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Liability of foreignness in immersive technologies: evidence from extended reality innovations

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Abstract

Emerging extended reality (XR) technologies, such as augmented reality (AR) and virtual reality (VR), enable global businesses to deliver immersive experiences to customers beyond geographical borders. Despite the opportunities, leveraging XR innovations in foreign markets can present significant challenges. This study investigates whether and under what conditions global businesses experience liability of foreignness (LOF) when leveraging XR innovations. We argue that LOF in XR innovations arises from the inherent disadvantages foreign firms face in delivering mentally fluent XR experiences, which in turn can diminish the effectiveness of their XR innovations compared to local counterparts. We further contend that the extent of LOF in XR innovations varies depending on the features of XR technology, with greater LOF in less realistic, more interactive, and more vivid XR innovations. We also suggest that foreign businesses can mitigate LOF by strategically leveraging brand newness and brand platforms. Our empirical analyses, based on a dataset of 257 beauty brands in South Korea from 2019 to 2022, support the presence of LOF in XR innovations and show how technology features and brand-specific factors influence the extent of LOF. Our findings provide valuable insights for global businesses developing strategies to configure immersive technologies in international markets.

Keywords Augmented reality (AR) · Virtual reality (VR) · Extended reality (XR) · Liability of foreignness (LOF) · Immersive technology configuration · Brand platform

Introduction

Emerging technologies such as augmented reality (AR) and virtual reality (VR) have enabled global businesses to deliver novel, immersive experiences to customers beyond geographical borders (Kumar, 2018; Meyer et al., 2023). We use *extended reality* (XR) technologies as an umbrella term to encompass a variety of AR and VR technologies. XR technology-driven innovations (*XR innovations* hereafter) allow customers to experience products or services in highly interactive and personalized virtual environments (Gonzalez, 2021). For example, the IKEA Place app visualizes how furniture will look in homes; Bobbi Brown's virtual make-up app allows users to virtually try different shades of cosmetics; and virtual stores on metaverse platforms allows users to explore products and interact with brands in a fully digital environment (see examples in Web Appendix A). The global XR market is rapidly growing. In 2021, it reached US $28 billion and by 2028 it is expected to reach over US $250 billion (Alsop, 2022).

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Despite the opportunities XR innovations offer to global businesses, delivering compelling XR experiences in foreign markets can be challenging. Cultural contexts significantly influence how individuals interact with technologies (de Bellis et al.,2019; Nam & Kannan, 2020; Reinecke & Bernstein, 2013) and thus customers in the host country are likely to interact with XR technologies differently from those in the home country. This systematic difference poses significant challenges for multinational firms aiming to offer effective XR experiences in foreign markets. We refer to the distinct challenges and disadvantages multinational firms face when leveraging XR innovations in an overseas market as *liability of foreignness (LOF) in XR innovations* (cf. Zaheer, 1995) and examine *whether* and *when* multinational firms bear LOF in XR innovations.

Given the widespread popularity of XR innovations among global businesses, it is crucial to understand the challenges posed by foreignness in XR innovations and to recognize their contextual nuances. Nonetheless, there has been limited scholarly attention to LOF in XR innovations thus far. Prior studies on LOF in traditional market contexts (e.g., Mata & Freitas, 2012; Wu & Salomon, 2016; Zaheer & Mosakowski, 1997) may not fully explain LOF in XR innovations which deliver immersive, interactive, and sensory-rich virtual experiences. The emerging literature on LOF in the digital domain presents divergent and nuanced perspectives (Bei & Gielens, 2020; Chen et al., 2019a; Kumar et al., 2023). Moreover, it remains unclear to what extent previous findings from other digital domains apply to XR, considering the unique immersive and interactive nature of XR technologies compared to other media (Harz et al., 2022).

Addressing this gap, we conceptualize LOF in XR innovations drawing upon cognitive fluency theory (Schwarz, 2004). We argue that LOF in XR innovations arises from foreign firms' inherent disadvantages in delivering mentally fluent XR experiences. *Mental fluency*, denoting how easily individuals visualize the experience with products or brands, is critical in delivering effective XR experiences (Heller et al., 2019). Foreign firms, which often lack a good understanding of host-country customers and their culture, face disadvantages in achieving mental fluency, making their XR innovations less effective compared to those of local firms. We then identify technology- and brand-specific factors that influence the extent of LOF. We argue that LOF is more pronounced in XR innovations that simulate less realistic, more interactive, and more vivid experiences, where cultural contexts play a greater role in shaping mental fluency. Additionally, we contend that foreign firms can mitigate LOF by leveraging newness and host-country-specific marketing assets acquired through brand platforms.

We empirically test our hypotheses using data on XR innovation deployment of 257 beauty brands operating in South Korea from 2019 to 2022. To assess the extent of LOF in XR innovations, we compare the effectiveness of XR innovations in enhancing brand engagement for foreign versus local brands, employing 375,477 brand–day–level observations of brand buzz.[1] Our findings confirm the presence of LOF in XR innovations and support the hypothesized contingent effects of LOF based on technology- and brand-specific factors.

Our research contributes to the international business (IB) literature and the multidisciplinary literature on immersive technologies. *First*, our work broadens the understanding of LOF in the novel context of emerging technologies by theoretically conceptualizing and empirically examining whether and when global businesses experience LOF in leveraging XR innovations, considering both technological features and brand-specific contexts. *Second*, our research enriches the understanding of international configurations of technologies by showing that LOF varies across different technology contexts. Specifically, we propose how foreign and local businesses should configure XR technologies differently and how foreign brands can adapt XR technologies based on brand tenure and host-country-specific marketing assets. *Lastly*, our work contributes to the broader multidisciplinary literature on immersive technologies by showing that foreignness can introduce systematic biases in the outcomes of XR innovations, underscoring the importance of integrating an international perspective into research on immersive technologies.

Theoretical background

XR innovations

XR innovations have transformed the retail industry by enabling interactive and immersive customer experiences in virtual environments. For example, virtual try-ons like IKEA Place and Maybelline's virtual make-up apps help customers visualize what the products will look like on them in an augmented environment (see Web Appendix A.1). Metaverse platforms like Roblox and Zepeto offer virtual worlds where customers can browse products and interact with brands (see Web Appendix A.2). Compared to traditional digital media, XR innovations provide highly interactive and sensory-rich experiences, resulting in more intense and enduring shopping experiences (Harz et al., 2022; Heller et al., 2019). Interactions with XR enhance cognitive, emotional, and social dimensions of the customer experience and therefore drive engagement, word of mouth, and sales (Harz et al., 2022; Hilken et al., 2022; Tan et al., 2022; Yan et al., 2024).

[1] We assess the impact of XR innovations by measuring the increase in brand engagement, using the volume of brand buzz to capture the intensity of customer participation in content creation and sharing.

Despite the potential offered by XR innovations, not all firms successfully leverage XR innovations. XR experiences involve complicated cognitive processes that stimulate the visualization of product images or consumption experiences, and thus achieving *mental fluency*, which refers to how easily customers imagine images of products and consumption experiences, plays a pivotal role in delivering effective XR experiences (Heller et al., 2019; Wedel et al., 2020). Highly fluent XR experiences enhance user satisfaction, enrich overall user experience, boost brand engagement, and ultimately drive sales; however, less fluent XR experiences can lead to discomfort with the interface and diminished immersion, and consequently reduce brand engagement and purchase intentions (Heller et al., 2019; Hilken et al., 2022). In this paper, we question whether this unique nature of XR innovations presents distinct challenges for foreign firms compared to their local counterparts and how foreign firms can effectively configure XR innovations for international markets.

