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The role of firm-level and country-level antecedents in explaining emerging versus advanced economy multinationals' R&D internationalization strategies

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ABSTRACT

We examined firm-level and country-level antecedents of R&D internationalization strategies, focusing on differences between enterprises in emerging and advanced economies. Previous research often focuses on the relative importance of home-base-exploiting versus home-base-augmenting knowledge transfer strategies. We suggest that country-level and firm-level effects differ for the two strategies, and hence, we examined each strategy independently. Collecting data in China, India, the United States, and Germany, we demonstrated that firms' relative technological position as a firm-level characteristic can explain differences in home-base-exploiting strategies between emerging and advanced economies. In contrast, home-base-augmenting is more closely related to exploratory institutional environments, a country-level factor. Thus, either firm- or country-level antecedents can gain a dominant role, depending on the strategy implemented.

1. Introduction

Corporate R&D internationalization strategies determine the knowledge flow between the foreign and home locations. Consequently, these strategies affect firm performance and the economy at large through technological diffusion and knowledge spillover processes (Aldieri, Sena, & Vinci, 2018; Griliches, 2007; Orlando, 2004). Extant research highlights two prominent R&D internationalization strategies: The exploitation of ownership and firm-specific advantages, like technological capabilities, are referred to as home-base-exploiting strategies, with the primary knowledge flow from the domestic to the foreign location. Conversely, home-base-augmenting R&D internationalization aims at enhancing a firm's home-based and global technological competencies based on knowledge acquired internationally (Di Minin, Zhang, & Gammeltoft, 2012; Kuemmerle, 1999). The rapid rise of emerging-economy multinational enterprises (EMNEs) has sparked a new discussion on the generalizability of existing internationalization theories, mostly based on advanced-economy multinational enterprises (AMNEs) (Cuervo-Cazurra & Ramamurti, 2014), and empirical research has shown that EMNEs and AMNEs differ in their international R&D and innovation activities (Awate, Larsen, & Mudambi, 2012; Awate, Larsen, & Mudambi, 2015; Khan, Lew, & Marinova, 2019; Khan, Amankwah-Amoah, Lew, Puthusserry, & Czinkota, 2021). Hence, understanding heterogeneity in these R&D internationalization strategies and the origins of these differences helps us to better grasp how firms develop capabilities that may form the basis of a competitive advantage. Accordingly, in this paper, we aim to explain strategic differences between EMNEs and AMNEs with respect to their R&D internationalization by analyzing the influence of firm-specific and country-specific antecedents.

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A common starting point in international business research is that AMNEs are, on average, technologically advanced, which allows them to follow a home-base-exploiting strategy abroad. In contrast, the average EMNE has comparatively fewer technological capabilities, which results in EMNEs typically being classified as laggards seeking to catch up with AMNEs through internationalization (Bell & Pavitt, 1993; Brandl & Mudambi, 2014; Mathews, 2002; Mathews, Hu, & Wu, 2011; Awate et al. 2015; Guillén & Garcia-Canal, 2009). It is expected that EMNEs more often follow a home-base-augmenting strategy to overcome their firm-specific disadvantages. Focusing explicitly on R&D internationalization strategies, Awate et al. (2015) showed that EMNEs place higher relative importance on home-base-augmenting than on home-base-exploiting strategies.

These findings, however, raise two important issues. First, categorizing AMNEs as leaders and EMNEs as followers is neither always true nor does it sufficiently explain the origins of these differences in R&D internationalization strategies. Second, taking only the relative importance of both strategies might mask strategy-specific antecedents distinct to either home-base-exploiting or home-base-augmenting. Consequently, we analyze each strategy separately, which allows us to identify strategy-specific antecedents that determine each strategy. We suggest investigating factors that influence a firm's strategic choice, namely firm-specific differences, such as technological leadership, and home country factors, such as the institutional environment (Cuervo-Cazurra & Ramamurti, 2014; Ramamurti, 2012; Liu, Yang, Li, & Liu, 2021).

By investigating the R&D internationalization strategies of 375 EMNEs and AMNEs from China, India, the U.S., and Germany, we confirmed that EMNEs focus less than AMNEs on home-base-exploiting R&D strategies, because EMNEs lack a competitive knowledge base, as indicated by their relative technological position, which hinders them from exploiting it in foreign markets. Hence, firm-level technological leadership constitutes a vital contingency that helps explain EMNE-AMNE differences. In contrast to our expectations, the EMNE-AMNE difference in home-base-augmenting R&D is not contingent on the firm-level technology position but instead relates substantially to country-level heterogeneity. Firms place greater emphasis on home-base-augmenting R&D strategies when they come from countries with a more exploratory institutional environment, thereby stressing the role of country-specific advantages and institutional factors for R&D internationalization (cf., Cuervo-Cazurra & Ramamurti, 2014; North, 1990; Peng, 2002).

Our paper contributes to the literature in at least two ways. First, Awate et al. (2015) focus on the relative importance of home-base-augmenting versus home-base-exploiting strategies in R&D internationalization. We expanded on this by examining each strategy in its own right (also compare), which in turn allowed for the detection of differences in underlying strategy-specific mechanisms. We documented that EMNEs' weaker focus on home-base-exploiting is contingent on their technological leadership. Consistent with international business scholars who stress the need to incorporate boundary conditions (Hernandez & Guillén, 2018; Luo & Wang, 2012), our results suggest that a firm's technological position within its industry is a strategy-specific firm-level contingency factor when comparing EMNEs and AMNEs for their home-base-exploiting strategies in R&D internationalization. EMNEs' stronger focus on home-base-augmenting, however, is not contingent on firm-level technological positions.

Second, we took into account the scholarly calls to consider the importance of home country effects when analyzing EMNE internationalization (e.g., Cuervo-Cazurra & Ramamurti, 2014; Ramamurti, 2012). Our dataset included firms from two important emerging economies (China and India) and from two advanced economies (the U.S. and Germany), which enabled us to examine heterogeneity across and within both country pairs (Pedersen & Stucchi, 2014; Khanna, 2009). While home-base-exploiting R&D strategies are less affected by country differences, we found that institutional factors, such as a country's exploratory environment, substantially contribute to an MNE's preference for home-base-augmenting strategies. Moreover, even though the group of EMNEs is, on average, more likely to follow home-base-augmenting strategies, the substantial heterogeneities observed within the groups of AMNEs and EMNEs suggest that considering country-level effects rather than EMNE-AMNE differences might be more important.

Overall, and combining the contributions, we demonstrated the need to consider both firm-level and country-level heterogeneity and distinguish between home-base-exploiting and home-base-augmenting strategies to better understand the similarities and differences in R&D internationalization strategies of EMNEs and AMNEs. Identifying strategic differences and their determinants is the first and most vital step to explain the development and performance of EMNEs in comparison to AMNEs, which, in turn, will allow testing and adapting internationalization theories.

2. R&D Internationalization of EMNES

2.1. Two independent R&D internationalization strategies

The internationalization of R&D activities requires firms to decide *which* R&D internationalization strategy to follow and subsequently *how* to transfer the knowledge back home or between locations. The latter decision is linked to the literature on technology diffusion and knowledge spillover processes (Griliches, 1979) aiming to assess and measure the actual returns from international R&D (Aldieri et al., 2018; Griliches, 2007; Orlando, 2004). In this paper, we focused on the former, namely the knowledge-related strategic orientation of firms. We believe that international strategies in R&D, and strategy-specific drivers, are an important starting point to better understand the R&D internationalization of MNEs from emerging and advanced economies.

R&D is a key source of knowledge and technology, which can be sourced abroad from both foreign subsidiaries and foreign external partners.[1] We focused on the two most prominent knowledge-related R&D internationalization strategies, a focus shared with previous studies on EMNEs' R&D internationalization (Di Minin et al., 2012): *home-base-exploiting* (HBE), which aims at adapting products, processes or functions, and procedures of the firm to host country markets (e.g., Kuemmerle, 1999; Pearce, 1990; Casson, 1991; Pearce & Singh, 1992), and *home-base-augmenting* (HBA), which aims at tapping into capabilities available in host countries to generate or acquire new knowledge and capabilities for the MNE as a whole (Kuemmerle, 1999, see also Cantwell & Mudambi, 2005). The literature uses different terminologies for these two internationalization strategies. For example, HBE is also referred to as market-seeking, and HBA is referred to as technology-seeking (cf., Steinberg, Urbig, Procher, & Volkmann, 2021). However, the underlying motives are consistent.

Both R&D internationalization strategies are pursued by well-known EMNEs and AMNEs, respectively. Luxury automotive OEMs, like Tesla or Porsche, are examples of firms that follow primarily a home-base-exploiting strategy in their R&D internationalization. Core innovations stem from R&D centers in the home country, though they might be adapted and customized in foreign R&D locations to cater to local tastes. In their case study of two wind turbine manufacturers, Awate et al. (2015) documented that for Vestas, an incumbent manufacturer from Denmark, knowledge flows from headquarters to R&D subsidiaries. Similarly, although L'Oreal has a worldwide network of R&D locations, all three global R&D centers are located in the hexagon of France. It is important to note that HBE is not limited to AMNEs. The Chinese tech

[1] While some studies, such as Kuemmerle (1999) and Cantwell and Mudambi (2005), focus on the mandates of subsidiaries, we broaden the definition to include external foreign R&D activities, because these activities are usually part of an integrated internationalization strategy (cf. Lewin et al., 2009).

giant Tencent also follows HBE, with its main R&D center in Wuhan serving as knowledge creator and diffuser. In contrast, Alibaba, another giant in China's digital economy, has set up several R&D centers in the United States, Singapore, and Israel with the aim of discovering breakthrough technologies in artificial intelligence, pointing to home-base-augmenting R&D internationalization. Other examples of EMNEs following an HBA strategy are the Indian wind turbine company Suzlon (Awate et al. 2015) and the Chinese Midea Group, which acquired Kuka, the leading German manufacturer of industrial robots. An HBA strategy, however, is not restricted to firms from emerging markets. Siemens, the largest industrial manufacturing company in Europe, has an important research hub in India for their health business division (now Siemens Healthineers). Similarly, Bosch has large R&D hubs in the United States, Russia, Israel, Singapore, and China, each of which is "expected to act as a kind of radar for Bosch Research by scanning its respective region to detect megatrends" (Bosch website, October 2021).

