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Dare to Sell! Impacts of “Make and/or Buy” Decision Strategies on Outbound Open Innovation

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ABSTRACT

This study adds to the previous literature on outbound open innovation (OI)—that is, external knowledge commercialization activities—by exploring the effects of “make and/or buy decisions” on outbound OI. Notwithstanding the critical role of outbound OI in shaping firms’ competitive advantages, there has been a notable gap in research regarding the drivers of outbound OI. Drawing on the knowledge-based view, this empirical paper addresses this research gap by exploring an array of identified determinates of outbound OI. Through analyzing 468 New Zealand firms, we found that larger and more established firms show a stronger connection between research and development (R&D) investment and outbound OI, whereas smaller firms benefit more from external knowledge sourcing. Additionally, inbound OI positively affects outbound OI, yet the effect diminishes with more international collaborations. Interestingly, small and medium-sized enterprises (SMEs) favor formal appropriation strategies, such as patents and contracts, while larger firms prioritize informal methods, such as secrecy.

1 | Introduction

This paper seeks to explore when, and under what circumstances, firms can enhance their outbound open innovation (OI), defined as “the commercialization of technological knowledge exclusively or in addition to its application inside the firm” (Lichtenthaler and Ernst 2007). Besides generating revenue, outbound OI enables firms to gain access to the technology portfolios of other firms, establish industry benchmarks, and attain learning outcomes (Arora et al. 2001). As such, EOS GmbH, the predominant player in the 3D-print technology sector globally, has licensed out its technologies to rivals, contributing to the establishment of industry standards (Helm et al. 2019).

Despite the pivotal role that outbound OI plays in helping firms establish and maintain a competitive edge in global markets, few studies have undertaken a comprehensive exploration of the

conditions under which a firm can enhance its outbound OI activities (Gentile-Lüdecke et al. 2020; Hu et al. 2015; Kim et al. 2015). Investigating the antecedents of outbound OI is important for both theory and practice, since such nuanced understanding optimizes collaboration with external partners, provides insights into factors influencing successful commercialization, and, at a broader level, fosters a more efficient innovation ecosystem (Cheah and Yuen-Ping 2021; Chesbrough and Bogers 2014). Ultimately, this strategic insight positions firms to outperform competitors in terms of speed, efficiency, and the quality of outbound OI outcomes (Chesbrough 2006).

Drawing on the knowledge-based view (KBV), a firm’s success in outbound OI activities hinges on its ability to efficiently generate and leverage valuable, rare, and difficult-to-replicate knowledge (Barney 1991; Conceição et al. 2012). Hence, firm managers actively engage in the exploration of strategies to

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overcome challenges posed by knowledge scarcity (Combs et al. 1999). One common strategy involves allocating resources to research and development (R&D) investments, which help firms generate original ideas internally, establishing a strong basis for outbound OI initiatives (for recent examples, see Hervás-Oliver et al. (2021); Hervás-Oliver et al. (2021b)). Another effective strategy involves establishing collaborations with external partners, referred to as inbound OI (Sikimic et al. 2016). This approach strategically taps into external sources of knowledge, expertise, and diverse perspectives.

In alignment with this theoretical framework, our research focuses on the pivotal roles of R&D intensity and inbound OI, exploring how these factors—representing the “make” and “buy” aspects of innovation strategy—distinctly influence outbound OI activities. By doing so, we aim to provide a more robust and tailored understanding of the dynamics at play, enabling both scholars and practitioners to glean actionable insights to enhance the outcomes of their outbound OI activities. This holds particular significance given the conflicting findings in previous research concerning the effects of outbound OI on firms’ innovation performance (see, e.g., Madrid-Guijarro et al. (2021); Mazzola et al. (2012); Scaliza et al. (2022)).

Building on the KBV and OI literatures, our paper offers two main contributions. First, the presence of in-house R&D is considered a central determinant of outbound OI (Arora et al. 2001; Grindley and Teece 1997). Studies show that firms actively engaged in licensing out knowledge typically exhibit a high level of commitment to R&D intensity (Lichtenthaler and Lichtenthaler 2009). Hence, our study aims to provide a nuanced perspective regarding how in-house R&D shapes and contributes to successful outbound OI activities. By doing so, our study also responds to the earlier call for exploration of varied innovation strategies within the domain of outbound OI (Hervas-Oliver et al. 2021a; Santamaría et al. 2009).

Second, our research contributes to the existing literature by providing a theoretical framework and empirically examining the effects of inbound OI on outbound OI activities. Previous scholars have discussed that the strategic choice to pursue outbound OI cannot be viewed separately from inbound OI (Sikimic et al. 2016). Through inbound OI, firms collaborate with a variety of external partners, such as competitors and universities. Previous studies show that knowledge transfer from external sources can be transformed with internal resources and create difficult-to-copy assets for the focal firm (Fleming and Sorenson 2004; Kogut and Zander 1992), which “may represent valuable out-licensing opportunities as the firm looks for external partners to complete their development and to commercialize the resulting products” (Sikimic et al. 2016). We also examine the moderating effect of the geographic breadth of collaborations on the relationship between inbound and outbound OI. Collaborating with firms across multiple countries positions the focal firm to gain entry to various national knowledge bases, which makes it easier to acquire “complementary knowledge from locations that specialize in a variety of scientific and technological domains” (Hsieh et al. 2018).

2 | Theoretical Background

2.1 | Knowledge-Based View

According to the KBV, firms strategically leverage their unique blend of knowledge to develop capabilities that yield above-normal returns (Barney 1991). In the context of outbound OI, the success of firms hinges on the effective creation and deployment of novel knowledge, particularly pertaining to the quantity and quality of technologies ready for external commercialization (Barney 1991; Conceição et al. 2012). This knowledge, often considered a key resource, becomes instrumental in conferring a competitive advantage to the firm within its industry.

Therefore, for firms to strategically harness and derive advantages from outbound OI, it is crucial to nurture knowledge that is both difficult to replicate and holds substantial value (Barney 1991). This strategic imperative manifests through two primary avenues. First, firms invest in in-house R&D to generate novel ideas that can be commercialized. In other words, firms with a higher R&D intensity are better equipped to produce novel ideas internally, forming a robust foundation for outbound OI initiatives (Arora et al. 2001; Grindley and Teece 1997). The KBV lens underscores the strategic importance of R&D intensity, positioning it as a catalyst for the generation of proprietary knowledge that can be externalized through outbound OI.