LOF in conventional and digital contexts

The theory of LOF suggests that multinational firms face disadvantages, relative to their domestic counterparts, in doing business in overseas markets (Zaheer, 1995). These disadvantages stem from various sources, including increased transaction costs due to geographical boundaries and unfamiliarity with the host country's institutional environment (see Lu et al., 2022 for a detailed review). According to institutional theory, LOF primarily arises from unfamiliarity with the host country's multifaceted institutional environment, including its socio-cultural, regulatory, political, and economic dimensions, which may result in less tailored products or communications that are less appealing to local consumers (Denk et al., 2012; Eden & Miller, 2004; Zaheer, 2002). While extensive prior research examines LOF in traditional contexts, such as product markets, offline retail businesses, and banking (e.g., Maruyama & Wu, 2015; Mata & Freitas, 2012; Wu & Salomon, 2016; Zaheer & Mosakowski, 1997), these studies may not fully explain LOF in the digital domain (Lu et al., 2022).

Recently, scholars have begun to investigate LOF in the context of digital platforms and related business models. While the prevailing view is that digital platform technologies can mitigate LOF by enhancing user connectivity and dampening location-specific advantages in international markets (Brouthers et al., 2016; Chen & Kamal, 2016; Kumar, 2018; Steenkamp, 2020), recent studies document mixed empirical findings. Bei and Gielens (2020) suggest that platform technologies can mitigate LOF by showing that online marketplace adoptions generate significant market value for both foreign and local manufacturers, regardless of their origin. Conversely, other research suggests that foreign liabilities may persist in digital contexts. For instance, Chen et al. (2019a) show that i-businesses face challenges in foreign markets due to liabilities of outsidership arising from bounded international network effects. Kumar et al. (2023) show that even in unblind crowdsourcing contests, where information asymmetry is significantly diminished, LOF persists due to cognitive biases rooted in cultural differences. These nuanced findings suggest that LOF in digital contexts may have intricate layers, underscoring the need to clarify the contextual drivers of liabilities of foreignness.

Our research differs from prior LOF literature in two ways. First, our research context differs from traditional market contexts, where firms primarily sell *tangible products* and rely on *one-way, firm-driven communication*. In contrast, XR innovations deliver *intangible experiences* and foster *instantaneous two-way interactions*, presenting a novel context for examining technology-driven challenges faced by foreign businesses (Lu et al., 2022; Meyer et al., 2023). Second, our research context differs from other digital domains. Unlike conventional platforms, XR technologies enable dynamic, sensory-rich interactions that adjust instantaneously based on user input, posing distinct challenges for foreign firms and setting LOF in XR apart from LOF in other digital domains. Therefore, we need a new study on LOF in XR innovations, grounded in a solid understanding of this novel technology.

International configurations of innovations

Scholars in marketing and information systems emphasize the importance of configuring technologies based on cultural backgrounds. Hofstede's framework of cultural dimensions (Hofstede, 1980) has been instrumental in analyzing cross-cultural differences in technology use. Cultural dimensions shape how users interact with technology, influencing its acceptance and effectiveness (Leidner & Kayworth, 2006; Nam & Kannan, 2020). Customers across cultures vary in preferences for website interface design such as information density, navigation, and colorfulness (Reinecke & Bernstein, 2013). Aligning information presentation with cultural cognitive styles—for instance, offering isolated product information for Western customers and contextualized information for Eastern customers—enhances user experience (de Bellis et al., 2019). Adjusting how virtual agents build relational distance based on cultural backgrounds improves user evaluations of virtual agents (Degens et al., 2014; Mascarenhas et al., 2016).

IB scholars have explored international configuration models of technology transfer. Rezk et al. (2016) present a framework that outlines multinational firms' international configuration options based on product architecture and knowledge flows in firms' value networks and demonstrate how emerging technologies affect these configuration options. Kim (2013) presents configurations of international

knowledge transfer for semiconductor firms based on firms' inherent knowledge characteristics and the geographic scope of knowledge sourcing. While prior studies provide valuable insights into the international configurations of technologies, research specifically addressing immersive technologies like XR remains limited. We aim to fill this gap by identifying strategies for the international deployment of XR technologies, considering both technology- and firm-specific factors.

Hypothesis development

In this section, we begin by discussing the question of whether LOF exists in XR innovations (H_1). We then discuss how LOF in XR innovations varies by technological features: realism (H_2), interactivity (H_3), and vividness (H_4). Within the brand context, we explore the contingent effects of brand newness (H_5) and brand platform orientation (H_6).

Liability of foreignness in XR innovations

The central focus of our investigation is whether LOF exists in XR innovations. Specifically, we examine whether foreign brands' XR innovations are less effective in enhancing brand engagement than those of local brands. To create compelling XR experiences that enhance brand engagement, it is essential to ensure that customers can effortlessly visualize product images and consumption experiences with high mental fluency (Heller et al., 2019; Hilken et al., 2022). Cognitive fluency theory suggests that mental fluency improves when communication channels align with individuals' cognitive processing styles (Schwarz, 2004). Given that cultural backgrounds significantly influence individuals' cognitive processing styles (Hofstede, 1980) and how they interact with technologies (Leidner & Kayworth, 2006; Nam & Kannan, 2020), adapting communication channels and interfaces to users' cultural contexts is crucial for achieving mental fluency. Culturally aligned user interfaces lead to higher user satisfaction, improved user experience, and increased sales (e.g., de Bellis et al., 2019; Reinecke & Bernstein, 2013).

Building on this logic, we propose that customers from different cultural backgrounds may pursue different verbal, visual, and multi-sensory interactions with XR technologies. As a result, XR experiences that are mentally fluent in one culture may not effectively translate to another. Given foreign firms' lack of familiarity with host-market customers and cultures (Denk et al., 2012; Eden & Miller, 2004; Zaheer, 1995), we argue that cultural differences in cognitive processing styles pose persistent challenges for foreign brands in delivering mentally fluent XR experiences to host-country customers. Consequently, these challenges can hinder foreign firms' ability to leverage XR innovations for brand engagement, compared to local firms that have a good understanding of the host-country's cultural context. Thus, we hypothesize:

Hypothesis 1 All else being equal, foreign brands, compared to local brands, are likely to have lower lift in brand engagement when utilizing XR innovations.

Contingent effects of technology context

Although foreign brands are likely to experience LOF in XR innovations due to a lack of cultural understanding, the disadvantages they face may vary across different types of XR innovations. In certain XR innovations, cultural alignment may become more important for achieving mental fluency, posing greater challenges for foreign brands in delivering effective XR experiences. We examine the contingent effects of XR technology context on LOF, focusing on three key elements: realism, interactivity, and vividness. We select these three factors because they are crucial in shaping mental fluency and fostering immersion with XR technologies (Harz et al., 2022; Yim et al., 2017). Moreover, they represent fundamental technological design features that firms consider. Thus, understanding how these elements interact with foreignness provides insight into the nuanced effects of LOF in XR innovations.

Realism of XR innovations

We propose that the extent of LOF in XR depends on the degree of realism of XR innovations. *Realism* refers to "the resemblance of the simulated environment of a real-world environment" (Harz et al., 2022). We conceptualize the realism of XR innovations as a design feature that determines how closely an XR experience resembles the real world. For instance, virtual stores that replicate real-world environments offer high-realism XR experiences, while imaginative virtual worlds on metaverse offer low-realism XR experiences. Scholars suggest that highly realistic XR experiences demand less cognitive effort for users to immerse in, making the experience feel more mentally effortless and plausible (Harz et al., 2022; Roggeveen et al., 2015). Conversely, a less realistic XR experience, which presumably relies on more imaginative content, may demand more cognitive resources to engage with.

We assert that foreign firms face greater disadvantages in low-realism XR than in high-realism XR. Cultural differences in cognitive processing styles significantly affect the outcomes of creative tasks (Kumar et al., 2023), particularly in less structured creative tasks compared to more structured tasks with specific guidelines (cf., Erez & Nouri, 2010). As such, low-realism XR, which allows firms greater flexibility in designing imaginative virtual worlds, may leave more room for cultural contexts to influence XR experiences than

high-realism XR, which is anchored in real-world imagery. Consequently, a thorough understanding of the host-country's culture becomes even more critical when delivering less realistic and more imaginative XR experiences. Therefore, we expect LOF to be greater for less realistic XR innovations compared to more realistic ones. Hence, we propose:

Hypothesis 2 All else being equal, foreign brands deploying more realistic XR innovations experience a lesser degree of LOF when utilizing XR innovations.