In their fore-mentioned seminal case study, Awate et al. (2015) demonstrated that the relative importance of both strategies, HBE and HBA, differs for R&D internationalization, depending on whether the firm is from an advanced or an emerging economy. However, the two approaches are not mutually exclusive. Firms might follow a dual strategy of both technology exploitation and augmentation (cf., von Zedtwitz & Gassmann, 2002; Kedia, Gaffney, & Clampit, 2012; Di Minin et al., 2012; Jansen, Vera, & Crossan, 2009; Khan et al., 2021). There may be factors that lead firms to attribute equal importance, high or low, to the exploitation and augmentation of firm-specific advantages within their international R&D activities (cf., Cantwell & Mudambi, 2005, 2011). Given the independence between these two strategies, the importance that firms assign to each strategy may be driven by very distinct mechanisms, which may reside at the firm or the home-country level. Consequently, we proposed separating these two strategies to analyze strategy-specific antecedents for EMNEs and AMNEs. We developed baseline hypotheses on the general differences between EMNEs and AMNEs regarding HBE and HBA strategies and then introduced strategy-specific antecedents. Fig. 1 provides a graphical summary of our conceptual framework and hypotheses.

2.2. MNEs' R&D internationalization using home-base-exploiting (HBE) strategies

Despite EMNEs' aggressive internationalization (Ramamurti, 2012) and capturing global market shares from AMNEs (Awate et al., 2012; Azevedo et al., 2016; Brandl & Mudambi, 2014), many EMNEs can still be classified as "infant" MNEs or late-movers with weaker technologies when compared to incumbent AMNEs (Awate et al., 2012; Cuervo-Cazurra & Genc, 2008; Ramamurti, 2016). AMNEs can benefit from their more advanced technological base in their international expansion by engaging in home-base-exploiting strategies through the transfer of existing knowledge from their headquarters to foreign subsidiaries (Awate et al., 2015; von Zedtwitz & Gassmann, 2002). AMNEs exploit their existing home-based capabilities abroad. In contrast, EMNEs are less likely to develop superior technologies at their home base (Cuervo-Cazurra & Genc, 2008). They lack the capabilities and innovation that can be exploited in other markets (Deng, 2012). Hence, EMNEs, on average, are less likely to follow an HBE strategy when internationalizing their R&D, which forms Hypothesis 1a as a baseline hypothesis:

Hypothesis 1a. *For their international R&D activities, EMNEs focus less than AMNEs on home-base-exploiting (HBE) strategies.*

Ramamurti (2012) and Ramamurti & Hillemann (2018) emphasize the relevance of considering the development stage of an MNE when analyzing its internationalization. Although EMNEs may share some general laggardness, existing qualitative research suggests that the difference between EMNEs and AMNEs is partly driven by firm-specific technological inferiority (Awate et al., 2015), that is, a firm's distance from the technological frontier representing the maximum of available technological opportunity at a given time (Grimpe & Sofka, 2016; McCain, 1977). The firm's technological advancement consequently determines its technological position within an industry (Grimpe & Sofka, 2016; Salomon & Jin, 2010; Steinberg, Procher, & Urbig, 2017),[2] within a country (Mahmood & Rufin, 2005), and worldwide (Kumar & Russell, 2002). The closer EMNEs are to the technological frontier, the more opportunities there are to exploit these technological positions in foreign markets. Hence, the difference between EMNEs and AMNEs in the importance of home-base-exploiting strategies will be much less pronounced if firms are technological leaders relative to their competitors in their main sales markets and substantially more pronounced if they are laggards. For example, China's leading ICT companies (e.g., Huawei, Lenovo, and Tencent) can most likely exploit their technological expertise and capabilities through internationalization as much as competitors from advanced economies. Hence, we hypothesize that a firm's relative technological leadership (i.e., being close to the technological frontier) positively affects the relation between EMNEs (versus AMNEs) and an HBE strategy:

Hypothesis 1b. *The negative relationship between EMNEs (*vs. *AMNEs) and the focus on home-base-exploiting (HBE) strategies is less negative for MNEs closer to the technological frontier.*

2.3. MNEs' R&D internationalization using home-base-augmenting (HBA) strategies

EMNE headquarters often have lower knowledge competencies than their foreign subsidiaries, while for AMNEs, the opposite is observed (Awate et al., 2015). Technologically lagging firms, however, can use their international investments to catch up with leading firms (Chung & Alcácer, 2002). Headquarters of EMNEs can gain knowledge and technologies from foreign R&D subsidiaries or R&D partners, such that the headquarters of these EMNEs would become net users of knowledge, while their foreign subsidiaries are the knowledge providers (Awate et al., 2015). By sourcing knowledge and technology from foreign locations that are not available in their home country, EMNEs may be able to close the technology gap between themselves and their AMNE competitors (Luo & Tung, 2007). Since lagging firms also have more opportunities to improve their technological position and thus, might gain more from exposure to new technologies and knowledge (Blalock & Gertler, 2009), EMNEs might indeed have stronger incentives and be more likely to actively seek and explore technology through international investments (Chung & Alcácer, 2002; Luo & Tung, 2007). Concerning R&D internationalization strategies, EMNEs, in their efforts to catch up and transfer knowledge from foreign locations to their home base, are thus more likely than AMNEs to strive for knowledge exploration, which leads to Hypothesis 2a:

Hypothesis 2a. *For their international R&D activities, EMNEs focus more than AMNEs on home-base-augmenting (HBA) strategies.*

Apart from firm-specific assets that are partly grounded in their home country origin, we had to take into account the technological development stage of an MNE when analyzing its R&D internationalization (Ramamurti, 2012, Ramamurti & Hillemann, 2018; Awate et al., 2015). EMNEs that are already in a leading technological position are assumed to be similar to incumbent and mature AMNEs, so they are less pressured to pursue an innovation catch-up strategy. Consequently, for technologically leading MNEs from emerging economies, the difference between EMNEs and AMNEs in following home-base-augmenting

[2] A firm's relative technological position within an industry strongly overlaps with its technological position relative to competitors in its main sales market, since the main sales-market usually determines the firm's primary industry within industry classifications, such as ISIC or NACE.

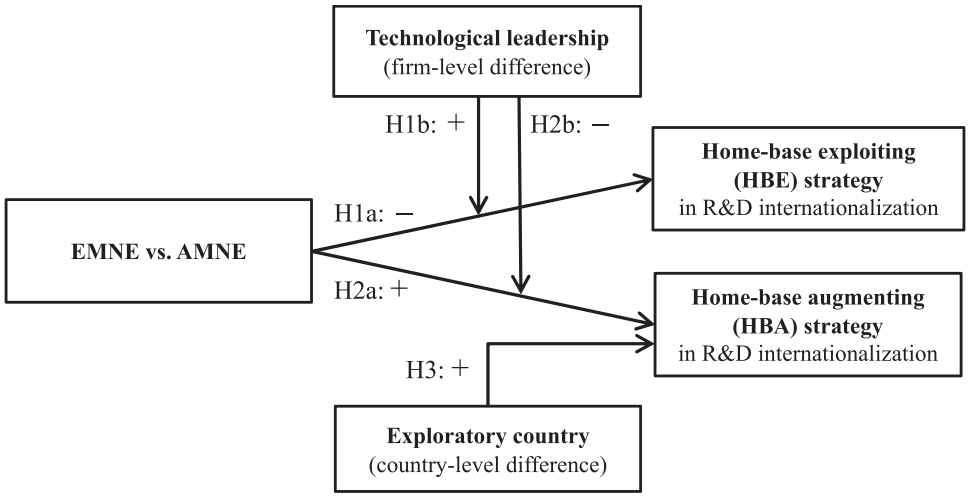

Fig. 1. Conceptual model.

strategies in R&D internationalization is less pronounced (cf., Awate et al., 2015).

Hypothesis 2b. *The positive relationship between EMNEs (*vs. *AMNEs) and the focus on home-base-augmenting (HBA) strategies is less positive for MNEs closer to the technological frontier.*

2.4. Institutional environments and MNE's R&D internationalization strategies

In addition to firm-level factors, country-level factors, such as institutions, laws, and regulations, are external controls on firms' behavior (Cuervo-Cazurra, Mudambi, & Pedersen, 2019). Institutional economics research suggests that formal and informal rules affect corporate processes and decision-making (North, 1990). Specifically, scholars emphasize the role of the institutional environment and home country characteristics in firms' internationalization (Buckley et al., 2007; Buckley, Munjal, Enderwick, & Forsans, 2016; Cuervo-Cazurra, Luo, Ramamurti, & Ang, 2018; Hitt & Xu, 2016; Holtbrügge & Berning, 2018; Hoskisson, Eden, Lau, & Wright, 2000; Ramamurti & Hillemann, 2018). Institutions include not only formal rules, laws, and regulations but also professional norms in the home country, such as the norm of contributing to technology acquisition, or cultural requirements suggesting a more curious and exploratory culture, all of which shape firms' global strategies (Cuervo-Cazurra et al., 2018).

