

How International Physical Presence and Infrastructure Differences Moderate the Link Between Digital Internationalization and MNE Performance

Abstract

While prior work has predominantly studied the performance implications of multinational enterprise (MNE) physical internationalization, research on how MNEs perform when simultaneously coordinating international digital channels and physical presence remains scarce. This challenge is particularly acute in retail, where the strategic convergence of born-digital retailers expanding physically and traditional retailers going digital creates new cross-domain challenges. Nonetheless, the impact of international physical presence and differences in home country physical infrastructure relative to host countries on MNE performance remains unexplored. Drawing on the integration-responsiveness (IR) framework, we suggest that a non-linear, U-shaped pattern governs the relationship between digital internationalization and performance for these retail MNEs, because the costs of integration and responsiveness are dominant at lower levels of internationalization while their advantages become more pronounced with increased internationalization. Further, we argue that the digital internationalization and MNE performance relationship steepens (a) with a higher international physical presence and (b) for firms originating from home countries with superior physical infrastructure relative to their host countries. Utilizing an 11-year panel of some of the largest retail MNEs, our research contributes to international strategy literature by extending the IR framework to a multidomain digital and physical context, stressing the strategic importance of firm- and country-level physical resources and infrastructure in digital internationalization.

Keywords: digital internationalization; MNE performance; integration-responsiveness framework; physical infrastructure; physical resources

INTRODUCTION

Retailers that pursue digital internationalization, i.e., the process by which firms' products are made available to customers in foreign markets through digital channels (Ipsmiller et al., 2022), face complex decisions about introducing digital channels alongside their international physical presence. In this environment, born-digital retailers often invest heavily in international physical presence (Soper, 2018), while born-physical retailers tend to embrace digital channels across their international operations (Businesswire, 2025) and continue to invest in their physical store network (CNBC, 2023). This strategic convergence, where born-digital retailers are expanding their physical footprint and born-physical retailers are prioritizing digital presence (Rigby, 2020), challenges a fundamental assumption that firms leverage their core competencies when internationalizing.

Prior research has recognized the importance of digitalization (Reinartz et al., 2019; Menz et al., 2021) and internationalization (Gielens and Dekimpe, 2001; Trigeorgis et al., 2021) and has also examined the role of digital channels on internationalization (Petersen et al., 2022; Drori et al., 2024) while acknowledging the complementarity between digitalization and internationalization (Dimitrova et al., 2018). Evidence suggests different approaches to balance digitalization and internationalization: Born-digital firms tend to increasingly expand their physical footprint (Monaghan et al., 2020; Maier et al., 2023; van Crombrugge et al., 2023). By contrast, some going-digital firms have been divesting their physical presence, like H&M (Radojev, 2021), while others are counting on their digital capabilities to enhance their existing

physical operations. These complementary strategies reveal a deeper theoretical puzzle: While the traditional Integration-Responsiveness (IR) framework focuses on the fundamental tension between a multinational firm's need for global integration and its need for local responsiveness within a single domain, digital internationalization requires coordinating digital and physical channels across diverse foreign markets. This raises a fundamental question: 'How do firm- and country-level physical infrastructure influence the IR trade-offs in firm digital internationalization?'

Drawing on the IR framework (Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989), we argue that the digital internationalization-performance relationship of digitalizing multinational enterprises (MNEs) is U-shaped. At low to moderate levels of digital internationalization, firms face high responsiveness and integration costs that outweigh any respective benefits. While responsiveness costs originate from adapting to diverse digital environments, regulatory systems, and customer expectations, integration costs arise from fragmented IT systems and front-loaded coordination challenges across fewer foreign markets. However, at moderate to high levels of digital internationalization, firms increasingly benefit from the advantages of responsiveness and integration by gaining efficiencies through accumulated market knowledge, scalable digital infrastructure, and network learning. These capabilities reduce marginal adaptation costs, enabling firms to coordinate their global operations more efficiently.