Interactivity of XR innovations

The extent of LOF foreign firms face may vary depending on the degree of interactivity of XR innovations. *Interactivity* is a multifaceted concept that encompasses the dynamics of two-way communication between users and computer-mediated environments (Steuer, 1992). Scholars define it based on technological design components, such as the speed of the mediated environment and the degree of user control (Hoffman & Novak, 1996; Steuer, 1992). We conceptualize the interactivity of XR innovations as a design feature that determines user interaction and control over the virtual environment. Interactivity ranges from low, with limited simulation scope and tracking, to high, with features like first-person perspective and 360-degree views enabled by extensive mapping and automated tracking. While higher interactivity of XR innovations tends to produce more effective user experiences (Harz et al., 2022; Yim et al., 2017), it does not always lead to more positive experiences, especially if not aligned with users' cognitive styles or task goals (Liu & Shrum, 2002).

We contend that foreign firms' challenges in delivering mentally fluent XR experiences are more pronounced in highly interactive XR innovations. Cultural backgrounds significantly influence how users interact with media and technologies, leading to diverse preferences for user interface design elements across cultures (Reinecke & Bernstein, 2013). Such cultural differences are particularly evident in interactive XR design elements like navigation style, interface controllability, and interactions with virtual agents (de Bellis et al., 2019; Degens et al., 2014; Mascarenhas et al., 2016; Reinecke & Bernstein, 2013). Highly interactive XR interfaces involve intricate coordination of various interactivity elements, increasing the potential for cultural misunderstandings to disrupt the delivery of mentally fluent experiences. As a result, the disparity in achieving mental fluency between local and foreign brands is likely to be more pronounced in highly interactive XR innovations. Therefore, we hypothesize that LOF in XR innovations, stemming from cultural differences in cognitive processing styles, is expected to be greater for highly interactive XR innovations than for those with lower interactivity. Thus, we propose:

Hypothesis 3 All else being equal, foreign brands deploying XR innovations with higher interactivity experience a greater degree of LOF when utilizing XR innovations.

Vividness of XR innovations

We propose that the extent of LOF in XR innovations can be contingent on the degree of vividness of XR innovations. *Vividness* denotes the extent to which information is concrete, visually stimulating, physically proximal, or emotionally appealing (Nisbett & Ross, 1980). In the context of XR innovations, vividness is defined as "the extent to which consumers feel that a simulation is lively and detailed" (Harz et al., 2022). The degree of vividness varies across XR innovations and is influenced by factors like image size, image resolution, sensory depth, and the extent to which images are concrete and detailed (e.g., Adaval et al., 2019; Keller & Block, 1997; Steuer, 1992). Vivid presentations are likely to capture attention and stimulate imaginary processes, enhancing persuasion and memory compared to less vivid presentations (Baddeley & Andrade, 2000; Nisbett & Ross, 1980). New product presentations in XR are perceived as more vivid than that those in traditional studio tests, enabling a more accurate assessment of the demand for new products (Harz et al., 2022).

Nonetheless, high vividness does not always result in positive experiences; its impact depends on the context. Vividness congruency, defined as "the extent to which the vivid elements of a message are congruent with the theme of the message," is a crucial moderator of the vividness effect (Smith & Shaffer, 2000). Presenting vivid imagery that does not align with the core message may require users to process peripheral or irrelevant images, demanding more cognitive effort and reducing motivation to engage with the information (Frey & Eagly, 1993). Expanding upon this rationale of vividness congruency, we argue that if XR interfaces do not align with customers' cultural cognitive processing styles, vividness may accentuate the visibility of culturally incongruent elements. As such, cultural misunderstandings may become more pronounced in highly vivid XR compared to less vivid XR, exacerbating LOF in highly vivid XR innovations. Therefore, we hypothesize:

Hypothesis 4 All else being equal, foreign brands deploying XR innovations with higher vividness experience a greater degree of LOF when utilizing XR innovations.

Contingent effects of brand context

Although foreign businesses face similar challenges in delivering mentally fluent XR experiences, not all are equally affected. Some can better mitigate LOF because their product characteristics align more closely with the nature and benefits of XR innovations. Additionally, certain businesses are more capable of alleviating LOF by leveraging the marketing assets they have developed in the host country (Miller & Eden, 2006; Zaheer, 1995; Zaheer & Mosakowski, 1997). Below, we discuss the contingent effects of brand context, focusing on brand newness and brand platform.

Brand newness

We posit that the extent of LOF in XR innovations may depend on brand or product characteristics. Specifically, we expect that LOF would be less pronounced when customers feel a greater need to resolve information uncertainty. Customers constantly encounter uncertainty, stemming from their inability to perfectly assess product quality (Dimoka et al., 2012) or the suitability of products for their specific needs (Bell et al., 2018). This uncertainty is particularly pronounced in online retail environments where customers can not physically examine products prior to purchase as they can in traditional retail settings (Bell et al., 2018; Dimoka et al., 2012). XR innovations emerge as effective tools for mitigating such uncertainty by providing sensory-rich and immersive experiences that enable virtual interactions with products as they would do in the physical world (Harz et al., 2022).

Nonetheless, the level of uncertainty customers face during the purchase process may vary depending on product characteristics (Bell et al., 2018; Castaño et al., 2008). Thus, brands or products that entail greater uncertainty may benefit more from XR innovations than those with lower uncertainty. For instance, a recent study by Tan et al. (2022) shows that the impact of augmented reality applications on sales is greater for products that entail higher information uncertainty such as less popular, niche, and high-priced products, and among customers who are unfamiliar with the retail channel or the product category. Building on this line of reasoning, we expect that customers will find XR experiences from newer foreign brands useful and satisfactory, even if the XR is less culturally aligned, due to their strong need to mitigate uncertainty. Therefore, we posit that LOF in XR innovations would be less pronounced for newer foreign brands compared to more established foreign brands. Thus, we hypothesize:

Hypothesis 5 All else being equal, newer foreign brands experience a lesser degree of LOF when utilizing XR innovations.

Brand platform orientation

Multinational firms can overcome LOF by building host country-specific marketing assets and skills (Miller & Eden, 2006; Zaheer, 1995; Zaheer & Mosakowski, 1997). We propose that brand platforms create new location-bound firm-specific advantages by enabling foreign brands to build direct customer relationships and access customer data without intermediaries in value chains (Steenkamp, 2020; Wichmann et al., 2022). Furthermore, we argue that the orientation of brand platforms influences the extent to which foreign brands can mitigate LOF. We identify two prominent types of brand platforms, each serving distinct objectives.[2] *Communication-centered platforms* focus on brand building through informational exchange by providing content such as product guidance and new product updates. In contrast, *transaction-centered platforms* focus on facilitating direct selling by offering deals and effective search functions. Both platforms collect, manage, and utilize customer interaction data, but cater to different levels of consumer goals. According to the theory on the hierarchy of consumer goals (Huffman et al., 2000; Pieters et al., 1995), communication-centered platforms address higher-level goals, such as enhancing brand knowledge and improving the self, while transaction-centered platforms fulfill lower-level consumer goals, such as finding product matches and deals (Huffman et al., 2000; Wichmann et al., 2022).