While government interventions related to firm internationalization are mostly limited to antitrust and M&A regulations in advanced economies, the role of governments in emerging economies is often more active with respect to economic growth and the internationalization of EMNEs (Holtbrügge & Berning, 2018; Hoskisson et al., 2000; Khanna, 2009; Luo, Xue, & Han, 2010; Peng, 2012). In some countries, the government formulates strategic development and industrial policy aims and actively engages in the implementation of international R&D activities. For instance, following the 1997 Asian financial crisis, the Chinese government promoted a "go-out" plan (zou chuqu, 走出去) designed to encourage outward foreign direct investments by Chinese MNEs, which was actively supported by governmental regulations and incentives. Ramamurti & Hillemann (2018) explicitly refer to "government-created advantages (GCA)" that can affect the internationalization and competitiveness of EMNEs via both direct channels, such as running state-owned enterprises (cf., The Economist, 2012; Cuervo-Cazurra, 2018), and indirect channels by, for example, strengthening firms' bargaining power vis-à-vis foreign competitors, as well as by providing national champions preferential access to labor, capital, and markets. With the "Made in China 2025" initiative (MIC 2025), the Chinese government continued its enormous efforts to let Chinese EMNEs catch up and evolve into internationally leading players. State involvement occurs via policy measures and state funding opportunities that support firms' internationalization in order to upgrade technological capabilities and move up the value chain. India does not have comparable catch-up initiatives to encourage R&D growth and internationalization (Khanna, 2009; Kennedy, 2016), thus indicating that country differences are not just limited to a cross-group comparison of advanced and emerging market economies but can also exist within each respective group.

The availability of government-created advantages and their influence on the R&D investments of firms also becomes discernible through public research expenditures and tax policies designed to foster innovation (OECD, 2008; PwC, 2010). For example, the United States grants R&D tax credits that favor national and international R&D investments, while Germany does not provide such incentives. Moreover, a government can support a country's exploratory culture and innovative infrastructure by financially supporting higher education and basic research and, in the extreme, even launching very ambitious trend-setting and often resource-intensive space exploration programs. Although it is difficult to directly measure the productivity returns from R&D (Griliches, 1979, 2007), government-financed R&D can serve as a diffusion channel of new knowledge and create national spillover effects. For example, the NASA develops hundreds of new technologies each year and transfers thousands of products, services, and processes to private businesses (Zelalem, Drucker, & Sonmez, 2019). While universities and research institutions are centers of innovation excellence, they also foster a highly educated workforce that can evaluate and implement innovation processes in a globalized and knowledge-based economy (PwC, 2010). In sum, a country's formal and informal institutions can create an explorative environment that, in turn, animates and supports both individuals and firms in accessing and exploring new knowledge, which leads to Hypothesis 3:

Hypothesis 3. *MNEs originating in countries where the institutional environment more strongly supports exploration will focus more on home-base-augmenting R&D strategies than MNEs originating in countries that less strongly support exploration.*

3. Methods

3.1. Research design and sample

The critical variables related to home-base-exploiting and home-base-augmenting strategies in R&D internationalization cannot be

derived from official balance sheet data or nationwide innovation surveys like the Community Innovation Survey (CIS). Therefore, we base our analyses on primary data collected through an extensive quantitative survey of 500 MNEs in four countries, China and India as emerging economies and the United States and Germany as advanced economies. The data, collected in partnership with EY (Ernst & Young) in 2016, were carefully validated and merged with secondary data from Bureau van Dijk's financial ORBIS database. The dataset has also been used by Steinberg et al. (2021) to analyze and compare practices that facilitate knowledge transfer and integration across domestic and foreign R&D activities. The survey focuses on MNEs' national and international R&D activities and includes several relevant control variables.

In developing the survey, we aligned the questions with well-known surveys, such as the Swiss Innovation Survey 2011 conducted by ETH Zuerich and the Eurostat survey on global value chains and international sourcing of business functions (Tilewska, Nielsen, Alajaäskö, Bley, & Roodhuijzen, 2013; Eurostat, 2018), where applicable, followed standards like the Frascati and Oslo Manual (OECD, 2002, 2005). To ensure comprehensibility, the survey was designed using an iterative process involving senior managers from the R&D departments of selected companies. To increase the reliability of the data and reduce threats from common method variance, we varied response modes for survey questions related to different variables and ensured the anonymity of companies (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The survey questionnaire was created in German and subsequently translated into Chinese and English by professional translators. Due to the many different languages and dialects in India, the main part of the survey in India remained in English while the welcome address and farewell were translated into local languages.

The survey addressed MNEs with foreign R&D activity from ICT and manufacturing industries, excluding pharmaceuticals,[3] focusing on firms with at least 50 million USD in global sales. Data were collected at the parent company level. Based on these selection criteria, we drew a sample of firms from the ORBIS database. Firms in this sample were then approached via structured computer-aided telephone interviews employing specialized service providers with fluent language speakers in April and May 2016 until the envisioned sample size of 125 responses (irrespective of whether all questions were answered) from each country was achieved. Survey respondents were senior executives responsible for the enterprise's R&D. The short period during which the survey was conducted afforded the advantage of minimizing the potential influence of changes in economic conditions over time.

Further, information from the survey on the MNEs' sales and number of employees was carefully cross-checked with the related information from ORBIS. These data, as well as information on the MNEs' industry classification according to the ORBIS database, were merged into the data before conducting the survey. When substantial differences were detected during the collection process, the company was contacted again to verify the information. When data collection was complete, all data were anonymized. To reduce the likelihood that firms could be identified by matching their reported characteristics to ORBIS data, responses for some critical variables, such as firm age and export share, were provided in categories rather than precise levels. Note that the dataset has also been used before to analyze and compare practices that facilitate knowledge transfer and integration across domestic and foreign R&D activities (Steinberg et al., 2021).

Our final sample comprised 375 firms for whom we had information on all variables of interest (114 from China, 63 from India, 93 from the United States, and 105 from Germany). To understand whether the firms in our final sample differ from the selected population in ORBIS, we tested for differences between these groups per country for the available variables from both data sources. We did not find statistically significant differences ($p > 0.10$) for number of employees (in linear and logarithmic form) or industry composition (based on the categories used in the regression and two-digit NACE Rev. 2 codes).[4] We also checked for differences between early and late respondents, that is, number of contacts before responding below or equal to versus above the median. A generalized Chow test based on interacting all variables with a corresponding dummy variable (Doran, 1989) did not indicate that our hypothesis-related estimates differed between early and late respondents.[2] Average domestic employment was 2527 employees, and their average global revenue was 896 million USD. Manufacturers of machinery and equipment (14.9%) and manufacturers of computer, electronic, and optical products (11.7%) represented the largest industries in our sample.

3.2. Country context

Despite the absence of universally applicable defining criteria for emerging and developing economies (International Monetary Fund, 2016), an emerging economy is often defined as having low to middle per capita income, rapid economic development, and being in transition from a closed to a free-market economy (Arnold and Quelch, 1998; Cuervo-Cazurra and Ramamurti, 2014). Following recent studies (Ramamurti and Williamson, 2019; Steinberg et al., 2021), we selected China and India as two economically relevant emerging economies that are heterogenous in their institutions and policies directed at HBE- and HBA-related firm behavior (Kennedy, 2016; Chittoor and Aulakh, 2015). Again, following recent studies (Ramamurti and Williamson, 2019; Steinberg et al., 2021), we selected the United States and Germany as two economically relevant advanced countries with different institutional environments. Overall, these four countries ranked in the top five of the largest economies in the world (measured in nominal GDP) in 2016.

To test for country-level effects on firms' R&D internationalization strategies, it is important to select countries with sufficient heterogeneity. Our country selection offers differences between the two advanced economies and the two emerging economies, especially in terms of the countries' institutional exploratory environment and knowledge-related activities, including research and development. For example, the field of artificial intelligence (AI) is increasingly important in the innovation eco-system of countries and firms' competitiveness. The selected countries differ significantly in their AI activities. According to an Elsevier (2018) study, China is the top contributor with 135,000 AI publications between 1998 and 2017, while India has displayed strong growth, becoming the third largest country with 36,000 AI publications. The United States is the leading advanced economy with 107,000 publications, while Germany is in sixth place with 23,000 publications. Similarly, government expenditure for exploratory space programs, exemplifying countries' exploratory tendencies to invest in new technologies and capabilities, ranges from 36 billion USD in the United States and five billion USD in China to two billion USD in Germany and one billion USD in India in 2016 (Euroconsult, 2017).

3.3. Variables

3.3.1. Dependent variables

Firms' R&D internationalization strategies were captured by asking

[3] The pharmaceutical industry was excluded due to the special role of clinical drug trials (which are partly declared as R&D expenditures) and related regulatory issues.

[4] The 16 country-specific comparisons of samples and targeted populations concerning the distribution of two measures of firm size and two operationalizations of industries are available upon request.