We also examine how firm-level international physical presence (i.e., retail stores) and country-level physical infrastructure differences ^[1] (i.e., logistics performance) moderate the digital internationalization and MNE performance relationship. Physical stores remain essential for firms' digital strategies, as omnichannel shoppers typically buy 70 percent more frequently and spend 34 percent more than offline-only shoppers (Briedis et al., 2019), while robust

country-level infrastructure facilitates online purchases (Eduardsen et al., 2023). Specifically, international physical presence reflects a firm-level strategic configuration that drives cross-border coordination and orchestration, while home-country physical infrastructure represents a country-level institutional condition that shapes institutional adaptation costs and capability transfer in a digital context. Their distinct characteristics demonstrate how firm strategies and external environments create distinct pathways for resolving IR tensions during digital internationalization.

Therefore, this study examines the relationship between digital internationalization and MNE performance through the lens of IR trade-offs and then focuses on the contingent effect of international physical presence and physical infrastructure differences in the context of the largest retail MNEs. Specifically, we argue that these moderators influence the steepness of the U-shaped digital internationalization-MNE performance relationship by affecting the magnitude of integration benefits and responsiveness costs: (a) international physical presence amplifies both cross-border coordination complexity at low to moderate digital internationalization levels but offers global orchestration advantages at moderate to high digital internationalization levels, and (b) physical infrastructure differences creates adaptation challenges at low to moderate digital internationalization levels but enhanced capability benefits at moderate to high digital internationalization levels.

This study contributes to previous research by extending the IR framework to digital internationalization contexts. In particular, we reveal how the fundamental IR trade-offs shape the performance of MNEs that need to coordinate digital and physical channels abroad. In addition, our work documents the distinct moderating influences of the physical presence and cross-country infrastructure differences on the IR relationship for digital retail firms. In doing so,

we introduce physical assets and environmental context as important firm- and country-level boundary conditions to the main IR relationship that amplify both, the costs and benefits of integration and responsiveness. We test our hypotheses using a sample of the world's largest retail MNEs that engage in digital internationalization for the period between 2006 and 2016.

THEORY AND HYPOTHESES DEVELOPMENT

Digital Internationalization and the Integration-Responsiveness (IR) Tension

The IR framework is a central concept in global strategy research and posits that MNEs face a fundamental strategic dilemma: the need for global integration to achieve efficiency and scale economies, and the need for local responsiveness to adapt to diverse market conditions (Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989). Previous work has predominantly studied this tension in physical businesses (e.g., Luo, 2001; Meyer and Estrin, 2014), but has largely neglected digital internationalization. Digital internationalization represents a unique expression of the IR tension, as digital technologies can simultaneously enhance both integration and responsiveness across international markets for born-digital and going-digital firms (Boyd and Bresser, 2008; Dekimpe et al., 2020). Digital channels enable firms to communicate with customers, collect market research data, promote goods and services, and provide online support (e.g., Basu and Muylle, 2003; McKechnie et al., 2006; Adhikary et al., 2021). They also facilitate market broadening, product line extensions, and cost-efficiencies (e.g., Wu et al., 2003; Doherty and Ellis-Chadwick, 2009; Herhausen et al., 2015). As consumers gain greater control over the information they seek, firms increasingly develop digital customer orientation and digital business capability (Kopalle et al., 2020; Abebe et al., 2024). For example, brick-and-mortar firms rely more heavily on digital means, such as search engines and digital maps, as consumers

seek store-related information online (e.g., location, opening hours) before their visit (Maier and Wieringa, 2021). However, MNEs must balance global digital integration with local market responsiveness requirements, making digital internationalization a very suitable setting for the IR framework.

To clarify how IR mechanisms are linked to digital internationalization and MNE performance, we provide an overview of the cost–benefit dynamics associated with different IR configurations. Figure 1 summarizes how combinations of responsiveness (low vs. high) and integration (low vs. high) generate distinct patterns of coordination challenges, adaptation requirements, and scale benefits, and how these patterns evolve as firms progress from low to high levels of digital internationalization. In doing so, the 2x2 matrix in Figure 1 illustrates the underlying theoretical logic behind the main hypothesized relationship.