We expect that foreign brands utilizing communication-centered platforms can mitigate LOF in XR innovations more effectively than those utilizing transaction-centered platforms for two reasons. First, communication-centered platforms help foreign brands understand customers' higher-level goals related to personal values better than transaction-centered platforms (cf., Huffman et al., 2000; Wichmann et al., 2022), helping better mitigate LOF. Second, communication-centered platforms foster personal connections and emotional engagement, building attitudinal loyalty, unlike transaction-centered platforms that nurture transactional, instrumental loyalty (Perren & Kozinets, 2018; Wichmann et al., 2022). This attitudinal loyalty cultivated through communication-centered platforms can become intangible marketing assets that help foreign brands mitigate LOF (Miller & Eden, 2006; Zaheer, 1995; Zaheer & Mosakowski, 1997). Taken together, we expect that brands using communication-centered platforms, compared to brands using transaction-centered platforms, can gain deeper insights into host-market customers and foster greater attitudinal loyalty, thereby enhancing their capability to address LOF in XR innovations. This reasoning leads to the following hypothesis:

[2] While some exemplary brand flagship stores serve both objectives, most brands with limited resources prioritize one objective over the other (Arora et al., 2020).

Hypothesis 6 All else being equal, foreign brands with communication-centered platforms, compared to foreign brands with transaction-centered platforms, experience LOF to a lesser degree when utilizing XR innovations.

Methodology

Research context

We test our hypotheses in the context of the beauty industry in Korea for several reasons. First, the beauty industry presents an attractive context for studying the effects of XR innovations. During our data period, many firms in this industry increasingly adopted XR technologies to accelerate their digital transformation efforts. The adoption of XR technologies in the global beauty market is projected to grow at a compounded annual growth rate (CAGR) of 25.5% from 2022 to 2027 (Global Market Estimates, 2022). Such market trends allow us to observe the outcomes of various brands' XR innovations.

Second, Korea, one of the top ten largest beauty markets, accounted for 2.8% of the global market in 2019, with a market value of $9 billion and an annual growth rate of 4.3% (Korea Health Industry Development Institute, 2020). The country imported $1.6 billion in beauty products primarily from France, the U.S., and Japan. Korean consumers, known for being highly trend-conscious and eager to try new products, have played a significant role in shaping unique K-beauty trends and driving the global rise in the popularity of K-beauty products (Jobst, 2021). Over the past 10 years, the size and growth of the Korean beauty market have encouraged the entry of foreign brands.

Third, Korea is known for its tech-savvy population, boasting the highest smartphone ownership rate, broadband penetration, and fastest average Internet speed. As a result, global businesses often use Korea as a testing ground for emerging technologies (Chitrakorn, 2018), making it an ideal market to observe various XR innovations. However, despite its advanced technological infrastructure, the Korean market presents significant challenges for global digital service providers, largely due to language and cultural differences (Ramirez, 2017). Korean customers have a strong preference for domestic digital services over global platforms like Google. This unique context allows us to examine the challenges foreign businesses are likely to encounter when deploying XR innovations.

Data and measures

We compiled data from multiple sources: social media, XR deployment announcements, brand information, and macroeconomic data. Table 1 presents a list of the variables and their operationalization.

Sample

Our data consist of 257 beauty brands, which we judiciously sampled as follows. First, we identified all the beauty brands available in the ten major beauty retail stores in Korea.[3] Second, we selected brands from firms that own at least two brands in the beauty category.[4] Third, we selected brands that were in business during our data period (from January 1, 2019, to December 31, 2022).

Dependent variable

We define the dependent variable, $Brand\ Buzz_{it}$, as the volume of social media content generated for brand i on day t. Brand buzz, reflecting the intensity of customer participation in content creation and sharing, is an important component of brand equity that significantly drives brand awareness and sales (e.g., Babić Rosario et al., 2016; You et al., 2015). Brand buzz is particularly important for global brands to assess brand interest and sentiment in foreign markets (Katsikeas et al., 2020). We obtained the daily volume of brand buzz for each brand—a total of 375,477 brand-day observations—from a major social media analytics company in Korea.[5] The company provides a real-time social media tracking service by collecting and analyzing user-generated text data from various channels, including social media, blogs, news media, online communities, and discussion forums.

Foreignness

We define brand's foreignness, $Foreign_i$, as a binary variable by checking if the country of origin of a brand is local or foreign.[6] This leaves us with 113 foreign and 144 local brands.

[3] The ten major beauty retail stores include three offline department stores, four online sites linked to these department stores, and three drugstores operating both offline and online (Korea Health Industry Development Institute, 2017). Online open markets like eBay are excluded due to minimal entry barriers for beauty brands.

[4] Using multiple brands to cater to diverse beauty audiences is common practice in the beauty industry, helping create distinct brand positioning for different target markets. We excluded brands from firms that own only one brand in the beauty category due to their limited presence in the market.

[5] This company has provided services to over 2500 firms in Korea, including major multinational firms, government entities, and global research companies.

[6] Although we measure foreignness as a time-invariant binary variable based on a firm's country of origin, we acknowledge that foreignness can be defined at a firm-country pair level (Eden & Miller,

Table 1 Variable operationalization

Variables	Operationalization
Dependent variable	
Brand $Buzz_{it}$	The volume of brand buzz generated for brand *i* on day *t*
Key variables	
XR_{it}	Equals 1 if brand *i* utilizes XR innovations on day *t*, 0 otherwise
$Foreign_i$	Equals 1 if brand *i*'s origin is foreign, 0 otherwise
$Realism_i$	Degree of realism of XR innovations deployed by brand *i*[a]
$Interactivity_i$	Degree of interactivity of XR innovations deployed by brand *i*[a]
$Vividness_i$	Degree of vividness of XR innovations deployed by brand *i*[a]
Brand $Newness_{it}$	Log of number of years of operation since brand *i*'s Korean market entry on day *t*
Comm $Platform_i$	Equals 1 if brand *i* owns a communication-centered platform, 0 otherwise
Trans $Platform_i$	Equals 1 if brand *i* owns a transaction-centered platform, 0 otherwise
Control variables	
Previous week's brand $buzz_{it}$	Log of volume of brand *i*'s buzz for the past 7 days before day *t*
Scope of XR_i	Number of product categories in which brand *i* deployed XR innovations
Premium $brand_i$	Equals 1 if brand *i* is available at high-end department stores, 0 otherwise
Brand app_i	Equals 1 if brand *i* owns a brand app, 0 otherwise
Dual $channel_i$	Equals 1 if brand *i* is available on both online and offline retail channels, 0 if brand *i* is only available on online retail channels
KakaoTalk $followers_i$	Log of number of brand *i*'s followers on KakaoTalk
Instagram $followers_i$	Log of number of brand *i*'s followers on Instagram
Facebook $followers_i$	Log of number of brand *i*'s followers on Facebook
YouTube $followers_i$	Log of number of brand *i*'s followers on YouTube
Consumer price $index_t$	Weighted average price of consumer goods and services in the month of day *t*
Economic sentiment $index_t$	Composite measure of the Business Survey Index and the Consumer Trend Index in the month of day *t*
Employment $rate_t$	Proportion of the employed among the civilian noninstitutional population age 16 and older in the month of day *t*
Time $trend_t$	Daily time trend

[a]These variables are measured based on using a battery of items on a five-point interval scale. See Web Appendix B for detailed measurement scales for each variable

XR innovation deployment

We identified brands' XR innovation deployment by following the methodology of prior studies on innovation deployment announcements (e.g., Dotzel & Shankar, 2019). We searched all news articles on Naver, Korea's major news portal, using search terms such as "augmented reality", "virtual reality", "virtual try-on", "virtual make-up", "virtual store", and "virtual product" for each brand from 2019 to 2022.[7] After manually reviewing each news article to determine if it pertained to XR innovation deployment, we recorded the XR deployment date. We did not observe any gaps in announcement and deployment dates in our sample. Based on this protocol, we operationally define XR_{it} as a binary variable as 1 if brand *i* utilizes XR innovations on day *t*, and 0 otherwise.