[5] Jointly testing all differences reveals significant differences ($\chi^2(39) = 61.16$, $p = 0.01$). However, these relate only to control variables ($\chi^2(32) = 53.62$, $p < 0.01$) but not to other hypothesis-related effects ($\chi^2(7) = 3.73$, $p = 0.81$).

firms to evaluate the importance of various motives for their R&D internationalization as "not important" (1), "important" (2), or "very important" (3).[6] We selected two items each for the *home-base-exploiting* (HBE) and the *home-base-augmenting* (HBA) strategies. The items reflect the critical characteristics of these strategies, as described by Kuemmerle (1999), and are consistent with items from the 2012 Eurostat survey on international organization and sourcing of business activities and the 2011 Swiss Innovation Survey. The HBE strategy was measured via items capturing market-seeking motives: "access to new markets" and "adaptation of products to the foreign sales market" (cf., Steinberg et al., 2021). The HBA strategy was measured via items capturing technology-seeking motives: "access to specialist knowledge or technologies" and "access to qualified personnel" (cf., Steinberg et al., 2021). On average, the motives for selecting the HBE strategy seemed to be slightly less important than motives for selecting the HBA strategy (average scores for the items are 2.21 and 2.22 for HBE versus 2.47 and 2.44 for HBA).[3] Since responses to all four motives correlated positively, we ran a principal component analysis to explore the distinctiveness of the two strategies. Both the Eigenvalue-greater-than-one criterion and Horn's parallel test indicated the presence of two sufficiently distinct components. To focus on the two strategies' independent variation, we used the VARIMAX rotation to derive orthogonal (i.e., independent) factors.[8] Factor loadings on theoretically related factors were larger than 0.8, and the cross-loadings were all lower than 0.3. The coefficient alpha was 0.70 for the items related to the HBA strategy and 0.69 for the HBE strategy items. These analyses indicated a sufficient internal and discriminant validity of our measures of HBE and HBA R&D internationalization strategies.

3.3.2. Explanatory variables

EMNE is a dummy variable given the value of 1 if the firm is a multinational enterprise from an emerging economy (China or India) and 0 if the firm is a multinational enterprise from an advanced economy (the United States or Germany).

As an indicator of a country's institutional exploratory environment (referred to in brief as an *exploratory country*), we used data on government spending on space exploration projects in 2016 (Euroconsult, 2017). We normalized this spending by the country's population and applied the natural logarithm. To identify the effects that this variable has beyond the distinction of EMNE versus AMNE, we centered it within the groups of emerging and advanced economies.

Technological leadership is a variable measuring the innovativeness of a firm compared to its competitors in its primary sales market (cf., Makino, Lau, & Yeh, 2002). On a five-point scale from 1 ("very rarely first") to 5 ("very often first"), participants evaluated whether their firm, when compared to its competitors in their primary sales market in the 2013–2015 period, were innovative first-movers when launching new products, services, business processes, and technologies (Covin, Slevin, & Schultz, 1994; Hansen, Shrader, & Monllor, 2011). R&D intensity relative to a firm's industry is often used as a proxy for technological leadership (Grimpe & Sofka, 2016; Salomon & Jin, 2010; Steinberg et al., 2017). In our case, when comparing EMNEs and AMNEs, input into R&D was not a suitable proxy for technological leadership. To catch up, EMNEs may dramatically increase their R&D intensity as input into the innovation process but may not yet have achieved sufficient innovation output and a sufficient knowledge base to be considered a technology leader. In this particular case, R&D intensity as a proxy for technological leadership would incorrectly suggest that these firms are already technological leaders.

3.3.3. Control variables

We controlled for a third cost-related though not knowledge-related strategy, which nevertheless might relate to and hence distort the analyses of the knowledge-related strategies (cf., Cantwell & Mudambi, 2005). Following Steinberg et al. (2021), we operationalized *cost focus* as the average response to a multi-item measure, including survey items on the importance of "cost savings due to lower personnel expenses", "cost savings due to lower tax burden or tax incentives abroad", "greater funding opportunities for R&D abroad", and "other savings", which were rated on the same scale as the items reflecting exploitation and exploration strategies ($\alpha = 0.87$).

To reduce the risk of spurious results caused by, for example, differences in MNEs' general R&D input, we controlled for R&D capacity. We measured *R&D capacity* as the number of domestic R&D employees divided by the number of total domestic employees (Berchicci, 2013; Cassiman & Veugelers, 2002).

To control for experience and learning effects, we included *international R&D experience* and *export share*. As Ramamurti (2012) states, international R&D experience is an important variable because effects that may seem to be related to the headquarters country (e.g., the EMNE effect) are, in fact, attributable to the international experience of MNEs. Based on the available data, we included a categorical variable identifying "1–5 years", "6–10 years", "11–15 years" and "> 15 years" of international R&D experience. We did not have a category "no experience" because engaging in international R&D activities was a prerequisite for inclusion in the study. *Export share* controls for a firm's reliance and dependence on foreign markets. It was measured as the proportion of a firm's total revenue from exports; firms classified themselves as "no export", "1–25%", "26–50%", "51–75%", or "> 75%".

We included further firm-specific control variables that may relate to the firms' international R&D activities and correlate with strategies. We operationalized *firm age* as the natural logarithm of the mid-point of the five-year age intervals reported by participating firms. *Firm size* was measured by the logarithm of a firm's number of employees. Moreover, we controlled for any remaining industry effects by including *industry* fixed effects, since some unique features of EMNEs may stem from industry rather than country heritage (Brandl & Mudambi, 2014; Ramamurti, 2012). In accordance with the OECD categorization for the manufacturing industry (OECD, 2011), we included dummy variables for high-tech, medium-high-tech, medium-low-tech, and low-tech manufacturing industries, as well as a dummy variable for ICT industries.

Given the interdependent nature of strategy and structure (Burgelman, 1983; Grøgaard, 2012), which involves potential reverse causality problems, we include variables related to the location and structure of international R&D only as a robustness check. First, following the operationalization of Steinberg et al. (2021), we included a variable capturing whether the majority of international R&D activities were located in the knowledge-intensive economies of North America and Western Europe. *Knowledge-intensive location* was given the value 1 if at least 50% of a firm's foreign R&D activity was located in North America and Western Europe, and 0 otherwise. Second, we included two measures for the share of R&D engagement in foreign locations. For 362 firms, we had data on the share of employees in foreign locations relative to all R&D employees, which focused on internal R&D. For 337 firms, we had information on the relative shares of internal and external "R&D activities" in domestic and foreign locations (in percentage). Missing responses were scored as zero and, to avoid bias due to keeping these responses, we included two dummy variables indicating missing values in these two statistics.

[6] The response format followed the Eurostat survey. As our survey was conducted via computer-aided telephone interviews; excessive alternative responses can be confusing and incomprehensible to respondents.

[7] For two observations the response to one item was missing. These are imputed based on the inter-item covariance matrix. Excluding these two responses or imputing the sample mean does not change the results.

[8] In a robustness check, we allowed the two factors to correlate.

4. Results

Table 1 reports descriptive statistics for our sample and the bivariate correlations. Small to moderate correlations and variance inflation factors below 5.0 in all models indicate that multicollinearity is not a problem (Belsley, Kuh, & Welsch, 2005). The issue of common method variance is reduced, as our main explanatory variable, EMNE, was not measured in the survey but rather was predetermined by the survey design. Other explanatory variables (e.g., exploratory country) were derived from separate databases, and our hypothesized moderation effects based on self-reported measures tend to be less susceptible to common method biases (Siemsen, Roth, & Oliveira, 2010). Table 1 reveals that the association of an EMNE with home-base-augmenting as a motive for R&D internationalization is positive, while the association with home-base-exploiting is negative. A similar picture emerged for firm age, with younger firms tending toward home-base-augmenting and older firms toward home-base-exploiting.

Turning to our hypothesis tests, Table 2 reports the results of our regression analyses. To account for biases that may result from the interdependency of estimations of effects on HBE and HBA strategies, we employed Seemingly Unrelated Regression (SUR) analyses and reported the covariance of errors as a measure of the dependency of both equations (Zellner, 1962; Cameron & Trivedi, 2010). Model 1 estimates the average effect of being an EMNE rather than an AMNE on both strategies. We observed that firm age is positively related to an HBE strategy, reflecting the fact that mature MNEs may exploit their technological superiority through internationalization (Ramamurti, 2016). Moreover, the cost focus is positively related to both strategies but much more strongly to the knowledge-exploiting HBE strategy, reflecting a potential association between the cost focus and exploiting strategies (cf., Cantwell & Mudambi, 2005) and supporting the inclusion of the cost focus as a control variable. Furthermore, we observed that more international experience in R&D enhances the likelihood that firms will follow HBA strategies, indicating that technological exploration might require a longer-term commitment and substantial investments (Steinberg et al., 2017).

Model 1 also reveals that being an EMNE significantly related to both HBE (negative) and HBA (positive) strategies. Hence, we supported our hypotheses stating that EMNEs, in comparison to AMNEs, have a weaker focus on HBE strategies (Hypothesis 1a) and a stronger focus on HBA strategies (Hypothesis 2a) when internationalizing their R&D activities. As the dependent variables are standardized, we can directly quantify the effect sizes: Being an EMNE, on average, decreases the importance of HBE by 20% of one standard deviation and increases the importance of HBA by 30% of one standard deviation.

In Model 2, we included interactions of EMNE with technological leadership (see Hypotheses 1b and 2b) and the effect of whether a country is more or less exploratory on the importance of HBA (see Hypothesis 3). To simplify interpretation of regression results, Fig. 2 graphically illustrates the key findings; it plots the importance of HBE for different levels of technological leadership (mean minus/plus one standard deviation) and the importance of HBA depending on single countries' exploratory culture for both EMNEs and AMNEs (part A of Fig. 2). Supporting Hypothesis 1b, we see that the difference between EMNEs and AMNEs in the importance of HBE was particularly pronounced among technological laggards while being statistically insignificant and almost absent among technological leaders.