INSERT FIGURE 1 ABOUT HERE

At low to moderate levels of digital internationalization, responsiveness and integration costs substantially exceed their respective benefits for several reasons. Firms face higher responsiveness costs from adapting to diverse local digital market contexts, including regulatory complexities, payment systems, and customer digital behavior expectations, while requiring distinct customer management skills (Hult et al., 2019). Further, coordination costs increase responsiveness costs when firms simultaneously manage multiple strategic actions across diverse contexts (Verbeke and Asmussen, 2016). These coordination challenges are critical for managing complex IR trade-offs in multichannel environments (Ailawadi and Farris, 2017), where firms face dual responsiveness pressures from both physical and digital channel adaptation

requirements (Herhausen et al., 2020). Moreover, firms cannot justify extensive digital infrastructure investments in enterprise-wide platforms, forcing them to develop fragmented, market-specific solutions that increase responsiveness costs, while addressing cultural adaptation, marketing strategy differences, and learning how to execute ‘technology-enabled customer journeys’ (Schweidel et al., 2022).

Integration costs are also expected to exceed benefits at low to moderate levels of digital internationalization, because early digital international expansion requires connecting diverse IT platforms and logistics systems across only a few foreign markets, with front-loaded coordination costs that the firm struggles to amortize due to the relatively small customer base. According to Mauri and Sambharya (2001), integrating initially increases configuration and coordination costs, which outweigh the benefits of improved performance. In addition, significant home–host contextual differences make it harder to standardize systems and processes globally with presence in only a few foreign digital markets (Meyer and Estrin, 2014). While global integration creates benefits when the MNE operates as a fully connected network (Bartlett and Ghoshal, 1989), when a firm has foreign digital operations scattered across a few foreign markets, it cannot capture the full benefits of integration; a partial global digital network creates more friction than synergies through fragmented systems and increased transaction costs.

At moderate to high levels of digital internationalization, the benefits of local responsiveness become more pronounced. Accumulated market knowledge lowers marginal adaptation costs as firms turn accrued localized experience into reusable resources and recombine capabilities (Grøgaard et al., 2022). Repeated exposure to diverse foreign markets builds dynamic capabilities that raise speed and quality of local responsiveness. Local responsiveness investments also become increasingly beneficial at scale, improving legitimacy

and building stakeholders' trust, and generating data for better global coordination across headquarters and subsidiaries (Janssens, 1995; Barin Cruz and Boehe, 2010). Finally, contextual agility becomes a competitive edge as subsidiaries' local embeddedness provides resources and know-how that the MNE can orchestrate across the digital network. Thus, the advantages of responsiveness outweigh its challenges and make responsiveness a source of advantage that complements large-scale integration (Meyer and Estrin, 2014).

Integration benefits are also expected to outweigh integration costs at moderate to high levels of digital internationalization. First, extensive digital internationalization enables cross-market digital capabilities with strong economies of scale and scope (Schweidel et al., 2022), allowing coordinated digital operations and integration benefits from better handling of the idiosyncrasies scaling over diverse digital markets. For instance, retailers have developed integrated omnichannel capabilities that enable coordinated customer experiences across physical and digital channels, avoiding delivery costs, shortening lead times, and increasing customer retention (Mahar et al., 2014). Second, high digital internationalization generates network-based learning effects that are inherently integrative (Tolstoy et al., 2023), enabling rapid adjustments to digital marketing strategies and a tailored digital customer experience (Warner and Wäger, 2019). Third, while digital business models typically offer limited value at first (Iansiti and Lakhani, 2020), extensive digital internationalization enables global digital scalability through coordinated operations (Adner et al., 2019; Monaghan et al., 2020) that can ultimately surpass the value of traditional models (Banalieva and Dhanaraj, 2019; Chen et al., 2019). Hence, while responsiveness and integration still require ongoing effort at high levels of digital internationalization, accumulated capabilities and scale ensure that benefits substantially outweigh these residual costs, thereby improving MNE performance.

Therefore, we hypothesize:

Hypothesis 1 (H1): The relationship between digital internationalization and MNE performance follows a U-shape, with a negative slope at low to moderate levels of digital internationalization and a positive slope at moderate to high levels of digital internationalization.