Second, firms acquire new knowledge through collaborative efforts with external partners—that is, inbound OI (Cassiman and Veugelers 2006; Hervás-Oliver et al. 2021; Santamaría et al. 2009). Combs et al. (1999) stated that “if a firm possesses some but not all needed resources, a common response is to combine resources with an external organization using a cooperative arrangement”. In this view, inbound OI can contribute to replenishing a firm’s knowledge stock, as it helps the firm complement its internal R&D through knowledge exchange with other partners in its environment (Teece 2020). This collaborative approach allows the firm to tap into a diverse pool of talents, technologies, and insights that may not be readily available within its organizational boundaries (Wang et al. 2021). These accumulated resources can be leveraged to develop innovative products, services, or solutions that extend beyond the firm’s traditional boundaries. Hence, the knowledge acquired through inbound OI becomes valuable input for the firm’s outbound OI.

In summary, within the KBV paradigm, the strategic decision for outbound OI is influenced by both inbound OI and R&D intensity. Inbound OI serves as the conduit for external knowledge infusion, while R&D intensity underscores the importance of a well-nurtured internal knowledge base. Together, these antecedents form a holistic framework that guides firms in strategically navigating the complex landscape of OI.

2.2 | Modes of Strategic Openness

The innovation paradigm has considerably moved from closed to open and from internal exploitation to external collaborations

(Bhimani et al. 2023; Candi et al. 2018; Von Tunzelmann and Acha 2005; West and Bogers 2014). Following this, two types of OI are identified: “inbound” and “outbound.” Inbound OI involves searching and absorbing new ideas from the external environment to develop innovation, whereas outbound OI refers to the deliberate commercialization of internally generated novel solutions in the firm’s external environment, which can be “through selective revealing or through selling the technology or service to customers” (Chesbrough and Bogers 2014).

Outbound OI can help firms sell unused ideas, which can assist in “decongesting” the in-house process of innovation (Chesbrough 2006). In essence, it allows firms to avoid the stagnation that can occur when promising ideas remain unused or shelved within the confines of the organization. When inventors, who are often the firm’s employees, witness the practical application of their novel solutions beyond the company’s boundaries, it serves as a powerful motivational factor. This sense of impact and recognition encourages them to work harder and, consequently, fosters a culture of continuous ideation and creativity (Cassiman and Valentini 2016).

Furthermore, the benefits extend beyond internal motivation. Outbound OI opens doors to external networks, providing firms with access to novel technologies and valuable learning opportunities that may not be available within their own organizational boundaries (Moreira et al. 2019). This external exposure can act as a catalyst for innovation, exposing employees to diverse perspectives, approaches, and industry trends. By engaging in outbound OI, firms position themselves as active contributors to the broader innovation ecosystem. They not only monetize their unused ideas but also stimulate a more dynamic and productive internal innovation culture (Cassiman and Valentini 2016).

While outbound OI plays a crucial role in shaping firms’ competitive advantage, the drivers behind this aspect have not received adequate consideration in the current literature (Symeonidou and Bruneel 2017). A few limited empirical studies in this area include Arora and Ceccagnoli (2006) and Gambardella et al. (2007), who limited themselves to the effects of patent protection and complementary assets on technology licensing, while leaving other antecedents unexplored. Similarly, Fosfuri (2006) examined the effect of competition in the market on the rate of technology licensing. In contrast, much attention has been devoted to scrutinizing outbound OI’s effect on a company’s performance, and whether it facilitates or hinders such processes (Hu et al. 2015). Some studies highlight that outbound OI could decrease the performance of organizations because of potential challenges arising from the diffusion of intellectual property, increased competition, or the risk of losing strategic control over proprietary information (Arora et al. 2001; Fosfuri 2006). Scaliza et al. (2022) found a lack of association between outbound OI and performance development, attributing this outcome to the prevailing inclination of Brazilian firms toward inbound OI. Similarly, both Mazzola et al. (2012) and Hung and Chou (2013) failed to observe a significant effect of outbound OI on innovation and economic–financial performance.

In contrast, other scholars have found that outbound OI may not necessarily influence a firm’s performance, and, in some cases, engaging in outbound OI can positively contribute

to and enhance a firm’s overall performance. For instance, Lichtenthaler (2009) provided empirical evidence supporting the notion that participating in outbound OI can lead to positive contributions and enhancements in a firm’s overall performance. Similarly, Madrid-Guijarro et al. (2021) showed that outbound OI directly enhances overall performance. Table 1 presents selected empirical investigations on the relationship between outbound OI and firms’ performance.

As indicated in Table 1, these contrasting results can be ascribed to the need for a more thorough examination of the factors influencing outbound OI, as a nuanced understanding of these factors is crucial to unravel the complex dynamics influencing the success of these initiatives.¹ The pronounced emphasis by prior scholars on probing the antecedents of outbound OI underscores a noticeable gap in the current scholarly landscape (Cheah and Yuen-Ping 2021; West and Bogers 2014). Thus, our study deliberately concentrates on identifying the factors that influence outbound OI activities, opting to contribute insights into the determinants, rather than scrutinizing the outcomes of such activities, such as technology licensing or the quantity of patents generated.

3 | Hypothesis Development

3.1 | Internal Capabilities

The KBV suggests that in-house R&D activities can determine the success of outbound OI (Zahra and Nielsen 2002). Investment in in-house R&D gives the firm the flexibility to generate difficult-to-copy knowledge and upgrade current knowledge. Firms that allocate substantial resources toward R&D investment are inclined to operate across diverse product markets, resulting in a broad comprehension of numerous potential applications. This wide-ranging knowledge may facilitate their ability to recognize opportunities for outbound OI (Lichtenthaler and Lichtenthaler 2009).

Furthermore, commitment to R&D investment not only demonstrates a company’s dedication to advancing its knowledge base, but also results in the creation of tangible outcomes and innovations. These outcomes serve as evidence of the practical applications and viability of the knowledge generated through R&D efforts (Arora et al. 2001; Jensen and Thursby 2001). In the realm of outbound OI, where external partners often seek assurances and tangible demonstrations of the value they can gain from collaboration, having a robust portfolio of proven concepts and innovations becomes a strategic asset (Jensen and Thursby 2001).