Our results indicate that the difference between EMNEs and AMNEs concerning an HBE strategy for R&D internationalization can indeed be explained by firm-level differences in technological leadership, which supports catch-up-based explanations (Awate, Larsen, & Mudambi, 2012, 2015). In contrast, technological leadership has a smaller and statistically not significant moderating effect on the HBA strategy, such that Hypothesis 2b is not supported, meaning that the gap between EMNEs and AMNEs for HBA strategies is unlikely to be explained by firms' differences in technological position.

Hypothesis 3, concerning country-level effects on the HBA strategy, is supported, suggesting that a country's institutions and therefore its particular institutional exploratory environment may contribute to explaining differences in focus on an HBA strategy. Since the exploratory country variable was centered within each of the groups of EMNEs and AMNEs, hence reflecting only within-group variation, the significant effects suggest that there is a country-level effect beyond any potential difference in exploratory institutions related to being an EMNE rather than an AMNE. Fig. 2B illustrates that while being a more exploratory country within each respective group of EMNEs and AMNEs (here, China and the United States) is clearly associated with a stronger emphasis on home-base-augmenting strategies, overall, the group of EMNEs displays a higher level of home-base-augmenting. While the gap between EMNEs and AMNEs in using HBA strategies is not substantially reversed, its magnitude is highly sensitive to the selected pairs of emerging and advanced economies and might, in some circumstances, even disappear when, for example, comparing firms from India with firms from the United States. While this might be counted as evidence against a systematic difference between EMNEs and AMNEs, it should be noted that it only implies that, in addition to an EMNE effect, there is a country-specific variation overlapping the EMNE effect.

To test the robustness of our analyses, Tables 3 and 4 report additional estimations that relate to alternative specifications, alternative measurements, and alternative estimations of standard errors. First, we tested whether the effect of a country's exploratory institutional environment on its HBE strategy differs between EMNEs and AMNEs (Model 3). Including an interaction term between EMNE and the country's institutional exploratory environment, produced a negligible moderation effect, indicating that the context dependency of the exploratory-country effect is not supported. Further, we allowed the exploratory environment to affect the HBE strategy as well, but the observed coefficient is small and not statistically significant. Thus, the exploratory institutional environment of a country affects the HBA, irrespective of being an EMNE or an AMNE, and does not affect the HBE strategy. (Table 5).

Second, we tested whether differences within the groups of EMNEs and AMNEs may confound the previously identified effects of EMNE on the HBE strategy and the related interaction between EMNE and technological leadership (Model 4). We included contrast codes[4] for both pairs of countries (i.e., *China (+1)* vs. *India* (−1) and 0 for the other two; the United States *(+1)* vs. *Germany (−1)* and 0 for the other two) as well as interactions of these contrast codes with technological leadership. By using contrast codes, the effects associated with the EMNE variable reflect the average effects of EMNEs compared to AMNEs (Cohen et al., 2013), and the effects associated with the contrast codes reflect the variation within each of these two groups. We observe only small differences in levels of HBE between countries within a group and almost negligible differences regarding the effect of technological leadership within groups. Therefore, country differences matter less than a firm's technological position in explaining the EMNE-AMNE gap in HBE strategies.

Model 5 replicates Model 2 but employs an alternative measure of being a more or less exploratory country based on scientific publications about artificial intelligence. We used the natural logarithm of a country's cumulative publications on artificial intelligence (AI) since 1998 (Elsevier, 2018). The model revealed that conclusions reached are robust.

Moreover, while our measurement of HBE and HBA strategies was based on orthogonal factors that emphasize the unique variation in the

[9] While the EMNE dummy together with dummies controlling for within-group differences (i.e., dummies for India and the United States) are econometrically equivalent, the contrast coding allowed directly interpreting coefficients estimated for the EMNE dummy as average effect of EMNE versus AMNE, averaged at the country level (Cohen et al., 2013).

Table 1
Descriptive statistics and bivariate correlations.

	Variables	Mean	SD.	1	2	3	4	5	6	7	8
1	EMNE (EMNE: 1, AMNE: 0)	0.47	0.50	1							
2	Exploratory country (centered)	0.07	0.74	0.17 **	1						
3	China versus India (China: +1, India: −1)	0.14	0.67	0.21 ***	0.64 ***	1					
4	U.S. versus Germany (U.S.: +1, Germany: −1)	-0.03	0.73	0.04	0.77 ***	0.01	1				
5	Home-base-augmenting (HBA) strategy	0.00	1.00	0.22 ***	0.31 ***	0.13 *	0.30 ***	1			
6	Home-base-exploiting (HBE) strategy	0.00	1.00	-0.22 ***	0.00	-0.29 ***	0.24 ***	0.00	1		
	Control variables										
7	Firm age (ln)	3.63	0.76	-0.41 ***	-0.42 ***	-0.30 ***	-0.30 ***	-0.16 **	0.14 **	1	
8	Firm size (ln)	6.98	1.33	0.39 ***	0.32 ***	0.22 ***	0.24 ***	0.22 ***	-0.03	-0.18 ***	1
9	R&D capacity	0.08	0.12	-0.01	0.15 **	0.09 +	0.12 *	0.09 +	0.02	-0.08	-0.17 **
10	Technological leadership	3.60	0.89	0.24 ***	0.18 ***	0.03	0.21 ***	0.27 ***	0.09^{+}	-0.16 **	0.26 ***
11	Cost focus	1.86	0.68	-0.11 *	0.14 **	-0.31 ***	0.44 ***	0.19 ***	0.53 ***	-0.06	0.13 *
12	Export share: 0	0.07	0.25	0.05	-0.02	0.04	-0.06	-0.03	-0.06	-0.15 **	-0.09 +
13	Export share: 1 – 25%	0.43	0.50	0.01	0.19 ***	0.01	0.24 ***	0.16 **	0.08	-0.04	0.00
14	Export share: 26 – 50%	0.31	0.46	0.07	-0.04	0.07	-0.11 *	0.00	-0.07	0.01	0.08
15	Export share: 51 – 75%	0.10	0.31	-0.09 +	-0.17 ***	-0.08	-0.15 **	-0.15 **	0.02	0.18 ***	-0.09 +
16	Export share: 75 – 100%	0.09	0.29	-0.06	-0.07	-0.08	-0.02	-0.10 *	0.01	-0.01	0.04
17	Interntl.R&D experience:1–5 years	0.23	0.42	0.26 ***	0.14 **	0.30 ***	-0.07	-0.01	-0.25 ***	-0.31 ***	-0.02
18	Interntl. R&D experience: 6–10 years	0.17	0.37	-0.08	-0.14 **	-0.03	-0.16 **	-0.09 +	-0.03	0.09 +	-0.00
19	Interntl.R&D experience: 11–15 years	0.10	0.30	-0.04	-0.01	0.05	-0.05	-0.01	0.07	-0.00	-0.06
20	Interntl.R&D experience: > 15 years	0.44	0.50	-0.21 ***	0.01	-0.19 ***	-0.17 ***	0.11 *	0.18 ***	0.20 ***	0.06
21	Interntl.R&D experience: not reported	0.07	0.25	0.13 *	-0.03	-0.15 **	0.09 +	-0.06	0.04	0.01	-0.02
	Variables			**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
9	R&D capacity			1							
10	Technological leadership			-0.06	1						
11	Cost focus			0.02	0.14 **	1					
12	Export share: 0			0.07	-0.06	-0.01	1				
13	Export share: 1 – 25%			0.02	0.06	0.17 ***	-0.23 ***	1			
14	Export share: 26 – 50%			-0.01	-0.01	-0.10^{+}	-0.18 ***	-0.58 ***	1		
15	Export share: 51 – 75%			0.01	-0.06	-0.10 +	-0.09	-0.30 ***	-0.23 ***	1	
16	Export share: 75 – 100%			-0.09^{+}	0.04	-0.03	-0.08	-0.28 ***	-0.21 ***	-0.11 *	1
17	Interntl.R&D experience:1–5 yrs			-0.07	-0.08	-0.23 ***	0.11 *	0.04	-0.04	-0.06	-0.04
18	Interntl.R&D experience: 6–10 yrs			0.00	0.05	0.01	-0.03	-0.08	0.06	0.08	-0.02
19	Interntl.R&D experience: 11–15 yrs			0.02	-0.10 *	-0.02	0.06	-0.07	0.05	0.03	-0.04
20	Interntl.R&D experience: > 15 yrs			-0.05	0.10 +	0.18 ***	-0.15 **	0.07	-0.02	-0.04	0.08
21	Interntl.R&D experience: no report			-0.04	-0.01	0.06	0.10^{+}	0.00	-0.06	0.01	-0.01
	Variables			**17**	**18**	**19**	**20**	**21**			
17	Interntl.R&D experience:1–5 yrs			1							
18	Interntl.R&D experience: 6–10 yrs			-0.24 ***	1						
19	Interntl.R&D experience: 11–15 yrs			-0.18 ***	-0.15**	1					
20	Interntl.R&D experience: > 15 yrs			-0.48 ***	0.39 ***	-0.29 ***	1				
21	Interntl.R&D experience: no report			-0.15 **	-0.12 *	-0.09 +	-0.24 ***	1			

N = 375. Standardized scores for HBA and HBE strategy because scores are derived from a factor analysis; the correlation between HBA and HBE is zero because orthogonal scores were extracted that focus on the independent variation of the two strategies. Exploratory country is centered within the baskets of AMNEs and EMNEs.
Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

two strategies, recent research related to ambidexterity (Khan et al., 2021) suggests that these strategies may correlate. Hence, we allowed latent factors to correlate (using a PROMAX rotation before extracting the latent factors). In Model 4, we observe that the covariance of the errors of the two equations is significantly larger and positive (as expected). Since the standard errors are slightly larger on average, the effects may be less well identified. However, our focal effects remained robust and are still statistically significant.