The Moderating Role of International Physical Presence

Physical assets play an important role in facilitating internationalization for born-digital firms and digital platforms (Galkina et al., 2023). Born-digital firms frequently place “boots on the ground” (Stallkamp et al., 2023) to more effectively orchestrate their digital and physical assets. Prior research calls for greater complementarity between locally embedded and digitally scalable resources (Verbeke and Hutzschenreuter, 2020) and emphasizes the need for physical and digital resource bundling in the internationalization process (Batsakis et al., 2023a; Stallkamp et al., 2023). Firms that effectively orchestrate digital and physical assets through a multichannel approach are in a better position to create value for themselves and their customers (Melis et al., 2016; Reinartz et al., 2019), with even online retailers now developing physical spaces to elevate their private-label product status (Gielens & Steenkamp, 2019). For digitalizing MNEs, the ratio of international to total physical presence represents a fundamental organizational configuration dimension that influences how firms navigate the IR tension in digital contexts (Casella and Formenti, 2019).

At low to moderate digital internationalization levels, greater international physical presence amplifies coordination complexity with adverse performance effects. Firms need to coordinate digital and physical channels across multiple countries with different operational

contexts, regulatory environments, and customer expectations (Verbeke and Hutzschenreuter, 2020), such as regulatory dynamics, evolving ecosystems, and AI-driven strategies (Parente et al., 2024). Consequently, greater physical presence abroad leads to greater cross-border coordination demands when digital operations are limited in scope (Stallkamp et al., 2023). Coordinating digital customer experiences across countries while maintaining physical operations consistency significantly increases coordination complexity. Specifically, firms need to align inventory visibility across online and offline channels, synchronize pricing and promotions across digital platforms and physical stores, and integrate customer data from multiple touchpoints for seamless omnichannel fulfillment. At low to moderate levels of digital internationalization, firms cannot sufficiently scale digitally to generate offsetting integration benefits (Mason and Jarvis, 2023). At this early stage, greater international physical presence increases the marginal coordination costs of digital expansion at a faster rate than its performance benefits, hence making the left-hand slope of the U-shaped curve steeper. This is because integration costs (systems interconnection, governance overhead, and duplicated logistics) escalate with added physical markets, while digital channel sales remain relatively small to amortize these costs. Hence, greater international physical presence initially steepens the downward part of the U-shape by deepening the “valley” where responsiveness and coordination costs dominate.

At moderate to high levels of digital internationalization, international physical presence enhances integration benefits, resulting in positive performance effects (Zhang et al., 2021). Extensive international physical presence enables firms to create globally coordinated 'phygital' strategies leveraging complementary channel strengths across multiple markets (Verhoef et al., 2015); physical stores reactivating inactive online customers (Chang and Zhang, 2016) while

mobile applications can generate additional sales from physical store customers (van Heerde et al., 2019). At this stage, as digital internationalization scales, coordination complexity increases marginally, while integration benefits accelerate, driven by economies of scope in global logistics, shared customer analytics, and cross-market process standardization. Each additional increment of digital internationalization now yields greater marginal returns, as international physical assets operate as integrated logistics and fulfillment nodes. Consequently, the right-hand (upward) slope of the U-curve becomes steeper, reflecting the amplified effect of integration benefits on performance once the firm surpasses a digital scale threshold. Further, extensive international physical presence enables global orchestration advantages through coordinated customer experiences, cross-border logistics optimization, and international knowledge transfer, with in-person store interactions creating an ‘availability effect’ that enhances customer engagement (Pauwels and Neslin, 2015). Firms can leverage their global physical infrastructure as an integrated logistics network for digital operations (Hänninen et al., 2021), thereby coordinating global fulfillment strategies and utilizing physical stores as logistics hubs to reduce delivery costs and improve delivery times (Difrancesco et al., 2021; Hübner et al., 2022a). In summary, greater international physical presence increases early-stage coordination and integration costs but delivers later-stage payoffs, steepening the entire U-shaped curve by making its negative slope more pronounced at low to moderate digital internationalization and its positive slope sharper at moderate to high digital internationalization.

Hence, we hypothesize:

Hypothesis 2 (H2): A firm’s international physical presence will steepen the U-shaped relationship between digital internationalization and MNE performance.