Features of XR innovations

For each brand's XR application, we assessed the degree of realism, interactivity, and vividness using scales adapted from prior studies (Cho et al., 2014; Harz et al., 2022; Keller & Block, 1997; Yim et al., 2017). The detailed measurement scales are provided in Web Appendix B. We hired three coders and provided an extensive training session on the rating scales using test XR applications unrelated to our study. Each coder then interacted with every XR application in our dataset and independently rated 11 questions regarding the features of each application. Intercoder reliability, assessed based on the intraclass correlation coefficient (ICC) inter-rater agreement, yields a score of 0.752, indicating excellent agreement (Cicchetti, 1994; Shrout & Fleiss, 1979). After

Footnote 6 (continued)

2004) or as a continuous variable (Lu et al., 2022). Our robustness checks confirm that the findings are robust to alternative measures of foreignness using geographical and cultural distances (see Web Appendix D).

[7] The Naver news portal provides access to Korea's largest electronic database of news articles published from almost all media outlets.

confirming the reliability and validity of each measure (see Web Appendix B for more details), responses to the measurement items were averaged to form composite variables, *Realism*, *Interactivity*, and *Vividness*.

Brand newness

We also obtained brand tenure, the number of years of operation on day t since the brand i's market entry in Korea to define $Brand\ Newness_{it}$.

Brand platform orientation

We examined the use of brand platforms and identified if each platform was communication-centered or transaction-centered. We define $Comm\ Platform_i$ an indicator for brand i's use of a communication-centered platform, which focuses on informational exchanges between a brand and customers (e.g., brand news and product guidance), with limited commercial transaction functions. $Trans\ Platform_i$ is an indicator for brand i's use of a transaction-centered platform, which focuses on commercial exchanges (e.g., direct selling and promotions).[8]

Brand controls

We controlled for additional brand characteristics that could influence the volume of brand buzz. First, we included the previous week's volume of brand buzz to account for time-varying unobserved effects and reduce autocorrelation. Second, we controlled for the scope of XR innovations, measured by the number of product categories in which each brand implemented XR innovations. Third, we accounted for brand prestige by including an indicator for whether brands were carried by high-end department stores (Madzharov et al., 2015). Fourth, we accounted for the brand's digital presence, including whether the brand offers a mobile app and whether the brand has a dual-channel presence (i.e., available both online and offline) or is exclusively available online. Lastly, we controlled for the brand's social media presence by including the number of brand's followers on major social media channels: KakaoTalk, Instagram, Facebook, and YouTube.[9]

Macroeconomic controls

To account for potential macroeconomic influences on brand buzz, we obtained the consumer price index, the economic sentiment index, and the employment rate from the Korea Statistical Information Service (KOSIS). The consumer price index measures the average price of goods and services that households purchase for consumption, having an average of 100 in 2015. The economic sentiment index is a composite index of the Business Survey Index and the Consumer Survey Index to comprehensively understand the psychology of the private economy, including both businesses and consumers. Exceeding 100 indicates that the economic sentiment of the private sector is better than the long-term historical average while falling below 100 indicates it is lower than the historical average. The employment rate refers to the proportion of the employed among the civilian noninstitutional population age 16 and older, excluding active-duty military personnel and inmates.

Summary statistics

Table 2 shows the summary statistics. The average daily volume of brand buzz is 46.56 with a standard deviation of 251.64, indicating a highly skewed distribution. After log transformation, the average daily brand buzz per brand is 2.08 (SD = 1.68). Twenty percent of brands deploy XR innovations, accounting for 11% of our observations. For XR innovations in our dataset, the average realism rating is 3.29 (SD = 0.96), the average interactivity rating is 3.85 (SD = 0.74), and the average vividness rating is 4.31 (SD = 0.65), all measured on a five-point scale. On average, brands are 11.76 years old (mean = 2.30, SD = 0.73 in log form). Regarding brand platform orientation, 25% of brands operate communication-centered platforms, while 17% operate transaction-centered platforms.

Model specification

We build seven models (Models 1–7) to assess the extent to which LOF affects the effectiveness of XR innovations in enhancing brand engagement and to examine the contingent effects of technology- and brand-specific factors proposed in the hypotheses. We use a log-linear form to address the skewness of brand buzz. The full model, Model 7, is as follows.

$$
\begin{aligned}
&ln\left(BrandBuzz_{it}\right)= \\
&\beta_1 \cdot XR_{it} + \beta_2 \cdot Foreign_i + \beta_3 \cdot XR_{it} \cdot Foreign_i + \\
&\beta_4 \cdot XR_{it} \cdot Foreign_i \cdot Realism_i + \beta_5 \cdot XR_{it} \cdot Foreign_i \cdot Interactivity_i + \\
&\beta_6 \cdot XR_{it} \cdot Foreign_i \cdot Vividness_i + \beta_7 \cdot XR_{it} \cdot Foreign_i \cdot BrandNewness_{it} \\
&\beta_8 \cdot XR_{it} \cdot Foreign_i \cdot CommPlatform_i + \beta_9 \cdot XR_{it} \cdot Foreign_i \cdot TransPlatform_i + \\
&\delta \cdot \overrightarrow{Lower - OrderTerms}_{it} + \beta_0 + \gamma \cdot \overrightarrow{Controls}_{it} + \varepsilon_{it}
\end{aligned}
$$

where $BrandBuzz_{it}$ represents the volume of brand buzz about brand i on day t. As explained earlier, XR_{it} and $Foreign_i$ are indicator variables that equal 1 if brand i deploys XR innovations on day t and if brand i is a foreign

[8] All brand platforms were launched prior to our data period and did not undergo major changes during our data period.

[9] We manually collected follower counts from four global social media channels on December 31, 2021.

Table 2 Summary statistics

Variables	Mean	SD	Min	Max
Dependent variable				
ln(Brand Buzz)	2.083	1.681	0.000	10.365
Key variables				
XR	0.111	0.314	0.000	1.000
Foreignness	0.440	0.496	0.000	1.000
Realism[a]	3.287	0.960	1.000	5.000
Interactivity[a]	3.850	0.739	1.000	5.000
Vividness[a]	4.310	0.650	1.000	5.000
Brand Newness[b,c]	2.299	0.728	0.080	4.143
Comm Platform	0.249	0.432	0.000	1.000
Trans Platform	0.167	0.373	0.000	1.000
Control variables				
Previous week's brand buzz[b]	3.756	2.040	0.000	11.244
Scope of XR[b]	1.654	0.926	0.000	4.000
Premium brand	0.230	0.421	0.000	1.000
Brand app	0.350	0.477	0.000	1.000
Dual channel	0.553	0.497	0.000	1.000
KakaoTalk followers[b]	3.254	4.610	0.000	14.096
Instagram followers[b]	6.071	4.723	0.000	13.864
Facebook followers[b]	5.647	5.297	0.000	16.975
YouTube followers[b]	2.310	3.672	0.000	12.397
Consumer price index	102.422	3.397	98.884	109.280
Economic sentiment index	94.202	11.469	61.400	109.400
Employment rate	0.609	0.012	0.574	0.630

[a]Conditional summary statistics are provided. [b]These are log-transformed. [c]Brand newness is measured by brand tenure

brand, respectively; 0, otherwise. As such, β_1 measures the effect of XR innovations on brand buzz for local brands whereas β_3 measures the differential effect of XR innovations on brand buzz for foreign brands, indicating the degree of LOF. Next, $XR_{it} \cdot Foreign_i$ is further interacted with the six moderators. As such, β_4 to β_9 measure if and to what extent LOF is affected by each moderator as hypothesized in H_2 to H_6. Note that the variables, $Realism_i$, $Interactivity_i$, $Vividness_i$, and $BrandNewness_{it}$, are mean-centered to avoid multicollinearity. $\overrightarrow{Lower-OrderTerms}_{it}$ denotes a vector containing lower-order interaction terms of the key variables and δ is the corresponding parameter vector. $\overrightarrow{Controls}_{it}$ contains the control variables in Table 1, linear and quadratic time trends as well as fixed effects. Specifically, firm-month fixed effects are included to address firm-specific time-varying unobserved heterogeneity. Week fixed effects and day-of-the-week fixed effects are included to address the common time-specific unobserved heterogeneity. γ is the corresponding parameter vector.