Because our tests of the differences between EMNEs and AMNEs may be biased by country-specific errors, Model 7 reports estimations with cluster-robust standard errors (clustered at the country level). Our findings were robust. However, clustering standard errors across only four clusters (resulting from four countries) may itself be biased due to the low number of clusters (MacKinnon & Webb, 2018). Therefore, we followed Roodman et al. (2019) and ran additional statistical tests on our key variables based on bootstrapped inference. That is, we performed tests based on bootstrapping standard errors and correcting for clustering. The results, that is, levels of these significance tests, are reported as in Model 7 as a second marker for p values for these key variables (a plus sign or asterisks following "b:" meaning bootstrapped). We observe that these conservative bootstrap-based inferences still yield significance levels with $p < 0.10$ and therefore support our initial conclusions.

Due to the interdependency of strategy and structure (Burgelman, 1983), the structure of international R&D may affect R&D internalization strategies. Hence, as a last robustness check, we included variables describing a firm's international R&D location and structure, that is, having more than 50% of their R&D activities in Western or North American countries, the share of R&D employees that work in foreign countries, and the share of overall (internal and external) R&D activities performed abroad (Model 8). While not statistically significant individually, a joint test indicated significance ($\chi^2(12) = 20.37$, $p = 0.06$). Nevertheless, the small effects are consistent with Grøgaard (2012), suggesting that strategy and structure are weakly aligned for international firms. Notably, our general findings were unaffected by including these structure-related control variables.

5. Discussion

In this paper, we explain strategic differences between EMNEs and AMNEs with respect to their R&D internationalization. A frequent starting point in the literature for understanding the evolution and strategies of EMNEs is the inferiority of their resources, capabilities, and technology (Cuervo-Cazurra & Ramamurti, 2014; Awate et al., 2012;

Table 2
Main regression analyses.

Model	1				2			
Dependent variable	HBE strategy		HBA strategy		HBE strategy		HBA strategy	
EMNE	-0.20	(0.09)*	0.30	(0.10)**	-0.21	(0.09)*	0.35	(0.11)***
EMNE × Technological leadership					0.16	(0.07)*	-0.06	(0.09)
Exploratory country							0.24	(0.07)***
Control variables								
Firm age (ln)	0.16	(0.06)**	-0.04	(0.08)	0.16	(0.06)**	0.04	(0.08)
Firm size (ln)	-0.04	(0.03)	0.07	(0.03)*	-0.03	(0.03)	0.03	(0.04)
R&D capacity	0.17	(0.28)	0.96	(0.36)**	0.22	(0.27)	0.70	(0.36)+
Technological leadership	0.08	(0.04)+	0.19	(0.05)***	0.01	(0.06)	0.20	(0.07)**
Cost focus	0.51	(0.04)***	0.14	(0.05)**	0.52	(0.04)***	0.13	(0.05)*
Export share: 1 – 25%	0.14	(0.20)	0.16	(0.20)	0.15	(0.20)	0.09	(0.18)
Export share: 26 – 50%	0.13	(0.21)	0.03	(0.20)	0.14	(0.21)	-0.00	(0.19)
Export share: 51 – 75%	0.23	(0.23)	-0.27	(0.24)	0.25	(0.23)	-0.26	(0.23)
Export share: 75 – 100%	0.21	(0.23)	-0.28	(0.23)	0.21	(0.23)	-0.27	(0.22)
Interntl. R&D experience:1–5 yrs	-0.22	(0.16)	0.25	(0.21)	-0.21	(0.16)	0.23	(0.21)
Interntl. R&D experience: 6–10 yrs	-0.26	(0.16)	0.14	(0.20)	-0.26	(0.17)	0.19	(0.20)
Interntl. R&D experience: 11–15 yrs	0.13	(0.18)	0.41	(0.23)+	0.12	(0.18)	0.41	(0.23)+
Interntl. R&D experience: > 15 yrs	-0.05	(0.14)	0.43	(0.18)*	-0.07	(0.14)	0.44	(0.18)*
Industry dummies	incl.		incl.		incl.		incl.	
Constant	-0.21	(0.36)	-0.88	(0.46)+	-0.24	(0.36)	-0.88	(0.44)*
Equation-specific R-squared (F)	0.36		0.21		0.37		0.23	
Covariance of errors	-0.08	(0.04)*			-0.07	(0.04)+		

Notes: N = 375. Seemingly unrelated regression analyses. Variables HBE strategy, HBA strategy, technological leadership, and cost focus standardized before entering into regression to simplify interpretation of effects. Base categories for international R&D experience: not reported. Robust standard errors in parentheses. Maximum variance inflation factors below 4 for all models.
Significance levels: *** p < 0.001, ** p < 0.01, * p < 0.05, + p < 0.1

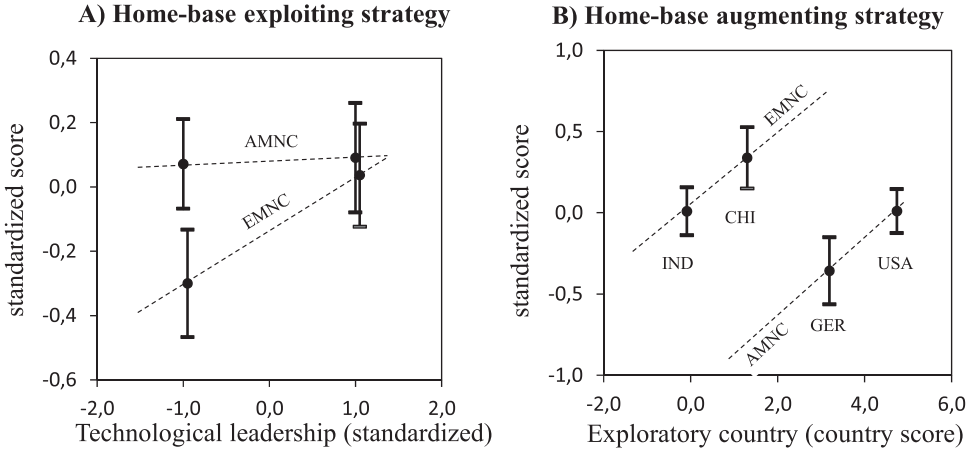

Fig. 2. Conditional HBE and HBA R&D internationalization strategies.

Cuervo-Cazurra & Genc, 2008; Ramamurti, 2016). Going beyond the usual assumption of EMNEs' laggardness and AMNEs' leadership, we allowed for heterogeneity in the strategies as well as antecedents that drive strategic decisions. We did this, first, by examining each of the two R&D internationalization strategies independently rather than according to their relative importance. Second, we identified strategy-specific antecedents that determine each strategy. Our empirical analyses show that differences in EMNEs' and AMNEs' R&D internationalization are driven by strategy-specific antecedents. Specifically, while home-base-exploiting strategies are strongly influenced by firm-level factors (e.g., a firm's technological leadership), home-base-augmentation strategies are mainly affected by home country-level factors (e.g., a country's exploratory institutional environment). Our research makes several contributions to international business and strategic management literature, three of which warrant further discussion.

First, the partial inability to explain the emergence, growth, and strategic orientation of EMNEs with existing (A)MNE internationalization theories has triggered case studies designed to better understand, for example, the peculiarities of EMNEs' R&D internationalization (Di Minin et al., 2012). However, Rugman & Nguyen (2014, p. 65f.) criticize that "the literature on EMNEs has reached implausible conclusions by studying a small number of firms from emerging economies." Additionally, they call for better alignment between theory and empirical analyses, which they identify as the main challenge faced by researchers comparing EMNEs and AMNEs. In a commentary, Ramamurti (2012) discusses what is really different about EMNEs and suggests that EMNEs' internationalization strategy is determined by the "global context of internationalization", the "country-of-origin", "EMNEs industry", and the "stage of evolution of an EMNE". In our research, we took a step toward addressing these challenges and incorporated the last three determinants. Admittedly, our in-depth analyses of international R&D strategies and strategic-dependent antecedents may not yet allow sketching a new full-fledged theory of corporate knowledge spillover processes, but they demonstrate the importantance of taking a relatively large sample of firms and heterogeneous countries.

Based on our four-country dataset – covering two key but heterogeneous emerging markets (China and India) and two leading but also

Table 3
Robustness checks (alternative specifications).