The Moderating Role of Home-Host Country Differences in Physical Infrastructure

The IR framework emphasizes the importance of institutional differences between home and host countries on the effectiveness of global strategies, because these differences require MNEs to adapt locally, orchestrate assets, and consider host market contingencies (Meyer and Estrin, 2014). While digital infrastructure, such as cloud platforms, payment systems, and e-commerce technologies, is standardized and globally accessible, physical infrastructure remains highly heterogeneous across countries and creates a binding constraint for retail digital internationalization. For example, a firm can deploy the same digital storefront globally, but a country's physical infrastructure determines whether it can fulfill its promises (Verbeke and Hutzschenreuter, 2020). This asymmetry makes physical infrastructure a critical moderator of digital internationalization performance in asset-intensive retail contexts. Therefore, differences between home and host countries' physical infrastructure represent a central institutional dimension, as it fundamentally affects MNEs' ability to deliver innovative business models in foreign markets, complicating the fungibility and transferability of such location-bound firm-specific assets (Hernández et al., 2022; Hewett et al., 2022).

At low to moderate digital internationalization levels, when a firm's home country has a better physical infrastructure than its host countries, i.e., a physical infrastructure difference, it creates significant responsiveness costs. Firms from countries with strong infrastructure develop digital capabilities calibrated to high-infrastructure environments that require extensive adaptation in infrastructure-constrained contexts (Schu et al., 2016), while systematic overestimation of host country digital capabilities leads to strategic missteps (Oxley and Yeung, 2001). At this stage, firms encounter disproportionately high adaptation costs for each incremental foreign digital expansion. Therefore, the downward-sloping part of the U-curve

becomes steeper as each additional increment of digital internationalization heightens responsiveness costs associated with logistics localization, last-mile fulfillment challenges, and mismatched consumer expectations. These costs rise disproportionately as firms extend their standardized digital systems into less developed physical contexts. Moreover, strong home-country infrastructure can delay learning about institutional constraints abroad, thus extending the period during which responsiveness costs exceed integration benefits. As firms progressively accumulate more host-market knowledge, these responsiveness costs start to decline, but only after repeated exposure enables them to realign logistics and digital fulfillment routines to operate effectively across diverse market conditions.

However, at moderate to high levels of digital internationalization, the home-host physical infrastructure difference enhances integration benefits through superior capability transfer. Firms from countries with strong infrastructure can leverage sophisticated digital capabilities to create competitive advantages in diverse markets by bundling physical assets (i.e., delivery, pick up, and return locations) and digital activities (i.e., e-commerce channels) to maximize their sales (Verbeke and Hutzschenreuter, 2020). At this stage, the cost–benefit mechanism reverses: responsiveness costs level off as adaptation processes become routinized, whereas integration benefits start to increase disproportionately. The same infrastructure gap that increased costs during the early digital internationalization stage now accelerates performance gains, as firms reuse advanced logistics algorithms, predictive inventory systems, and data-driven route optimization across multiple markets. Each incremental expansion of digital internationalization yields rising marginal integration benefits, steepening the upward trajectory of the U-shaped curve. This shift reflects a dynamic transition from infrastructure-induced rigidity to infrastructure-enabled scalability, once firms have learned to modularize and redeploy

their high-infrastructure capabilities. These retail firms can transfer advanced integration capabilities while adapting to local responsiveness requirements by applying an omnichannel or purely digital channel strategy (Legner et al., 2017). Retail firms from advanced infrastructure countries have developed capabilities for sophisticated customer experiences, such as quick order processing, expedited fulfillment, and availability of pick-up and return points, that can be successfully transferred and adapted across markets (Gielens et al., 2020). In contrast, firms from home countries with relatively weaker physical infrastructure do not possess the capabilities to fulfill customer expectations in host countries with advanced physical infrastructures and need to invest heavily in developing digital and internal logistics capabilities, which adversely affects their international expansion endeavors (Benmamoun et al., 2019). Thus, home-host country infrastructure differences initially magnify responsiveness costs at low levels of digital internationalization, but later become a transformative force that amplifies integration benefits at high levels of digital internationalization.

Therefore, we hypothesize:

Hypothesis 3 (H3): The home-host country difference in physical infrastructure will steepen the U-shaped relationship between digital internationalization and MNE performance.