In addition, R&D investment is vital for strengthening a firm’s absorptive capacity, which is the firm’s ability to identify, absorb, and utilize external knowledge effectively (Cohen and Levinthal 1990). To fully unlock the potential of outbound OI, firms must not only identify valuable external technology transfer opportunities but also minimize the transaction costs associated with these efforts to ensure effective implementation (Lichtenthaler and Lichtenthaler 2010). A firm with a high level of absorptive capacity is better equipped to build and maintain strong networks with a wide range of external partners, which are vital for identifying and leveraging technology

TABLE 1 | Selected empirical research on the relationship between outbound OI and firms' performance.

Author(s)	Method and data	Main results	Journal
Lichtenthaler (2009)	OLS regression, 155 firms	Positive relationship	<i>R&D Management</i>
Belderbos et al. (2010)	Regression, 168 research and development (R&D)-intensive firms	Inverted U-shaped relationship	<i>Journal of Product Innovation Management</i>
Mazzola et al. (2012)	OLS regression, 105 companies listed on the Industrial Machinery and Component index	Negative relationship	<i>International Journal of Innovation Management</i>
Hung and Chou (2013)	Hierarchical regression, 176 Taiwanese high tech manufacturing firms	Negative relationship	<i>Technovation</i>
Cheng and Huizingh (2014)	223 Asian service firms	Positive relationship	<i>Journal of Product Innovation Management</i>
Cheng and Shiu (2015)	Three-stage least square analysis, 304 Taiwanese-based firms	Positive relationship	<i>Management Decision</i>
Hu et al. (2015)	Regression, 180 firm	Inverted U-shaped relationship	<i>Technovation</i>
Mazzola et al. (2016)	Binomial regression analysis 120 companies	Negative relationship	<i>International Journal of Innovation Management</i>
Caputo et al. (2016)	Regression, 110 companies	Inverted U-shaped relationship	<i>Management Decision</i>
Madrid-Guijarro et al. (2021)	OLS regression, 267 SMEs	Positive relationship	<i>Review of Managerial Science</i>
Wang et al. (2021)	Hierarchical regression analysis, 270 firm	Positive relationship	<i>International Journal of Conflict Management</i>
Scaliza et al. (2022)	SEM, 169 companies	Not significant	<i>Journal of Business Research</i>
Zhang et al. (2024)	SEM, 157 articles	Positive relationship	<i>Journal of Product Innovation Management</i>

transfer opportunities (Spithoven et al. 2011; Zhang et al. 2024). Through these collaborations, firms can reduce uncertainty, accelerate the time-to-market for new innovations, and enhance their ability to scale technologies efficiently. The process of knowledge exchange becomes smoother when firms are able to tap into the capabilities and resources of their external partners, facilitating the transfer of intellectual property and technology to new markets or customers (Aliasghar and Haar 2021; West and Bogers 2014). Ultimately, a firm's absorptive capacity enables more effective implementation of outbound OI strategies, positioning the firm to expand its market reach and enhance its innovation output.

Hypothesis 1. *A higher share of R&D intensity in a firm is positively associated with outbound OI.*

3.2 | Firm's Openness

A number of studies have examined the mechanisms that drive the adoption of OI modes within organizations. Mortara and

Minshall (2011) emphasized the role of organizational culture, innovation needs, and timing as key factors in the successful implementation of OI in multinational firms. Similarly, Chiaroni et al. (2011) explored the transition of a cement manufacturer to an OI model, detailing a three-phase process of implementation.

While these studies provide valuable insights into the factors that influence the adoption of OI, there is a notable gap in the literature regarding the antecedents of OI activities, particularly outbound OI (West et al. 2014). For instance, Kim and Ahn (2019) explored the role of the OI climate in fostering inbound OI, yet their focus remained primarily on inbound OI, leaving the specific drivers of outbound OI in SMEs underexplored. Gentile-Lüdecke et al. (2020) extended this line of inquiry by examining how organizational structures—such as specialization, formalization, and centralization—affect both inbound and outbound OI activities in SMEs. While their study highlighted the dual impact these structures can have on OI activities, it did not address the interaction between inbound and outbound OI. Additionally, their focus was on Chinese SMEs, leaving a gap in our understanding of how internal and external

knowledge sources influence outbound OI activities in firms operating in more developed contexts. This represents a substantial oversight, as SMEs, by their nature, are more reliant on external knowledge sources to complement their innovation activities. The lack of attention to this dynamic in the literature highlights the need for further investigation into how inbound OI can drive outbound OI (Symeonidou and Bruneel 2017). In our study, we explore several ways in which inbound OI influences outbound OI activities.

First, the success of outbound OI activities depends heavily on novel innovations for successful commercialization. Inbound OI develops a firm's knowledge portfolio by accessing novel ideas from fields that may be nearby or distant (Rigby and Zook 2002). By providing access to novel and diverse innovations, inbound OI enriches a firm's knowledge portfolio and enables the creation of unique asset configurations that have high commercialization potential (Brown and Anthony 2011). Second, inbound OI provides firms with critical external knowledge, enabling them to identify new markets, applications, and commercialization pathways for their innovations. As a result, firms that actively engage in inbound OI are better positioned to successfully bring their innovations to market through outbound OI, ensuring long-term growth and competitive advantage.

Third, the reciprocal nature of OI implies that firms engaged in inbound OI are more likely to be seen as credible and trustworthy partners in the outbound context. As a result of successful knowledge exchanges and collaborative projects through inbound OI, a firm not only accumulates valuable external knowledge but also develops a reputation for innovation and a network of relationships (Cassiman and Valentini 2016). This accumulated social capital and positive reputation become crucial assets when venturing into outbound OI initiatives (Aliasghar and Haar 2021; Moreira et al. 2019). The credibility established through effective inbound OI reduces the perceived risks and transaction costs associated with collaborating externally, making the firm a more attractive and reliable partner (Chesbrough 2003, 2006).