Model	3 (exploratory country effect)				4 (technological leadership effect)			
Dependent variable	HBE strategy		HBA strategy		HBE strategy		HBA strategy	
EMNE	-0.22	(0.09)*	0.35	(0.11)***	-0.23	(0.09)*	0.35	(0.11)***
U.S. vs. Germany					0.07	(0.07)		
China vs. India					-0.12	(0.07)+		
EMNE × Technological leadership	0.16	(0.07)*	-0.06	(0.09)	0.18	(0.08)*	-0.06	(0.09)
U.S. vs. Germany * Techn. lead.					-0.05	(0.06)		
China vs. India * Techn. lead.					0.00	(0.06)		
Exploratory country	-0.01	(0.06)	0.27	(0.10)**			0.24	(0.07)***
EMNE × Exploratory country			-0.07	(0.15)				
Control variables								
Firm age (ln)	0.15	(0.06)*	0.04	(0.08)	0.15	(0.07)*	0.04	(0.08)
Firm size (ln)	-0.03	(0.04)	0.03	(0.04)	-0.03	(0.04)	0.03	(0.04)
R&D capacity	0.24	(0.28)	0.69	(0.36)+	0.20	(0.28)	0.69	(0.36)+
Technological leadership	0.01	(0.06)	0.20	(0.07)**	-0.01	(0.06)	0.20	(0.07)**
Cost focus	0.52	(0.04)***	0.12	(0.06)*	0.48	(0.05)***	0.13	(0.05)*
Export share: 1 – 25%	0.16	(0.20)	0.08	(0.19)	0.11	(0.20)	0.09	(0.18)
Export share: 26 – 50%	0.15	(0.21)	-0.01	(0.19)	0.12	(0.21)	-0.00	(0.19)
Export share: 51 – 75%	0.25	(0.23)	-0.27	(0.23)	0.21	(0.23)	-0.26	(0.23)
Export share: 75 – 100%	0.21	(0.23)	-0.29	(0.22)	0.14	(0.24)	-0.27	(0.22)
Interntl. R&D experience:1–5 yrs	-0.21	(0.16)	0.26	(0.22)	-0.11	(0.17)	0.23	(0.21)
Interntl. R&D experience: 6–10 yrs	-0.26	(0.17)	0.21	(0.22)	-0.17	(0.17)	0.19	(0.20)
Interntl. R&D experience: 11–15 yrs	0.12	(0.18)	0.43	(0.24)+	0.21	(0.18)	0.41	(0.23)+
Interntl. R&D experience: > 15 yrs	-0.07	(0.14)	0.45	(0.19)*	-0.01	(0.15)	0.44	(0.18)*
Industry dummies	incl.		incl.		incl.		incl.	
Constant	-0.24	(0.36)	-0.89	(0.44)*	-0.25	(0.37)	-0.88	(0.44)*
Equation-specific R-squared (F)	0.37		0.23		0.37		0.23	
Covariance of errors	-0.08	(0.04)+			-0.07	(0.04)+		

Notes: N = 375. Seemingly unrelated regression analyses. Variables HBE strategy, HBA strategy, technological leadership, and cost focus standardized before entering into regression to simplify interpretation of effects. Base categories for international R&D experience: not reported. Robust standard errors in parentheses.
Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table 4
Robustness checks (alternative measurements).

Model	5 (alternative measure for exploratory country)				6 (correlated measures of strategies)			
Dependent variable	HBE strategy		HBA strategy		HBE strategy		HBA strategy	
EMNE	-0.21	(0.09)*	0.35	(0.11)***	-0.16	(0.09)+	0.30	(0.10)**
EMNE × Technological leadership	0.16	(0.07)*	-0.06	(0.09)	0.14	(0.07)*	-0.03	(0.09)
Exploratory country			0.26	(0.08)***			0.23	(0.07)***
Control variables								
Firm age (ln)	0.16	(0.06)**	0.04	(0.08)	0.15	(0.06)*	0.07	(0.08)
Firm size (ln)	-0.03	(0.03)	0.03	(0.04)	-0.02	(0.03)	0.03	(0.04)
R&D capacity	0.22	(0.27)	0.70	(0.36)+	0.39	(0.26)	0.73	(0.34)*
Technological leadership	0.01	(0.06)	0.20	(0.07)**	0.05	(0.05)	0.20	(0.07)**
Cost focus	0.52	(0.04)***	0.13	(0.05)**	0.53	(0.04)***	0.21	(0.05)***
Export share: 1 – 25%	0.15	(0.20)	0.09	(0.18)	0.18	(0.21)	0.12	(0.19)
Export share: 26 – 50%	0.14	(0.21)	-0.00	(0.19)	0.15	(0.21)	0.02	(0.19)
Export share: 51 – 75%	0.25	(0.23)	-0.26	(0.23)	0.19	(0.23)	-0.22	(0.23)
Export share: 75 – 100%	0.21	(0.23)	-0.27	(0.22)	0.16	(0.24)	-0.23	(0.23)
Interntl. R&D experience:1–5 yrs	-0.21	(0.16)	0.23	(0.21)	-0.16	(0.16)	0.20	(0.20)
Interntl. R&D experience: 6–10 yrs	-0.26	(0.17)	0.19	(0.20)	-0.23	(0.17)	0.14	(0.20)
Interntl. R&D experience: 11–15 yrs	0.12	(0.18)	0.41	(0.23)+	0.19	(0.17)	0.43	(0.23)+
Interntl. R&D experience: > 15 yrs	-0.07	(0.14)	0.44	(0.18)*	0.01	(0.14)	0.42	(0.18)*
Industry dummies	incl.		incl.		incl.		incl.	
Constant	-0.24	(0.36)	-0.88	(0.44)*	-0.39	(0.37)	-0.90	(0.44)*
Equation-specific R-squared (F)	0.37		0.23		0.39		0.26	
Covariance of errors	-0.07	(0.04)+			0.17	(0.04)***		

Notes: N = 375. Seemingly unrelated regression analyses. Variables HBE strategy, HBA strategy, technological leadership, and cost focus standardized before entering into regression to simplify interpretation of effects. Base categories for international R&D experience: not reported. Robust standard errors in parentheses.
Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

diverse advanced economies (Germany and the United States) – we document that the overlap of firm-level and country-level effects may severely affect the reliability of conclusions derived from existing two-country studies. In our sample, Chinese MNEs place the highest importance on home-base-augmenting strategies, which is in line with evidence from public debates regarding the increasing number of acquisitions of advanced economy companies by Chinese MNEs, such as the acquisition of Kuka, a German manufacturer of industrial robots, by the Chinese Midea Group (The Economist, 2017a; 2017b). Furthermore, like Awate et al. (2015), we found a difference between Indian firms and firms from a European country (Denmark, as a European country for Awate et al., is replaced by Germany in this paper). However, the difference in levels of home-base-augmenting strategies nearly disappears when comparing U.S. firms to Indian firms. While this finding might, at first glance, be considered as invalidating studies suggesting a systematic difference between EMNEs and AMNEs, we want to stress that, apart

Table 5
Robustness checks (alternative measurements).

Model	7 (cluster-robust standard errors)				8 (incl. R&D location and structure)			
Dependent variable	HBE strategy		HBA strategy		HBE strategy		HBA strategy	
EMNE	-0.21	(0.10)*, b:+	0.35	(0.04)***, b:*	-0.22	(0.09)*	0.37	(0.11)***
EMNE × Technological leadership	0.16	(0.04)***, b:*	-0.06	(0.08)	0.16	(0.08)*	-0.04	(0.09)
Exploratory country			0.24	(0.03)***, b:+			0.24	(0.07)**
Control variables								
Firm age (ln)	0.16	(0.09)+	0.04	(0.06)	0.15	(0.06)*	0.05	(0.08)
Firm size (ln)	-0.03	(0.03)	0.03	(0.01)*	-0.03	(0.04)	0.02	(0.04)
R&D capacity	0.22	(0.29)	0.70	(0.52)	0.32	(0.29)	0.49	(0.38)
Technological leadership	0.01	(0.04)	0.20	(0.03)***	0.01	(0.06)	0.19	(0.07)**
Cost focus	0.52	(0.09)***	0.13	(0.11)	0.52	(0.05)***	0.14	(0.06)*
Export share: 1 – 25%	0.15	(0.25)	0.09	(0.13)	0.18	(0.20)	0.07	(0.18)
Export share: 26 – 50%	0.14	(0.21)	-0.00	(0.18)	0.16	(0.21)	-0.05	(0.18)
Export share: 51 – 75%	0.25	(0.14)+	-0.26	(0.17)	0.28	(0.23)	-0.22	(0.23)
Export share: 75 – 100%	0.21	(0.13)	-0.27	(0.06)***	0.24	(0.23)	-0.26	(0.22)
Interntl. R&D experience:1–5 yrs	-0.21	(0.16)	0.23	(0.16)	-0.23	(0.17)	0.21	(0.22)
Interntl. R&D experience: 6–10 yrs	-0.26	(0.12)*	0.19	(0.08)*	-0.29	(0.17)	0.21	(0.22)
Interntl. R&D experience: 11–15 yrs	0.12	(0.08)	0.41	(0.11)***	0.10	(0.18)	0.38	(0.25)
Interntl. R&D experience: > 15 yrs	-0.07	(0.11)	0.44	(0.17)**	-0.10	(0.15)	0.44	(0.20)*
Knowledge-intensive location: < 50%					0.11	(0.13)	0.23	(0.14)
Knowledge-intensive location: ≥ 50%					-0.02	(0.11)	-0.14	(0.13)
Share foreign R&D employees					0.00	(0.00)	0.00	(0.00)
Share foreign R&D employees (missing)					0.05	(0.15)	-0.25	(0.16)
Share foreign R&D activities					0.14	(0.18)	-0.08	(0.24)
Share foreign R&D activities (missing)					0.21	(0.21)	-0.31	(0.27)
Industry dummies	incl.		incl.		incl.		incl.	
Constant	-0.24	(0.34)	-0.88	(0.28)**	-0.35	(0.38)	-0.79	(0.45)+
Equation-specific R-squared (F)	0.37		0.23		0.37		0.25	
Covariance of errors	-0.07	(0.08)			-0.08	(0.04)*		

Notes: N = 375. Seemingly unrelated regression analyses. Variables HBE strategy, HBA strategy, technological leadership, and cost focus standardized before entering into regression to simplify interpretation of effects. Base categories for international R&D experience: not reported. For Model 7, standard errors in parentheses clustered at the level of countries. In Model 7, we additionally report (after "b:") inferences based on cluster-bootstrapped p values as recommended by MacKinnon & Webb (2018) and Roodman, MacKinnon, Nielsen, & Webb (2019). For Model 8, robust standard errors in parentheses. Reference category for location is "missing". Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

from any EMNE effect, there is substantial country heterogeneity that overlaps with EMNE effects to some extent (Pedersen & Stucchi, 2014; Khanna, 2009). This overlapping may also eventually balance an existing EMNE effect. In favor of such an interpretation, Fig. 2B suggests that the lines on which AMNEs and EMNEs vary are parallel with the difference between these lines likely reflecting a systematic EMNE-AMNE difference. Future studies might reflect more on the specific countries chosen when studying EMNE-AMNE differences and possibly use moderation or mediation approaches to disentangle technology-related firm-specific EMNE effects from possibly overlapping country effects (Choi, Cui, Li, & Tian, 2020).

