateral pressures, and designed to create a uniform global framework regardless of specific development contexts (Liebig 2001; Drahos 2002; Correa 2023). While TRIPS contains an obligation to provide incentives for technology transfer to least-developed countries (Article 66.2), the agreement has largely

“frozen” the comparative advantage of already industrialised countries by restricting latecomer strategies of emulation and learning historically mobilised in industrialisation processes (Correa 2023; Watal and Caminero 2019). In this account, IP rules do not merely reward innovation; they shape a global hierarchy of knowledge ownership and dependence (Nathan 2025).

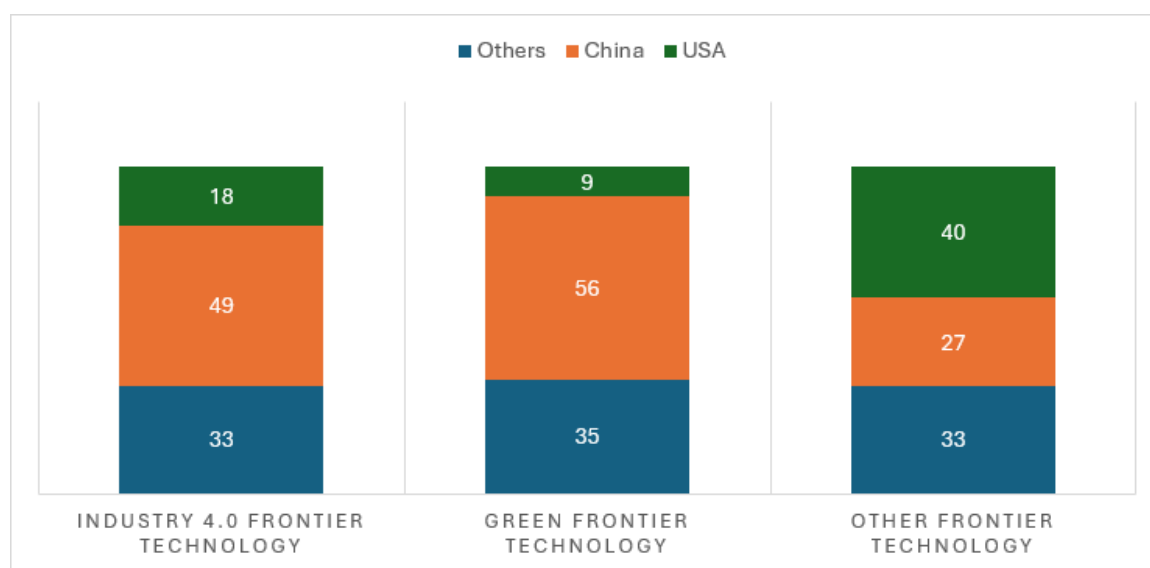
That is precisely the case of green technology. In this field, innovation and ownership are concentrated in a small set of countries and firms. UNIDO reports that high-income countries hold 79 percent of green patents, China holds 19 percent and other developing countries around 2 percent, with 85 percent of patents concentrated in five economies (Lavopa and de las Mercedes Menéndez 2023). Figure 1 presents the top 5 countries in terms of patent holders.

Figure 1: Percentage of patents per country (Top 5)



UNCTAD (2024b) reports that China leads in green frontier technologies with 56 percent of patents (2000–2021), with other emerging economies registering relatively few patents and a continuing gap with industrialised economies (See Figure 2).¹ Within the corporate landscape, private firms – particularly manufacturers – hold a dominant share of green patents. Sectoral examples (electric vehicles, batteries and wind turbines) to illustrate how large portfolios and market share can allow established firms to shape standards and constrain entry (Lavopa and de las Mercedes Menéndez 2023; Borthakur 2023; EconSight 2023).