We test the hypotheses by progressively adding variables. First, we estimate Model 1, excluding all three-way interaction terms, to examine whether and to what extent foreign brands experience LOF in XR innovations, as hypothesized in H_1. Next, we estimate Models 2 through 6 to examine whether and to what extent LOF in XR innovations varies by each moderator, as hypothesized in H_2 to H_6. Model 7 is the full model, testing all moderators simultaneously.

We address potential challenges that may arise from simultaneity and omitted variables to ensure proper identification of our model. First, although we control for various brand characteristics, unobserved firm-specific time-varying events such as new product launches or collaboration with social influencers may influence brand buzz and confound our findings. To avoid biased estimates due to omitted variables, we include firm-month fixed effects.[10] Second, despite controlling for the general time trends, unobserved time-specific factors, such as the seasonality of brand events in the beauty industry, may still affect brand buzz. Thus, we include week-fixed effects and day-of-the-week fixed effects to account for unobservable seasonality. Third, while our model controls for unobserved firm-specific time-varying heterogeneity and time-specific trends, brand-time-specific unobservables, such as promotion events specific to one brand, may still exist. To address this endogeneity problem, we add the previous week's volume of brand buzz as a control variable (see Chen et al., 2019b for a similar approach).[11] Lastly, to ensure the equivalence between local and foreign brands in our sample, we conduct a robustness check using the inverse probability of treatment weighting.

Results

Table 3 presents the estimation results for key variables in Models 1–7, with full estimation results available in Web Appendix C. Model 1 tests if LOF exists in XR innovations (H_1). Models 2–6 assess how LOF in XR innovations varies by technology and brand contexts (H_2 to H_6). Model 7 tests all moderators simultaneously. The contingent effects remain consistent across Models 2–7. Thus, our discussion on the contingent effects centers on the results of Model 7. The variance inflation factor (VIF) values are below 2

[10] We use firm-specific (not brand-specific) time-varying fixed effects because, in the Korean beauty industry, brands within the same firm often have similar marketing schedules (e.g., new product launches and advertisement allocation patterns) and share services from a single agency.

[11] Although brand platforms and apps can serve as vehicles for deploying XR innovations, only three brands in our data did so. Most XR innovations were deployed externally (e.g., through standalone apps, metaverse platforms, or AR apps), reducing concerns about endogeneity. We thank an anonymous reviewer for suggesting this point.

(under the threshold of 10) for all variables, confirming that multicollinearity is not an issue.

Liability of foreignness in XR innovations

As expected in H_1, we find support for LOF in XR innovations. The estimate of *XR* × *Foreign* is negative and significant in Model 1 ($\beta_3 = -0.166$, $p < 0.01$). Namely, controlling for firm-month fixed effects, seasonality, and other controls, foreign brands, compared to local brands, are relatively less effective in leveraging XR innovations to enhance brand engagement. This estimate suggests that in driving brand buzz, foreign brands can only obtain 75.3% of the lift that local brands enjoy from XR innovations. Note that XR innovations enhance brand engagement for both foreign and local brands, however, the effectiveness of XR innovations is lesser for foreign brands. Our finding provides new empirical evidence of LOF in the XR technology context, echoing prior research showing that LOF still persists in the digital landscape (Chen et al., 2019a; Kumar et al., 2023).

Contingent effects of technology context

H_2 examines whether LOF in XR innovations is mitigated in more realistic XR innovations compared to less realistic ones. We find that the estimate of *XR* × *Foreign* × *Realism* is positive and significant ($\beta_4 = 0.268$, $p < 0.01$ in Model 7), supporting H_2. This implies that LOF is alleviated in more realistic XR innovations but exacerbated in less realistic XR innovations. To illustrate, a one-unit increase in the realism rating leads to a notable 30.7% reduction in LOF, as evidenced by the increased lift in brand buzz. A potential explanation is that in highly realistic XR innovations, foreign brands' unfamiliarity with the host country's culture may be more pronounced, affecting their ability to deliver mentally fluent experiences compared to less realistic innovations.

H_3 tests whether the increased interactivity of XR innovations amplifies the disadvantages foreign brands face. The negative and significant estimate of *XR* × *Foreign* × *Interactivity* ($\beta_5 = -0.127$, $p < 0.01$ in Model 7) lends support for H_3, implying that LOF is exacerbated in XR innovations featuring higher interactivity. Specifically, a one-unit increase in the interactivity rating leads to a 12.0% increase in LOF. A plausible explanation is that high interactivity may increase the potential for cultural misunderstandings to affect the fluency of XR experience. Consequently, LOF driven by cultural differences in cognitive processing styles may be more pronounced in highly interactive XR innovations compared to those with lower interactivity.

H_4 investigates whether a higher degree of vividness of XR innovations exacerbates the disadvantages foreign brands face. The negative and significant estimate of *XR* × *Foreign* × *Vividness* ($\beta_6 = -0.162$, $p < 0.01$ in Model 7) supports H_4, indicating that LOF increases in XR innovations with higher vividness. Specifically, a one-unit increase in the vividness rating leads to a 14.9% increase in LOF. This finding suggests that greater vividness may accentuate culturally misaligned elements in XR innovations, exacerbating foreign brands' disadvantages in delivering mentally fluent XR experiences.

Contingent effects of brand context

H_5 tests if brand newness weakens LOF in XR innovations. Note that we measure brand newness using brand tenure, the number of years of operation since a brand's entry into the host country, and its negative coefficient indicating the positive effect of brand newness. The negative and significant estimate of *XR* × *Foreign* × *Brand Newness* ($\beta_7 = -0.148$, $p < 0.01$ in Model 7) supports H_5, indicating that as a brand's tenure decreases (i.e., brand newness increases), LOF is mitigated. Specifically, a one standard deviation increase in brand newness (which is comparable to a 2.07-year decrease in brand tenure) results in a 13.7% reduction in LOF. A plausible explanation for this mitigation is that customers may have a greater need to resolve uncertainty associated with newer foreign brands compared to more established foreign brands, and XR innovations effectively address this need, mitigating the potential disadvantages of less culturally aligned XR.

H_6 posits that foreign brands with communication-centered platforms, compared to foreign brands with transaction-centered platforms, experience a lesser degree of LOF in XR innovations. We find that the estimate of *XR* × *Foreign* × *Comm Platform* is significantly positive ($\beta_8 = 0.454$, $p < 0.01$ in Model 7), and the estimate of *XR* × *Foreign* × *Trans Platform* is also significantly positive ($\beta_9 = 0.074$, $p < 0.05$ in Model 7). The difference in the two estimates is positive and significant ($\beta_8 - \beta_9 = 0.380$, $p < 0.01$), suggesting greater mitigation for communication-centered platforms, thus supporting H_6. Using these estimates, we find that the use of communication-centered platforms mitigates LOF by 57.5% while the use of transaction-centered platforms lowers LOF by 7.7%. A plausible explanation is that communication-centered platforms help foreign brands gain deeper insights into host-country customers and foster attitudinal loyalty, enabling them to more effectively mitigate LOF in XR innovations.