Second, when analyzing EMNE-AMNE differences in R&D internationalization, researchers often focus on the relative importance of R&D internationalization strategies directed at exploiting existing knowledge versus generating new knowledge (cf. Awate et al., 2015). We took this analysis one step further and looked at both strategies separately to unveil underlying strategy-specific antecedents. We combined this more nuanced perspective with Aharoni's (2014) and Hernandez & Guillén's (2018) suggestion to theorize on firm-level characteristics that help distinguish MNEs and upon which a contingency theory of international business can be developed. Following Makino et al. (2002), who suggest technological leadership as a moderator for the internationalization process, we demonstrated the technological position of MNEs as a crucial factor for explaining differences between EMNEs' and AMNEs' strategies for R&D internationalization. We found that EMNEs become similar to AMNEs regarding home-base-exploiting strategies if they are technological leaders, thereby also supporting Narula's (2012) prediction that differences between EMNEs and AMNEs will diminish as EMNEs evolve. Surprisingly, there is no statistically significant evidence supporting the hypothesis that a firm's technological position moderates the relationship between EMNEs (vs. AMNEs) and its home-base-augmenting strategy. That is, the implicit premise that technological laggards explore more than technology leaders (Awate et al., 2015) should be refined with respect to the interplay between the technological position and a firm's focus on home-base-augmenting internationalization strategies.

Furthermore, only considering the relative importance of home-base-exploiting over home-base-augmenting can mask possibly diverging results for the two underlying individual strategies. For instance, EMNEs establishing more advanced technological positions (especially Chinese MNEs) might not only keep their earlier focus on home-base-augmenting strategies but also go for home-base-exploiting and thereby move increasingly toward a global R&D strategy with equal focus on home-base-exploiting and home-base-augmenting (cf., von Zedtwitz & Gassmann, 2002). As a consequence, such EMNEs might not only catch up with AMNEs, but potentially outperform them in the long run (Ramamurti & Hillemann, 2018, Ramamurti & Williamson, 2019). This finding further supports research showing that differences between EMNEs' and AMNEs' strategic asset-seeking investments may have been exaggerated, calling for more systematic comparative analyses of EMNEs and AMNEs (Sutherland, Anderson, & Hertenstein, 2018).

Third, while case studies may constitute an important first step toward identifying more general patterns, they may also mask country and firm heterogeneity. We acknowledge that neither EMNEs nor AMNEs form homogenous groups (Khanna, 2009; Pedersen & Stucchi, 2014). Taking home-country institutional differences into account, we focused on the country's exploratory institutional environment, which likely affects firms' international R&D strategies. While country effects for home-base-exploiting are negligible, we found robust and large within-country-group heterogeneity among EMNEs and AMNEs concerning the use of home-base-augmenting strategies in R&D internationalization. Since we focused only on a single dimension of the countries' environments, the extent to which home-country institutions

– in terms of laws, regulations, norms, and cultures – affect firms' R&D internationalization deserve a much more nuanced view in future research to further elaborate on EMNE-AMNE differences (Cuervo-Cazurra, Luo, Ramamurti, & Ang, 2018; Cuervo-Cazurra, Mudambi, & Pedersen, 2019).

Overall, our findings are in line with the expectation that MNEs' strategies are not independent of their heterogeneous home country conditions (Hennart, 2012; Luo & Wang, 2012; Luo & Zhang, 2016) and consistent with the view that EMNE catch-up processes are highly country-specific (Brandl & Mudambi, 2014; Ramamurti & Singh, 2009). While Indian firms exhibit slightly slower development, resulting in a – so far – less intensive focus on home-base-augmenting strategies for their international R&D activities, Chinese firms, with their massive policy support for technology exploration (Fan & Watanabe, 2006; Ramamurti & Hillemann, 2018), seem to have already mastered – if not leapfrogged – some stages. Institutional conditions may be more important than technological laggardness in systematically emphasizing home-base-augmenting strategies. In contrast, it seems that home-base-exploiting is inherently based on existing knowledge and capabilities at the headquarters, which cannot be overcome by institutional environment, such that the importance of this strategy is tied to individual firm characteristics rather than to the institutional environment. Consequently, categorizing firms into overly large baskets of EMNEs and AMNEs may mask firm- and country-level heterogeneity (Brandl & Mudambi, 2014; Luo & Zhang, 2016). Moreover, we emphasize that these overlapping effects are likely to be strategy-specific, too, such that heterogeneity is also masked if the two types of R&D internationalization strategies are not separately analyzed.

Turning to policy implications, our findings indicate that policy-makers should separate HBE and HBA strategies and consider that each strategy is likely to respond to different instruments. On the one hand, investing in an exploratory institutional environment, such as direct or indirect domestic subsidies to facilitate exploratory R&D in foreign locations, will stimulate firms to engage in HBA. Since the foreign knowledge accessed through HBA can also be transferred to the domestic arena (cf., Steinberg et al., 2021), it may further strengthen firms' (domestic) absorptive capacities (cf., Aldieri et al., 2018) and consequently the country's knowledge base. Hence, by investing in building an exploratory culture, governments may also indirectly strengthen the country's knowledge base by stimulating their firms' access to foreign knowledge. On the other hand, our findings imply that firms' HBE is mainly driven by firm-specific capabilities (i.e., technological leadership) and less so by country effects. This indicates that firms' HBE might be less sensitive to direct policy measures. If governments want their firms to increase HBE activities, they first need to invest in policies that allow their country's firms to build these firm-specific capabilities. However, there may even be policies intended to increase firms' HBA that might indirectly affect HBE. For example, during the Covid19 pandemic, countries that strongly invested in public research institutions indirectly encouraged private R&D investments through partnerships, thereby fostering corporate technological leadership.

While our study sheds new light on important aspects of the R&D internationalization of EMNEs, it has some limitations, three of which warrant more detailled discussion. First, the cross-sectional and self-reported nature of some of our data may create spurious correlations between our variables (Podsakoff et al., 2003). However, we reduced the potential risks of common method bias by employing different response scales within the survey and by aligning our questions with officially set standards for innovation surveys (OECD, 2002, 2005). We ensured anonymity, which is recommended to reduce common method variance (Podsakoff et al., 2003). Besides these efforts, we point out that the country of origin, a key explanatory variable, was derived from secondary data, and tests of moderation effects based on self-reported measures are not susceptible to bias by common method variance (Siemsen et al., 2010). Hence, common method variance is unlikely to account for our major findings.

Second, confidentiality requirements prevented us from including or merging our collected data with additional data from other sources. Future research comparing EMNEs and AMNEs may find it worthwhile to go beyond the R&D variables that we employed and merge additional information into their survey, such as patenting activities, balance sheet information, and detailed ownership information, including state ownership, which may allow them to base their analyses on even richer data. For example, several studies point to the fact that government ownership affects firm behavior, such as investments in intangible and tangible assets (He, Tong, & Xu, 2021), and outcomes, such as firm performance (Alfaraih, Alanezi, & Almujamed, 2012). In particular, the Chinese firms in our sample may be partly government-owned. Unfortunately, we did not have information on government ownership that would have allowed us to further isolate the specific mechanisms through which country background affects firms' HBA strategies. Our finding that exploratory environments affect firms' HBA strategy could be explained by direct government influence on firm strategies via government ownership or by indirect influence, for example, via formal and informal policies that incentivize HBA. While both mechanisms likely work together for Chinese firms, we call for future research to further disentangle the exact mechanisms through which exploratory country contexts affect firms' R&D internationalization. Nevertheless, we believe that our study reports important findings, such as our implication that firms from countries with higher exploratory tendencies are more likely to employ HBA strategies remains independent of isolating the specific mechanisms through which this influence is exercised.

Third, our study builds on one static point in time and only considers larger firms from four large economies. The bounded scope in time and breadth limited our ability to reflect on both the dynamism of technological catch-up processes and the generalizability of results from these larger countries to smaller ones. On the one hand, future research might look at how the two types of internationalization strategy can be implemented in terms of specific management practices (Steinberg et al., 2021) and assess the economic returns from both types of knowledge-related R&D strategies (Aldieri et al., 2018; Griliches, 1979, 2007; Orlando, 2004). On the other hand, differences between small and large home markets have been shown to affect internationalization (Murmann, Ozdemir, & Sardana, 2015) and may also account for differences in R&D internationalization strategies.

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