The relationship mentioned above becomes even more significant if a firm has established connections with companies in other countries, which enables it to obtain market-related knowledge that is not accessible within its own domestic market. Engaging in partnerships with companies from various countries exposes firms to a broader range of knowledge sources, thereby facilitating the acquisition of complementary knowledge from areas that specialize in diverse scientific and technological fields (Kafourous and Forsans 2012). Searching for knowledge from a wider range of knowledge sources enhances technological learning, amplifies the chances of generating a valuable combination of knowledge, develops problem-solving, and increases a firm's external knowledge commercialization potential (Hsieh et al. 2018). Hence, the geographic breadth of collaborations enhances a firm's outbound OI activities because it becomes easier to manage international commercialization endeavors when the firm has a constant presence in foreign countries (Atuahene-Gima 1993; Sikimic et al. 2014). In summary, interacting with foreign firms in different settings not only offers a firm complementary knowledge in different countries, but also enhances its market-related knowledge, which favors the external use of knowledge (Sikimic et al. 2014). Inbound OI thus reduces the

level of R&D risks and accelerates the innovation process, which enhances outbound OI activities. Therefore:

Hypothesis 2a. *Inbound OI is positively related to the development of outbound OI activities.*

Hypothesis 2b. *Geographic breadth of relationships positively moderates the relationship between inbound OI and outbound OI.*

4 | Methods

4.1 | Sample and Data Collection

In this study, New Zealand (NZ) firm managers were targeted in 2020 using a CINT survey panel. We focused on senior managers because they are best able to reflect on their firms' international collaborations and strategic decisions. Participants in the CINT system could remain confidential and anonymous while receiving payment for their involvement. We accessed respondents across the wide geography of NZ. The CINT system included quality checks based on survey time completion, with respondents who completed the survey too rapidly or too slowly being removed. This approach to panel data resulted in high-quality manager data being obtained from NZ samples. Walter et al. (2019) conducted a meta-analysis comparing data sourced through conventional means (e.g., mail survey) and panel data and found no significant differences. We initially conducted a pilot study with 30 NZ firm managers to test the suitability of our survey and identify potential issues. We focused on firms with a minimum of 50 employees to ensure they had the potential to engage in OI. Overall, data from 468 NZ firms with international collaborations were received. As a quality check, we compared respondent data from the first quartile of respondents with the last quartile and found no significant differences. Demographic information is presented in Table 2.

4.2 | Measures

Respondents were instructed to think about their organization when answering questions related to all constructs, with responses ranging from 1 = "not at all" to 7 = "a great deal". The full list of multi-item scales used is shown in Table 3.

Outbound OI was measured using five items ($\alpha=0.85$; Cheng and Huizingh (2014); Hung and Chou (2013)). The internal capabilities of the firm were measured by R&D intensity (Spithoven and Teirlinck 2015). R&D intensity represented the ratio of expenditure on in-house R&D over sales (coded 1 = less than 2%, 2 = 2% to less than 4%, 3 = 4% to less than 6%, 4 = 6% to less than 8%, 5 = 8% to less than 10%, 6 = 10% to less than 15%, 7 = 15% to less than 20%, 8 = 20% to less than 30%, 9 = 30% or more).

Our first variable for firm openness was inbound OI, which was measured using four items ($\alpha=0.86$; Hung and Chou (2013)). Our second variable was geographical breadth, based on Hsieh et al. (2018, 659). We used six items to capture the geographic breadth of sources of OI. Responses were coded 0 = no engagement, and a list of geographic engagement options was provided:

TABLE 2 | Study demographics.

	Total sample	SMEs (51–250 employees)	Large-sized firms (251+ employees)
Sample Size	N = 468	N = 149	N = 319
Sector			
Private	55.9%	56.4%	39.8%
Public	45.1%	43.6%	60.2%
Firm age			
7 years or less	14.1%	12.1%	15.0%
8–13 years	24.6%	16.8%	28.2%
14–19 years	28.6%	23.5%	31.0%
20–30 years	14.7%	16.8%	13.8%
31–50 years	11.2%	18.8%	7.5%
Over 50 years	6.8%	12.1%	4.3%
Firm size			
SMEs	31.8%	—	—
Large-sized	68.1%	—	—
Family firm?			
Yes	48.5%	55.0%	45.5%
No	51.5%	45.0%	54.5%

New Zealand, Australia, Europe, United States, United Kingdom, China, India, and others. We tallied all geographical regions for each category. Thus, engaging all OI sources across all eight geographical options was scored as eight. Overall, we summed the six categories (total geographic locations) and divided them by six (category options). An exploratory factor analysis was conducted, and all six categories loaded onto a single factor with an eigenvalue greater than 1 (3.661), explaining a substantial proportion of the variance (61.0%) and demonstrating good reliability ($\alpha = 0.87$).

4.3 | Control Variables

We controlled for several demographic factors, similar to the existing literature. For example, Aliasghar and Haar (2021) reported that older firms were more likely to be innovative and perform better. Hence, we controlled for firm age (1 = 7 years or less, 2 = 8 to 13 years, 3 = 14 to 19 years, 4 = 20 to 30 years, 5 = 31 to 50 years, 6 = over 50 years). Similarly, previous scholars (Hsieh et al. 2018; Spithoven and Teirlinck 2015) argue that sector differences may influence investment decisions, including public sector firms being more likely to invest heavily aligned with government policy (Aliasghar et al. 2019); thus, we also controlled for the private sector (1 = yes, 0 = no). We followed previous studies (Yacoub et al. 2020) and measured formal appropriability (four items, $\alpha = 0.66$) and informal appropriability (four items, $\alpha = 0.66$). Finally, in their meta-analysis, Carney et al. (2015) highlighted unique yet beneficial factors for family firms; thus, we also controlled for family firm status (1 = yes, 0 = no).

4.4 | Measurement Models

We used confirmatory factor analysis (CFA) in structural equation modeling with AMOS (v. 26) to validate the study constructs. To evaluate the model fit, we followed expert recommendations (e.g., Hu and Bentler 1998; Williams et al. 2009) and used three goodness-of-fit indices: (1) comparative fit index ($CFI \geq 0.90$), (2) root mean square error of approximation ($RMSEA \leq 0.08$), and (3) standardized root mean square residual ($SRMR \leq 0.10$). The proposed measurement model demonstrated good fit to the data, with $\chi^2(df) = 492.0 (238)$, $CFI = 0.94$, $RMSEA = 0.05$, and $SRMR = 0.04$. We tested a number of alternative CFA models, including combining outbound with inbound OI and combining formal and informal appropriability. All other CFAs tested were found to have a considerably worse fit to the data, with a significance level of less than 0.001 (Hair et al. 2010).