Robustness checks

We conduct additional analyses using Model 7 to assess the robustness of our results. The estimation results of the key variables are shown in Table 4. Web Appendix Table D.1 provides the summary of the robustness checks, Web Appendix Table D.2 describes the control variables

Table 3 LOF in XR innovations and contingent effects

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value
XR	0.268	[0.000]	0.341	[0.000]	0.241	[0.000]	0.219	[0.000]	0.084	[0.000]	0.367	[0.000]	0.293	[0.000]
Foreign	0.248	[0.000]	0.251	[0.000]	0.247	[0.000]	0.246	[0.000]	0.225	[0.000]	0.424	[0.000]	0.382	[0.000]
XR × Foreign	– 0.166	[0.000]	– 0.227	[0.000]	– 0.142	[0.000]	– 0.118	[0.000]	– 0.100	[0.000]	– 0.404	[0.000]	– 0.284	[0.000]
XR × Foreign × Realism			0.214	[0.000]									0.268	[0.000]
XR × Foreign × Interactivity					– 0.159	[0.000]							– 0.127	[0.000]
XR × Foreign × Vividness							– 0.183	[0.000]					– 0.162	[0.000]
XR × Foreign × Brand Newness									– 0.098	[0.000]			– 0.148	[0.000]
XR × Foreign × Comm Platform											0.470	[0.000]	0.454	[0.000]
XR × Foreign × Trans Platform											0.254	[0.000]	0.074	[0.029]
Lower-Order Terms	Included		Included		Included		Included		Included		Included		Included	
Control variables	Included		Included		Included		Included		Included		Included		Included	
Firm-month fixed effects	Included		Included		Included		Included		Included		Included		Included	
Week fixed effects	Included		Included		Included		Included		Included		Included		Included	
Day-of-the-week fixed effects	Included		Included		Included		Included		Included		Included		Included	
N	375,477		375,477		375,477		375,477		375,477		375,477		375,477	
R^2	0.8515		0.8515		0.8515		0.8515		0.8524		0.8522		0.8535	

The *p* values are reported in brackets. The full estimation results are available in Web Appendix C.

used in robustness checks, and the full estimation results are available in Web Appendix Table D.3. The synopsis of our robustness checks is as follows. First, to account for the potential negative impact of brand buzz, we use the volume of positive and neutral brand buzz as an alternative dependent variable in column 1. Second, we replicate our analysis using geographic distance and cultural distance as alternative measures of foreignness in Columns 2 and 3. Cultural distance is measured based on Hofstede's four dimensions, i.e., power distance, individualism, masculinity, and uncertainty avoidance (Hofstede, 1980). Third, to ensure the equivalence between local and foreign brands in our sample, we apply the inverse probability of treatment weighting in column 4 (Austin & Stuart, 2015). Using all key and control variables, the propensity score of foreignness is obtained and weights are calculated as the inverse of the propensity score to create counterfactual data (see Wu & Salomon, 2016 for a similar approach). Fourth, we exclude brands with particularly high or low brand buzz to control for bias from outlier brands in column 5. Fifth, we control for unobserved time-specific heterogeneity by using 209 week dummies instead of 52 week dummies in column 6. Sixth, we use firm-month random effects instead of firm-month fixed effects in column 7. Seventh, we add the length and breadth of host country experience, as additional control variables in column 8. Finally, since our data cover the pandemic period, we control for COVID-19-related variables in column 9, including the numbers of diagnoses and deaths and indices for governmental stringency and retail/recreational mobility (see Web Appendix Table D.2 for variable details). All robustness checks confirm that the estimation results remain consistent.

Discussion and conclusions

This study examines *whether* and *to what extent* foreign brands experience LOF in leveraging XR innovations and explores *under what conditions* LOF is pronounced or mitigated. Although extensive research has explored LOF in traditional market contexts, understanding LOF in the digital landscape, particularly regarding emerging immersive technologies, remains limited. We take XR innovations as a unique context to further examine LOF theory. Unlike prior LOF literature (e.g., Mata & Freitas, 2012; Wu & Salomon, 2016; Zaheer, 1995), which primarily examines LOF in the context of *tangible product exchanges* through *one-way, firm-driven communication*, our research centers on XR innovations that provide *intangible experiences* through *instantaneous two-way interactions*. These distinctive characteristics of XR underscore the importance of achieving mental fluency, which relies on a solid understanding of user–technology interactions (Heller et al., 2019; Hilken et al., 2022; Wedel et al., 2020). We argue that LOF in XR arises because foreign brands, with a limited understanding of host-country customers and their culture, face challenges in delivering mentally fluent XR experiences. We further contend that LOF in XR innovations varies across different types of XR innovations and depends on brand contexts. Our empirical analysis, based on a large-scale dataset of 257 beauty brands in the Korean beauty industry, confirms the existence of LOF in XR innovations and its nuanced nature across different technology and brand contexts. Below we summarize our key findings and discuss the implications for academia and global business managers.

Contributions

Our research contributes to the IB literature and adds to the growing multidisciplinary research on immersive technologies. First, our work enriches the understanding of LOF in the context of emerging immersive technologies (Meyer et al., 2023). We propose that highly interactive and sensory-rich XR innovations present a unique empirical context to examine LOF, distinct from those identified in prior research on traditional market contexts (Maruyama & Wu, 2015; Mata & Freitas, 2012; Wu & Salomon, 2016; Zaheer, 1995; Zaheer & Mosakowski, 1997). Our research aligns with prior LOF studies as we view cultural differences in cognitive processing styles as major sources of LOF in XR innovations. However, it differs from prior research by using this novel technology context to identify new technology- and brand-specific factors influencing LOF. By doing so, our work supports the notion that LOF in the digital landscape can still arise from systematic cognitive biases (de Bellis et al., 2019; Kumar et al., 2023) and complements recent studies on LOF in the digital landscape (Bei & Gielens, 2020; Chen et al., 2019a).

Second, our research documents the technology-driven contingencies of LOF in XR innovations, providing valuable insights for multinational firms on XR technology configuration strategies. Specifically, we show that LOF is more pronounced in less realistic, more interactive, and more vivid XR innovations, where cultural biases or misunderstandings may significantly impede achieving mental fluency. Notably, our findings suggest that unlike in traditional markets where superior technologies help mitigate LOF (Rugman & Verbeke, 2001; Zaheer & Mosakowski, 1997), in the XR context, the use of more advanced technologies may exacerbate LOF. Our findings underscore the importance of understanding the technology context to effectively manage LOF in the digital domain.

Furthermore, our research uncovers the nuanced nature of LOF in XR innovations based on brand contexts, offering fresh insights into foreign subsidiaries' XR innovation strategies. We find that LOF is mitigated for newer brands,

Table 4 Robustness checks

	1		2		3		4		5		6		7		8		9	
	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value	EST	*p* value
XR	0.294	[0.000]	0.209	[0.000]	0.306	[0.000]	0.232	[0.000]	0.194	[0.000]	0.289	[0.000]	0.273	[0.000]	0.294	[0.000]	0.285	[0.000]
Foreign	0.355	[0.000]	0.043	[0.000]	0.098	[0.000]	0.342	[0.000]	0.014	[0.000]	0.396	[0.000]	0.179	[0.000]	0.385	[0.000]	0.455	[0.000]
XR × Foreign	− 0.309	[0.000]	− 0.024	[0.000]	− 0.071	[0.000]	− 0.225	[0.000]	− 0.016	[0.000]	− 0.293	[0.000]	− 0.261	[0.000]	− 0.279	[0.000]	− 0.275	[0.000]
XR × Foreign × Realism	0.214	[0.000]	0.019	[0.000]	0.071	[0.000]	0.252	[0.000]	0.030	[0.000]	0.259	[0.000]	0.255	[0.000]	0.268	[0.000]	0.259	[0.000]
XR × Foreign × Interactivity	− 0.167	[0.000]	− 0.023	[0.000]	− 0.033	[0.000]	− 0.188	[0.000]	− 0.004	[0.000]	− 0.115	[0.000]	− 0.125	[0.000]	− 0.130	[0.000]	− 0.117	[0.000]
XR × Foreign × Vividness	− 0.121	[0.000]	− 0.016	[0.000]	− 0.046	[0.000]	− 0.154	[0.000]	− 0.033	[0.000]	− 0.167	[0.000]	− 0.159	[0.000]	− 0.161	[0.000]	− 0.160	[0.000]
XR × Foreign × Brand Newness	− 0.195	[0.000]	− 0.020	[0.000]	− 0.030	[0.000]	− 0.224	[0.000]	− 0.013	[0.000]	− 0.144	[0.000]	− 0.152	[0.000]	− 0.149	[0.000]	− 0.107	[0.000]
XR × Foreign × Comm Platform	0.505	[0.000]	0.049	[0.000]	0.114	[0.000]	0.415	[0.000]	0.033	[0.000]	0.459	[0.000]	0.435	[0.000]	0.447	[0.000]	0.474	[0.000]
XR × Foreign × Trans Platform	0.037	[0.278]	0.004	[0.361]	0.029	[0.000]	0.130	[0.000]	− 0.004	[0.312]	0.093	[0.000]	0.012	[0.711]	0.071	[0.037]	− 0.009	[0.798]
Lower-Order Terms	Included		Included		Included		Included		Included		Included		Included		Included		Included	
Control variables	Included		Included		Included		Included		Included		Included		Included		Included		Included	
Firm-month fixed effects	Included		Included		Included		Included		Included		Included		Included		Included		Included	
Week fixed effects	Included		Included		Included		Included		Included		Included		Included		Included		Included	
Day-of-the-week fixed effects	Included		Included		Included		Included		Included		Included		Included		Included		Included	
N	375,477		375,477		375,477		375,477		375,477		375,477		375,477		375,477		375,477	
R^2	0.8485		0.8533		0.8536		0.8625		0.8434		0.8597		0.8540		0.8535		0.8744	