Figure 2: Country share of patents by frontier technology (2000–2021)



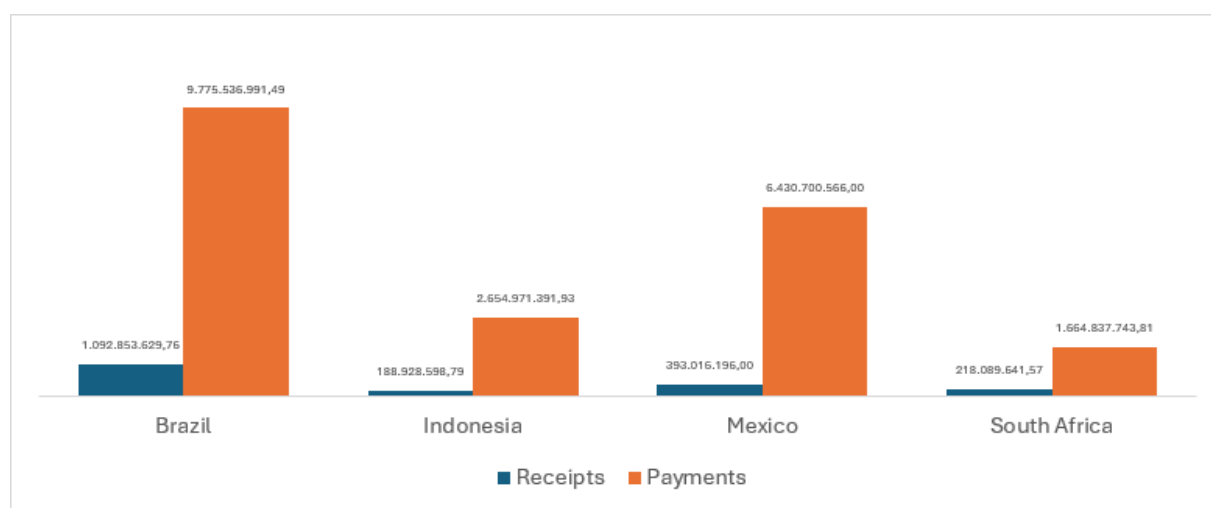
Source: (UNCTAD 2024b)

¹ The divergence between this 56% and the 19% reported above is not a contradiction but a difference in object: UNIDO's figure aggregates the cumulative stock of green patents under the broad Y02 classification, whereas UNCTAD's indicator isolates the flow of filings between 2000 and 2021 within the narrower segment of green frontier technologies – renewables, electric mobility, advanced batteries, and related fields. The gap, therefore, tracks China's pronounced specialisation at the frontier rather than its position in the wider green patent landscape.

UNIDO actor-level breakdown underscores the political economy underlying this concentration. Private companies are reported to account for over two-thirds of green technology patents filed since 2000, while individuals hold around 14 percent and universities or public research institutions about 9 percent. Within the private sector, manufacturing firms hold nearly 60 percent of all green-related patents (Lavopa and de las Mercedes Menéndez 2023). Considering such a landscape, as has been flagged, the control of key portfolios by a handful of firms can “limit the further commercialisation” of mitigation technologies and hinder access for those in need. (Raiser, Naims, and Bruhn 2017). It also points to an overlap with competition policy: if dominant firms use IP and licensing practices to exclude competitors or slow diffusion, competition law may be relevant as a complement to IP-specific measures (Dreyfuss and Pila 2018).

For developing countries, the immediate macroeconomic implications of IP concentration are found in the balance of payments. As shown in Figure 3, the imbalance between cross-border payments and receipts associated with licensed IP use in Brazil, Indonesia, Mexico, and South Africa is staggering.² Although the World Bank series aggregates IP-related charges across all sectors, the asymmetry it captures can reasonably be expected to hold – and most likely to deepen – within green technologies, where ownership is even more concentrated and licensing flows are growing alongside the energy transition. Moreover, these asymmetries lead to persistent dependence: UNCTAD reports that nearly half of UN member countries rely on raw materials for more than 60 percent of export revenue (UNCTAD 2024a).