4.5 | Common Method Bias

To address potential CMB concerns, our research design incorporated both procedural and statistical remedies. Regarding procedural remedies, we implemented the three-step process recommended by Podsakoff et al. (2003). First, we developed clear research measures through a systematic process and expert consultation, ensuring clarity and eliminating ambiguity. Second, we strategically organized the survey instrument by placing items related to dependent and explanatory variables in separate sections. This procedural remedy was implemented to minimize the risk of bias introduced through a single method. Third, our commitment to anonymity in data collection aligned

TABLE 3 | Construct details.

Items, reliability and validity details	Factor loading	α
Outbound open innovation (CR = 0.89, AVE = 0.63)		
“Our firm often sells licenses, such as patents, copyrights, or trademarks, to other firms so as to better benefit from our innovation efforts”	0.83	0.85
“Our firm founds spin-offs to better benefit from our innovation efforts”	0.81	
“We make it a formal practice to sell technological knowledge and intellectual property in the market”	0.79	
“We have a dedicated unit (i.e., gatekeepers, promoters) to commercialize knowledge assets (e.g., selling, cross-licensing patents, or spin-off)”	0.76	
“We co-exploit technology with external organizations frequently”	0.77	
Inbound open innovation (CR = 0.90, AVE = 0.71)		
“We often acquire technological knowledge from outside for our use”	0.84	0.86
“We regularly search for external ideas that may create value for us”	0.83	
“We proactively reach out to external parties for better technological knowledge or products”	0.86	
“We tend to build greater ties with external parties and rely on their innovation”	0.83	
Formal appropriability (CR = 0.80, AVE = 0.50)		
“Patent”	0.69	0.66
“Design registration”	0.74	
“Copyright”	0.73	
“Trademarks”	0.66	
Informal appropriability (CR = 0.80, AVE = 0.50)		
“lead time advantage”	0.68	0.66
“complexity of goods or services”	0.74	
“secrecy (include non-disclosure agreements)”	0.72	
“long-term collaboration contracts”	0.68	

with the procedural remedy recommendation, assuring respondents of the confidential nature of their contributions. In addition, the extensive pilot study undertaken played a pivotal role in substantiating the effectiveness of our procedural remedies. By ensuring that there was no ambiguity in the questionnaire items, we aimed to enhance the accuracy and reliability of our data collection process.

Regarding statistical remedies, we followed the recommendation from Podsakoff et al. (2003) and conducted Harman's one-factor test as a rudimentary test of CMB. This unrotated factor analysis produced a number of factors, with the largest accounting for 25.0% of the variance, well below the 50% threshold indicating CMB. We also tested for a moderation effect because Evans (1985) found CMB issues were rare in the presence of significant moderation effects. Subsequently, following Lindell et al. (2001), we proceeded to perform a partial correlation, taking into account the influence of an unrelated construct. This specific test serves the purpose of detecting CMB by examining whether the correlation strength undergoes any changes when an additional variable, unrelated to the main constructs, is introduced and controlled for in the analysis. Finally, Haar

et al. (2014) argued that confirming constructs (through CFA) and, importantly, alternative combinations (other CFA combinations) also enhance confidence and reduce CMB issues.

5 | Analysis

Ordinary least squares (OLS) regression was employed to test the hypotheses. In Step 1, control variables were included, and the three sets of factors that were our focus were entered in separate steps. Step 2 was the internal capabilities of the firm (R&D intensity), and Step 3 was the firm openness factors (inbound OI and geographical breadth). Given that we also hypothesized a potential interaction between these two factors, we used the centering procedure (z-scores) by Aiken et al. (1991) and included the interaction term in this step. We adhered to the guidelines presented by Cohen et al. (2013) and obtained the regression coefficients for the control effects from the first step, and the three sets of factors (internal capabilities, inbound OI, and geographical breadth) were captured from each step. We conducted analyses three times: (1) using the data from the whole sample, (2) for small and medium-sized enterprises (SMEs) only, and (3)

TABLE 4 | Correlations and descriptive statistics of study variables.

Variables	Mean	SD	1	2	3	4	5	6	7
1. Firm age	3.05	1.42	—						
2. R&D intensity	6.40	1.93	-0.29**	—					
3. Inbound OI	5.19	1.24	-0.19**	0.29**	—				
4. Geographical breadth	1.91	0.95	-0.10*	0.15**	0.22**	—			
5. Formal appropriability	2.20	0.56	-0.02	0.14**	0.32**	0.14**	—		
6. Informal appropriability	2.17	0.58	-0.03	0.19**	0.33**	0.15**	0.71**	—	
7. Outbound OI	5.00	1.20	-0.17**	0.25**	0.70**	0.20**	0.35**	0.34**	—

Note: † $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

for large-sized firms only. Finally, we reported the mean scores for each of the individual aspects within the appropriation strategies. We conducted paired-sample t -tests on each appropriation strategy approach to determine whether any were significantly different.

6 | Results

A descriptive statistic for each study variable is presented in Table 4. Table 4 indicates that outbound OI significantly correlated with all variables (all $p < 0.01$), while R&D intensity, inbound OI, geographical breadth, formal appropriability, and informal appropriability all significantly correlated with each other (all $p < 0.01$). Table 3 also shows the average variance extracted (AVE) scores, with the constructs having excellent composite reliability and accounting for more explained than unexplained variance, achieving convergent validity (Fornell and Larcker 1981).

Results of the regression model are presented in Table 5. Table 5 indicates that R&D intensity is significantly related to outbound OI ($\beta = 0.25$ [0.06], $p < 0.001$) and the analysis by firm size indicates this effect was significant in large-sized firms ($\beta = 0.32$ [0.07], $p < 0.001$), yet not for SMEs ($\beta = 0.03$ [0.09], $p > 0.05$). This supported Hypothesis 1. Inbound OI is also significantly related to outbound OI ($\beta = 0.80$ [0.04], $p < 0.001$) and this was consistent across SMEs ($\beta = 0.66$ [0.09], $p < 0.001$) and large-sized firms ($\beta = 0.81$ [0.05], $p < 0.001$). Next, geographical breadth was not directly related to outbound OI, including for SMEs and large-sized firms (all $p > 0.05$), and there were no significant interaction effects between geographical breadth and inbound OI toward outbound OI in the combined sample ($p > 0.05$). However, when comparing the analysis by firm size, significant interactions were found. Geographical breadth and inbound OI significantly interacted toward outbound OI for SMEs ($\beta = -0.25$ [0.09], $p < 0.01$) and large-sized firms ($\beta = 0.11$ [0.05], $p < 0.05$).