The *p* values are reported in brackets. The full estimation results are available in Web Appendix D

as customers may perceive sensory-rich XR experiences from newer foreign brands as more valuable than those from established ones (cf., Tan et al., 2022). This finding may seem to contrast with prior LOF literature, which emphasizes learning and adaptation through building host-country experience as an effective strategy to mitigate LOF (e.g., Miller & Eden, 2006; Wu & Salomon, 2016; Zaheer & Mosakowski, 1997). However, in our context, brand newness does not imply a lack of foreign subsidiaries' experience in the host country; rather, it represents newly launched products.[12] This advantage of newness in XR innovations is distinct from learning advantages (Zhou et al., 2010) and entrepreneurial proclivity (Zahra, 2005), as it relates to resolving consumer uncertainty with new products. Our study suggests that by strategically leveraging consumers' desire to resolve uncertainty with newer products/brands, foreign firms can mitigate LOF in XR and similar immersive technologies.

Moreover, we emphasize the distinct roles that communication-centered brand platforms play, compared to transaction-centered platforms, in mitigating LOF. Our research reveals that brands using communication-centered platforms are more effective at mitigating LOF than those using transaction-centered platforms. A plausible explanation is that foreign brands can acquire more tacit market knowledge and foster greater customer loyalty through communication-centered platforms than transaction-centered platforms, helping them better address the challenges related to delivering mentally fluent XR experiences. This finding reaffirms that developing host-country-specific marketing assets remains a viable strategy for mitigating LOF in XR innovations, as shown in traditional market contexts (Miller & Eden, 2006; Zaheer & Mosakowski, 1997) and other digital contexts (Kumar et al., 2023).

Lastly, our work contributes to the multidisciplinary literature on immersive technologies by showing that foreignness can introduce systematic biases to their outcomes. Despite global businesses leading the rapid adoption of XR innovations, there has been limited scholarly work exploring the outcomes of XR innovations from an international perspective. While prior studies in human–machine interactions underscore the importance of aligning interfaces to cultural cognitive processing styles (de Bellis et al., 2019; Degens et al., 2014; Reinecke & Bernstein, 2013), they have not directly investigated how systematic biases arising from foreignness affect the performance of XR innovations. Furthermore, we find that richer communication mediums, such as highly interactive and vivid XR simulations, which generally enhance user experience (Ceylan et al., 2024; Daft & Lengel, 1986), may paradoxically pose additional challenges for foreign firms. Our findings emphasize the need for tailored strategies for foreign firms that consider both technology- and brand-specific contexts.

Implications for international configurations of XR innovations

While immersive technologies like XR offer significant potential, their adoption comes with risks. Our research presents three meaningful insights for global businesses seeking to configure cross-cultural models of XR and similar technologies. First, our findings indicate that media richness does not always lead to better outcomes for foreign businesses. In fact, it can exacerbate the challenges foreign businesses face. We suggest that local businesses achieve optimal outcomes by utilizing low-realism, highly interactive and vivid XR innovations. However, these configurations may not necessarily yield the same outcomes for foreign businesses. For foreign businesses, particularly those unfamiliar with the host country's culture, we recommend starting with high-realism, low-interactivity, and less vivid XR innovations. For example, highly realistic AR applications or simple AR/VR apps with limited interactivity may work better for foreign firms, while local businesses can leverage more imaginative and interactive XR innovations like the metaverse.

Second, our findings suggest that newer brands are less likely to face LOF in XR innovations. We attribute this to customers' desire to resolve uncertainty with newer products or brands, which mitigates the disadvantages of less culturally aligned XR. In contrast, older brands may not offer enough benefits through XR innovations to make up for cultural misalignment. Since newer products or brands are less likely to experience LOF in highly interactive and vivid XR innovations, global business managers should recognize that newness allows for the flexibility to offer a more immersive and richer XR experience. Conversely, for established brands, managers should carefully assess whether XR innovations are suitable for international markets and which features would best meet customer expectations.

Third, our research suggests that foreign businesses with greater digital marketing experience in the host country are better positioned to implement more imaginative and richer XR experience. For instance, foreign businesses that have invested in brand platforms, especially communication-centered platforms, can afford low-realism, highly interactive, and vivid XR, as they have acquired localized digital marketing capabilities through these platforms. Conversely, foreign businesses lacking such host-country-specific digital marketing capabilities should consider starting with XR technologies that have limited interactivity, gradually adding more advanced features as they gain market insights.

[12] In industries like beauty or consumer goods, firms introduce new product lines with new brand names as part of a multi-brand strategy, while leveraging the shared market knowledge.

Furthermore, leveraging brand platforms and analyzing customer interaction data can help them better understand local preferences and cultural nuances. Overall, these insights provide valuable guidance for global businesses navigating the complexities of implementing XR technologies in international markets.

Limitations and directions for future research

Despite contributions, our study is not without limitations that in turn suggest promising avenues for future research. First, only 20% of brands in our sample implemented XR innovations during the data period. Although the Korean beauty industry is known for its active adoption of emerging technologies, XR technologies are still nascent and XR penetration remains low. We call for future research to collect data from a larger sample of brands or firms that implemented XR innovations in various contexts to enhance the generalizability and robustness of our findings. Second, our empirical analysis is based on data from foreign brands in one country. Although our hypotheses are not based on host-country-specific factors, unique characteristics of Korean customers and markets may influence our findings. For instance, Korean customers' tech savviness may make LOF in XR more pronounced compared to other countries. Thus, future studies should generalize our findings with caution to other countries or other industries. Third, while we propose a theoretical mechanism for LOF in XR innovations based on cognitive fluency theory, we have not yet empirically validated this mechanism. Future research could provide valuable insights by testing the underlying mechanism of our theory. Fourth, our work focuses on brand buzz, but future research could delve into outcomes like sales or revenue that would provide valuable insights into the tangible benefits of XR innovations. Analyzing the impact of XR innovations on customer loyalty and churning would help determine whether XR adoption leads to long-term benefits. Fifth, future research could explore LOF in other novel technology contexts such as virtual assistants, the metaverse, artificial intelligence, and the internet of things. We leave these potential directions to future research.

Conclusion

In conclusion, our research documents the presence of LOF in XR innovations, showing that foreign businesses' XR innovations are less effective in driving customer engagement than those of local businesses. We argue that LOF arises from the distinct challenges foreign businesses face in delivering mentally fluent XR experiences, primarily due to their unfamiliarity with the host-country culture. Our findings underscore the nuanced nature of LOF across different features of XR technology, with greater LOF observed in less realistic, more interactive, and more vivid XR innovations. Furthermore, we show that businesses can mitigate LOF by leveraging newness and brand platforms, particularly communication-centered platforms. Considering both technology- and brand-related contingencies, we propose XR configuration strategies for foreign businesses. We hope the current research stimulates more research into the international perspective on immersive technologies in IB and related disciplines.

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