Figure 3: Charges for the use of Intellectual Property (Balance of Payments – current US\$)



Source: World Bank, “Charges for the use of intellectual property, [payments](#) and [receipts](#)”

IP-related Access Barriers and Policy Options

A systematic review of existing literature enabled the identification of the four clusters of barriers (i) access costs, (ii) transaction costs, (iii) legal and institutional constraints, and (iv) information/capacity gaps. For policymaking, the key point is their interaction: even a legally available licence may be unaffordable; even a lawful flexibility may be unusable if procedures are complex; and even an accessible technology may not diffuse if absorption capacity is weak (Metz et al. 2000; Muñoz-Tellez, Syam, and Romero 2019).

Access costs

Access costs are direct financial barriers to obtaining green technologies. Patent-based monopoly pricing and licensing fees can keep advanced technologies unaffordable, thereby delaying adoption and constraining industrial upgrading (Baker, Jayadev, and Stiglitz 2017; Rafitoson and Correa 2025). Furthermore, complex patent landscapes can worsen these costs. Patent thickets and bundling create additional costs. While patent thickets require multiple licences and increase infringement risks and legal uncertainty (May and Sell 2006; Maurer 2015), bundling and restrictive licence terms can further raise costs by limiting scope or requiring the purchase of proprietary inputs (Hilty 2016).

Access costs, moreover, include “absorption” spending: implementing technologies requires investment in equipment, skills and infrastructure, which may exceed the cost of IP licences and can be decisive for diffusion outcomes (Metz et al. 2000; Olawuyi 2018). Countries considering lawful measures to reduce costs – such as compulsory licensing – may face the perceived risk of trade pressure or retaliation, including via unilateral processes such as the US Special 301 mechanism (Muñoz-Tellez, Syam, and Romero 2019).

² These balance-of-payments figures capture only direct, recorded charges and may understate total IP-related costs where such costs are embedded in the prices of imported goods or transferred through related transactions such as investment and mergers.

Proposed policy responses include using TRIPS flexibilities, such as compulsory licensing, and drawing lessons from the access-to-medicines debates (Maskus and Reichman 2004; Correa 2018; 't Hoen 2009; Zhou 2019). Climate-specific proposals include a stronger case for flexibilities on the grounds that climate change constitutes an urgent public interest or emergency (Vawda 2021; Nathan 2025). Beyond flexibilities, the literature proposes collective arrangements such as patent pools that standardise licensing and reduce transaction burdens, as well as financing measures (including differentiated pricing and “buy-down” subsidies) intended to address affordability constraints (World Bank 2012; Muñoz-Tellez, Syam, and Romero 2019; Rafitoson and Correa 2025).

Transaction costs

Transaction costs are the process costs of locating, negotiating and operationalising technology access. These costs are often underestimated yet can deter adoption even when technologies are nominally available (Muñoz-Tellez, Syam, and Romero 2019). Search costs arise because patent information is fragmented and technical, and because technology seekers may not know what solutions exist or which rights holders to approach (Ido 2019). Negotiation costs arise because licensing requires specialised expertise and involves asymmetric bargaining between local institutions and large multinational rights holders (Muñoz-Tellez, Syam, and Romero 2019; Nathan 2025).

To reduce transaction costs, the literature proposes strengthening information platforms and improving the accessibility of green patent and technology data, alongside greater transparency in ownership and licensing (Syam 2017). It also proposes standardised contract templates and toolkits to streamline negotiations and reduce legal uncertainty, and investments in domestic IP management capacity so that developing countries can undertake searches, assess options and negotiate licences on more equal terms (Syam 2017; Muñoz-Tellez, Syam, and Romero 2019).