Concerning our control variables, particularly appropriation strategies, we received mixed support, with formal appropriability being significantly related to outbound OI in the total sample ($\beta = 0.26$ [0.10], $p < 0.01$) and in SMEs ($\beta = 0.40$ [0.18], $p < 0.05$). Interestingly, while formal appropriability was not significantly related to outbound OI in large-sized firms ($p > 0.05$), informal appropriability was ($\beta = 0.24$ [0.12], $p < 0.05$). Regarding

significant control variables, in the total sample, this included firm age ($\beta = -0.12$ [0.04], $p < 0.01$) and part of a group ($\beta = -0.61$ [0.16], $p < 0.001$), while none were significant in the SME sample. In the large-sized firm sample, significant control variables included family firm ($\beta = -0.29$ [0.13], $p < 0.05$), part of a group ($\beta = -0.53$ [0.20], $p < 0.01$), and private sector ($\beta = 0.29$ [0.13], $p < 0.05$). Overall, the combined data accounted for a very robust 52% of the variance, with a slightly higher amount in large-sized firms (53%) compared with SMEs (47%). The significant interaction effects are shown in Figures 1 and 2.

Figure 1 shows that, in SMEs, those with low levels of inbound OI reported significantly different levels of outbound OI, with firms with low levels of geographical breadth reporting the lowest levels, and firms with high levels of geographical breadth reporting significantly higher levels of outbound OI. When we examined SMEs with high levels of inbound OI, they all reported superior outbound OI. However, the effects were reversed, with SMEs reporting the highest outbound OI when they had low-level geographical breadth, not high-level geographical breadth.

Figure 2 shows the interaction effects in large-sized firms, and these are almost the reverse of the SMEs. Large-sized firms with low levels of inbound OI reported low levels of outbound OI, but firms with high levels of geographical breadth reported the lowest levels, while those with low geographical breadth reported significantly higher levels of outbound OI. However, at high levels of inbound OI, all large-sized firms reported significantly higher outbound OI, although this differed slightly by geographical breadth. Here, the effects were reversed, with those with high geographical breadth reporting slightly higher levels of outbound OI. Finally, we explored appropriability strategy approaches in Table 6.

Table 6 shows the various appropriability strategy approaches for the entire sample, and by SMEs and large-sized firms. Comparing mean scores showed that patents were the highest formal appropriability strategy undertaken across all samples, including SMEs and large-sized firms. Further, paired-sample t -tests showed that patents were significantly higher than all other formal appropriability strategies (i.e., design registration, copyright, and trademarks). The findings were less uniform regarding informal appropriability strategies. In the entire sample, while secrecy was the most frequent strategy, this strategy was not significantly higher than the other forms of informal

TABLE 5 | Results of regression analyses (comparing SMEs vs. large-sized firms).

Variables	Outbound OI		
	Total sample <i>B</i> (SE)	SME firms <i>B</i> (SE)	Large-sized firms <i>B</i> (SE)
Controls			
Family firm	-0.18 (0.11)	-0.10 (0.21)	-0.29 (0.12)*
Firm age	-0.12 (0.04)**	-0.07 (0.07)	0.07 (0.05)
Part of a group	-0.61 (0.16)***	-0.34 (0.27)	-0.53 (0.20)**
Private sector	0.21 (0.11)	-0.21 (0.21)	0.29 (0.13)*
R ² change	0.07***	0.03	0.06***
Appropriation strategies			
Formal appropriability	0.26 (0.10)**	0.40 (0.18)*	0.10 (0.12)
Informal appropriability	0.05 (0.10)	-0.10 (0.16)	0.24 (0.12)*
R ² change	0.02**	0.02***	0.02**
Internal capability			
R&D intensity	0.25 (0.06)***	0.03 (0.09)	0.32 (0.07)***
R ² change	0.04***	0.00	0.06***
Firm openness			
Inbound OI	0.80 (0.04)***	0.66 (0.09)***	0.81 (0.05)***
Geographical breadth	0.04 (0.04)	0.03 (0.09)	-0.06 (0.05)
Inbound OI × geographical breadth	-0.01 (0.04)	-0.25 (0.09)**	0.11 (0.05)*
R ² change	0.40***	0.42***	0.39***
Total R ²	0.52	0.47	0.53
F statistic	49.380***	12.335***	34.885***

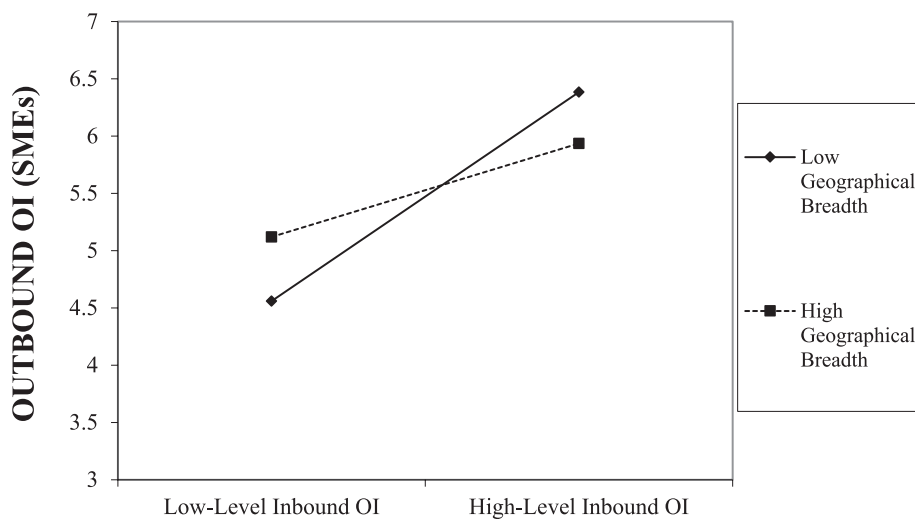
Note: Unstandardized coefficients. All tests are 2-tailed.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

**** $p < 0.1$.

**FIGURE 1** | Interaction between inbound OI and geographical breadth to outbound OI in SMEs.

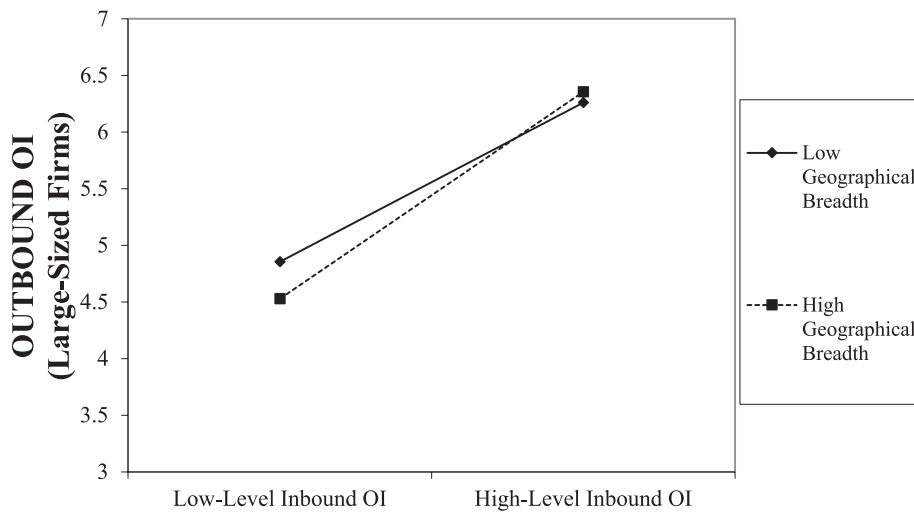


FIGURE 2 | Interaction between inbound OI and geographical breadth to outbound OI in large-sized firms.

TABLE 6 | Results of appropriation strategy approaches.

Type	Total sample	SME firms	Large-sized firms
Formal appropriability			
Patent	2.38^a	2.28^a	2.43^a
Design registration	2.10	2.04	2.13
Copyright	2.17	2.07	2.22
Trademarks	2.12	2.15	2.11
Informal appropriability			
Lead time advantage	2.16	2.13	2.18
Complexity of goods or services	2.16	2.07	2.20
Secrecy (include non-disclosure agreements)	2.21^b	2.11	2.25^c
Long-term collaboration contracts	2.13	2.15^b	2.13

Note: Scoring: 0 = not used, 1 = low use, 2 = medium use, 3 = high use. Highest mean scores are bolded.

^aSignificantly higher mean score than all other formal appropriability approaches [total sample, SMEs, and large-sized firms only].

^bNon-significant higher mean score than all other informal appropriability approaches [total sample and SMEs].

^cSignificant higher mean score than the informal appropriability approach long-term collaboration contracts only [large-sized firms only].

appropriability strategies (i.e., lead time advantage, complexity of goods/services, or long-term collaboration contracts). In large-sized firms, secrecy was the main informal appropriability strategy, and this was significantly higher than using long-term collaboration contracts only. In SMEs, a long-term collaboration contract was the most popular informal appropriability strategy, although this was not significantly different from the other strategies. Finally, when we compared appropriability strategies

between SMEs and large-sized firms, no significant differences were found across seven of the strategies, with only patents being significantly higher ($t=2.141$, $p=0.033$) in large-sized firms ($M=2.43$) than in SMEs ($M=2.28$).

7 | Conclusion and Implications

We examined the effects of internal and external sources of knowledge on outbound OI. While previous studies have explored the outbound OI concept (Tece 1986, 2006), they primarily focused on its outcomes, neglecting the firm-level factors that drive firms to actively commercialize knowledge externally. This study addressed this gap by examining the drivers of outbound OI through the lens of two key, yet underexplored, determinants: in-house R&D and inbound OI. Integrating insights from both the OI literature and KBV, we conducted an empirical investigation to understand how these factors influence a firm's decision to engage in outbound OI.

Regarding R&D intensity, our results suggest that in-house R&D is positively associated with outbound OI for larger firms. Larger firms typically allocate substantial budgets to R&D, allowing them to explore a range of potential innovations that can be transferred externally. Smaller firms, on the other hand, often focus on a narrower set of innovations, which limits the number of outbound OI opportunities they can pursue (Vanhaverbeke 2017). Since outbound OI depends on having a wide array of innovations suitable for licensing, technology transfer, or external collaborations, smaller firms are at a disadvantage when they lack the depth and breadth of a diversified innovation portfolio (Hu et al. 2015).

Instead of generating a wide range of new innovations internally, smaller firms are more likely to integrate external technologies that they can then commercialize. Prior research indicates that SMEs tend to favor market-driven strategies over research-driven approaches, placing significant reliance on non-R&D-based innovation activities (Barge-Gil et al. 2011; Hervas-Oliver et al. 2011; Hervás-Oliver et al. 2021; Santamaría et al. 2009).

Similarly, Rammer et al. (2009) highlighted that undertaking in-house R&D activities poses considerable challenges for the majority of SMEs, given the elevated risk exposure, substantial fixed costs, demanding minimum investment prerequisites, and severe financial constraints.

The second set of determinants examines the role of a firm's openness, particularly the role of inbound OI on outbound OI. Inbound OI plays a crucial role in reducing R&D risks by providing access to technologies that are often at more advanced stages of development and have demonstrated proven performance (Atuahene-Gima 1993; Zhang et al. 2024). A technology portfolio with lower uncertainty makes it easier to pursue outbound OI activities, particularly for SMEs. This is crucial given the inherent uncertainty surrounding the value of technology—being intangible, highly specific, and largely tacit—represents a significant barrier to effective technology transfer and the development of robust markets for innovation (Arora and Gambardella 2010). In this context, inbound OI not only strengthens a firm's technological capabilities but also creates a foundation for successfully commercializing and exchanging innovations externally.

Another potential explanation is that the market for knowledge is often imperfect and characterized by asymmetric information (Lichtenthaler and Lichtenthaler 2010). These market imperfections can make it difficult for firms to exchange knowledge. As firms engage in inbound OI, they gradually accumulate valuable market insights and expertise, which serve as a critical foundation for outbound OI activities. As these firms accumulate experience in sourcing and absorbing external knowledge, their ability to navigate the complexities of the knowledge market improves, leading to a reduction in transaction costs (Cassiman and Valentini 2016). Therefore, by investing in inbound OI, firms build the experience and confidence needed to engage in outbound OI. This process reduces the risks associated with commercialization, making it easier for firms to transfer their innovations to external markets.