Legal and institutional barriers

Legal and institutional barriers arise from uniform global IP rules and the broader trade and geopolitical environment. TRIPS requires all WTO members to provide minimum patent protection, including 20-year terms across fields, limiting differentiated treatment of green technologies (Glachant and Dechezleprêtre 2017). Where core technologies are held abroad, overlapping patents and thickets can make entry into technology-intensive sectors risky and legally complex (May and Sell 2006; Maurer 2015; Maskus 2012; Raiser, Naims, and Bruhn 2017). Furthermore, restrictive licensing practices—such as exclusivity and field-of-use restrictions—can inhibit broader diffusion (Ido 2019).

Beyond the multilateral setting, a second layer of constraint may be added by green technology owners: “TRIPS-plus” provisions in trade and investment agreements. Such commitments can strengthen protection beyond TRIPS, constrain compulsory licensing, and, in some cases, enable investor claims against public interest measures, thereby shrinking policy space for green industrial strategies (Syam and Cai 2016; Khor 2017; Menezes 2018).

Debates over access to green technology often raise issues typically discussed under competition law. When the same firms hold large portfolios and dominate markets, restrictive licensing or refusals to deal may raise competition concerns. The literature therefore suggests that competition agencies and trade ministries should consider IP policy and competition policy as jointly relevant to dissemination, including in assessing whether patent holders “unduly prevent” the spread of climate-critical technologies. (Dreyfuss and Pila 2018; Raiser, Naims, and Bruhn 2017).

Policy proposals include maximising the use of existing flexibilities (including compulsory licensing and stricter patentability criteria) and doing so collectively to reduce vulnerability to pressure (Maskus and Reichman 2004; Vawda 2021). Calls for international reforms such as a WTO climate waiver or climate-priority declarations, and for safeguards in trade agreements to protect the right to pursue access-oriented green technology policies, should not be dismissed either. (Blasetti and Correa 2021).

Information, knowledge and capacity gaps

Finally, technology diffusion is constrained by “soft” barriers. Many developing-country actors lack awareness of available technologies and of relevant information platforms, limiting their ability to match needs to solutions (Syam 2017; Abdel-Latif 2015). Institutions often lack IP literacy and negotiation expertise, which can lead to missed opportunities or acceptance of unfavourable licensing conditions (Ido 2019; Metz et al. 2000). In addition, the capacity to absorb technology – skilled labour force, and institutions that can adapt and learn from imported technology – is often insufficient, especially for complex technologies (Metz et al. 2000; Olawuyi 2018; Nathan 2025).

The literature therefore prioritises investments that build absorptive capacity alongside legal reforms: strengthening universities and

R&D institutes, adopting policies to enable technology transfer, investing in skills upgrading, and fostering networks that enable learning and spillovers (Metz et al. 2000). It also highlights South–South cooperation as an underused pathway, including collaborative innovation and technology transfer among developing countries (Menezes 2018; Uddin and Karim 2020).

Conclusion

The literature reviewed supports a consistent diagnosis: current IP regimes, in combination with market concentration and unequal capacities, create significant barriers to green technology diffusion for developing countries (Esteves et al. 2025). The green patent landscape is highly concentrated in a small number of economies and firms, underpinned by global IP rules and reinforced by trade structures and technology payments patterns (Lavopa and de las Mercedes Menéndez 2023; UNCTAD 2024a; World Bank n.d.). These dynamics risk widening technological and economic inequalities in the green transition, generating intractable dependencies (Nathan 2025).

The surveyed literature also suggests that the most effective strategies are not singular. Legal tools like compulsory licensing can lower access costs but require administrative capacity and a solid political strategy to succeed. Patent pools and other collective licensing mechanisms can reduce costs and complexity but require institutional design and coordination. Finance and domestic capability building are essential to translate access into deployed technologies and local learning (Metz et al. 2000; World Bank 2012). A coherent agenda, therefore, lies in combining legal flexibilities, collective licensing, financing mechanisms, and long-term investments in absorptive capacity.

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