In addition, inbound OI offers firms a strategic advantage by accelerating the innovation timeline, allowing them to bypass redundant R&D activities and direct internal resources toward more complex, high-value innovation challenges (Leone and Reichstein 2012; Markman et al. 2005). This rapid innovation process is increasingly critical in today's technology-driven environment, where the value of knowledge assets can diminish quickly, often within a few years (Ahuja and Katila 2001). Inbound OI helps mitigate the erosion of technology value, enabling firms to sustain the relevance and appeal of their technology portfolios for potential external partners.

Regarding the OI literature, this paper thus provides a comprehensive view of the OI concept, combining inbound and outbound perspectives. While this view has been frequently studied in theoretical OI research, it has rarely been empirically examined (with a few exceptions, e.g., Sikimic et al. (2016)), and studies have mainly focused on inbound OI (Laursen and Salter 2006) or outbound OI (Cheah and Yuen-Ping 2021). Our findings of the positive association between inbound and outbound OI suggest that it is necessary to monitor both inbound and outbound OI processes together, and thus offer empirical evidence for coupled

OI processes, which were introduced by Enkel et al. (2009), yet inadequately examined. This further addresses the earlier call to explore diverse innovation strategies within the context of outbound OI (Hervas-Oliver et al. 2021a; Santamaría et al. 2009). This study also adds insights to the growing literature on the market for technology (Natalicchio et al. 2014).

Regarding the relationship between geographic breadth and outbound OI, collaborating with international partners across different countries increases the likelihood of outbound OI activities for bigger firms than for smaller firms. Larger firms tend to have more extensive resources, which enable them to establish dedicated teams or specialized units focused on managing international collaborations. These teams are specialized in selecting partners, managing technology transfer, and overseeing contracts, with proficiency in both technical and legal aspects, such as intellectual property valuation and negotiations, which increase the likelihood of successful outbound OI activities (Lichtenthaler and Lichtenthaler 2009).

The opposite is true for SMEs and confirms the empirical strength of the present study. When examined together, there is no evidence of a significant interaction effect between inbound OI and geographical breadth. This is because the effects are in opposite directions for SMEs compared with large-sized firms. Splitting the analysis uncovered this finding and should encourage greater exploration of firm size. Previous studies have noted that “managing broad and heterogeneous sources of knowledge requires a more substantial share of managerial time and attention” (Aliasghar et al. 2020), which may not occur in SMEs. Given their constrained resources, SMEs must carefully prioritize and optimize their managerial efforts to extract maximum value from the myriad external knowledge inputs involved in outbound OI. This implies that SMEs must be selective when it comes to collaborating with partners, especially those beyond their national boundaries (Hervas-Oliver et al. 2011; Hervás-Oliver et al. 2021).

Regarding our control variables—particularly formal and informal appropriation strategies—we found interesting evidence. We found that SME managers should focus on formal mechanisms to protect their knowledge and successfully commercialize their technology, while larger organizations should focus on informal means to stimulate outbound OI. A possible reason for this is that smaller companies may use patents as a way to signal their potential to investors, even before the patented technology is turned into a commercial product (Blind et al. 2006). This approach can help SMEs, especially high-tech startups, attract investment more effectively (Dosi et al. 2006; Hall and MacGarvie 2010). The resulting reduction in capital costs might offset or even surpass the expenses incurred from patenting.

Another reason could be context specific. SMEs in NZ are often more reliant on international markets for growth, and in this context, patents and formal contracts are essential tools to protect their intellectual property in foreign markets (Elman and Zhang 2020; Grossman and Lai 2004). Additionally, patents can enhance an SME's bargaining power when negotiating licensing agreements or joint ventures, providing valuable opportunities for revenue generation through the commercialization of intellectual property

(Blind et al. 2006). For SMEs, leveraging patents in such negotiations is particularly important due to their limited resources and market presence (Gimenez-Fernandez et al. 2020).

Whereas, large firms often rely less on patents because their substantial marketing power enables them to gain lead-time advantages, allowing them to stay ahead of competitors without the need for formal protections (Cohen and Klepper 1992). Additionally, the size of their markets provides greater financial returns from investments in process innovations, making the costs and complexities of patenting less appealing (Arundel 2001). Hence, informal strategies enable firms to protect innovations without the time, cost, and complexity of patenting, which are particularly important in fast-moving markets where speed and confidentiality are crucial. Furthermore, the scale of these firms allows them to leverage their market power and brand reputation, which act as an informal barrier to imitation (Cohen and Klepper 1992).

7.1 | Implications for Managers and Policymakers

Regarding managerial implications, our study shows that firms should view outbound OI as a valuable opportunity that can complement their internal knowledge exploitation efforts (Gambardella et al. 2007). Interestingly, outbound OI is a necessity, rather than an option, to gain competitive advantage. However, managers must ensure that outbound OI is not viewed as a standalone task—it cannot be accomplished in isolation and is not a binary decision. Rather, managers must devote attention to both external and internal factors, which makes it a multifaceted concept. In other words, our findings suggest that external knowledge acquisition and IP protections are contingent factors to which managers must devote full attention before undertaking a high level of outbound OI activities.

In addition, our study shows that inbound and outbound OI have a complementary role. Balanced development of external exploration and external exploitation processes may offer the firm a competitive advantage through developing systematic processes to benefit more from its OI activities. It may also be difficult for a firm's competitors to copy two complementary approaches.

7.2 | Limitations and Future Study

Some limitations of this research are worth mentioning. First, this study was limited to firms operating in NZ. While the findings of this research can be employed in other nations, such as Denmark, Australia, and Singapore (Aliasghar and Haar 2021; Chetty et al. 2014), further research is strongly encouraged in other geographical contexts, particularly in firms operating in emerging economies. Second, it would be interesting for future research to focus on other contextual factors, such as organizational culture and leadership (Chesbrough and Garman 2009). Third, longitudinal research may enhance understanding of the sequential effects of employing inbound OI strategies on knowledge outflow. Finally, the type of newly acquired knowledge—such as novelty, radicalness, and relatedness to the firm's knowledge base—may affect the relationship between knowledge inflow and knowledge outflow.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Endnotes

¹“We are grateful to an anonymous referee for making this point.”

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