DATA AND METHODS

Context

The research context of our study is the world's biggest retail MNEs. Retail firms share similar strategic motivations for internationalizing (Powell, 2014; Mohr et al., 2018; Shi et al., 2018) and are strongly affected by digital technologies (Adhikary et al., 2021; Fang et al., 2021) providing

a very suitable context for examining the digital internationalization and MNE performance relationship. However, the literature has neither adequately assessed the effect of digital internationalization on retailer performance nor examined the influence of physical infrastructure on digital internationalization's effect at the firm or country level. Given the neglect of these topics and the significant theoretical relevance and practical importance of retail firm internationalization – particularly given retailers' massive investments in digital and physical infrastructure – we consider the global retail industry to be a very good context to examine our research questions.

Data

We utilized data from the Edge by Ascential database to test our hypotheses. This database covers more than 10,000 retail operations from 211 markets, providing detailed information about the number of outlets and the number of sales for each retailer in a given country and a given year (Oh et al., 2015; Swoboda et al., 2015; Batsakis and Theoharakis, 2021). We merged this retailer data with financial data collected from the Bureau van Dijk's OSIRIS database. The analysis in this study is at the MNE-year level. While the annual financial performance of these MNEs is based on consolidated annual group accounts, digital sales take place at the subsidiary (host country) level. Further, we set the following three restrictions for our sample. First, we did not include firms that have shown only domestic activity, i.e., they have not reported any foreign sales activity during the period under examination. Second, we chose 2006 as the first year for our dataset since it is regarded as the starting point of the current digital revolution wave, which has significantly influenced e-commerce (Brynjolfsson and McAfee, 2014). On average, firms in our sample reported USD 13.4 billion in total assets and USD 15.5 billion in total sales and

operated in different retail segments across a widespread geographic area (8.8 host countries on average), resulting in 1,632 firm/year observations for 208 multinational retailers.

Dependent Variable

Firm performance. We measure firm performance using the ratio of net income to total assets, i.e., return on assets (ROA) (Pereira et al., 2021), the most widely used performance measure in the internationalization–performance literature (Sullivan, 1994; Capar and Kotabe, 2003; Hennart et al., 2019). Extant research in retailing also uses ROA as a proxy for retailer performance (Nath et al., 2019; Wang et al., 2020), and its suitability has been widely acknowledged by marketing scholars (Hult et al., 2008) because ROA measures performance in relation to the resources a retailer deploys to fulfil its goals (Katsikeas et al., 2016). Additionally, ROA is relevant to the independent variable of our study, i.e., digital internationalization, as, according to the international accounting standards, it captures investments in digital assets, such as software, required to operate digital channels.^[2] Further, ROA is an appropriate dependent variable for our theoretical framing, as integration benefits may improve asset efficiency, leading to a higher ROA, while responsiveness costs would reduce it, thus lowering ROA. The data are obtained from Bureau van Dijk's Osiris database.

Independent and Moderating Variables

Digital internationalization. Consistent with long-standing practice in the IB literature, we measure a retailer's digital internationalization with the ratio of its foreign market digital sales to its total sales (DFSTS) (Capar and Kotabe, 2003; Contractor et al., 2003; Hsu et al., 2013). This foreign digital sales intensity indicator directly captures the share of ecommerce sales that

originates abroad, providing an intuitive and readily comparable proxy for a firm's international digital reach. Although the metric does not reveal how many countries the firm serves or the relative weight of each market, its transparency and widespread use make it well suited for cross-sectional benchmarking. Data is drawn from the Edge by Ascential database. To address the coverage concern, we later replicate our analyses using Blau's heterogeneity index as a sensitivity test, which explicitly accounts for both the number of foreign markets served and their relative revenue weights.

International Retail selling space ratio. We operationalize international retail selling space as the proportion of a retailer's selling area located abroad (expressed in millions of square feet) to its total global selling area (González-Benito et al., 2005). This metric serves as a proxy for the firm's international deployment of physical resources: the higher the ratio, the larger the retailer's physical footprint outside its home market. In our sample, the mean international retail selling space ratio is 26.8 percent. This information is collected from the Edge by Ascential database.

Physical infrastructure difference. The variable *physical infrastructure difference* measures the difference between the home and host countries' average logistics performance index (LPI) score, which captures the relative ease and efficiency with which products can be moved into and inside a country (Martí et al., 2014). A positive value denotes a relatively higher home country logistics performance (advantage), and a negative value indicates a relatively higher host country logistics performance (disadvantage). LPI is a longitudinal index that assesses the logistics environments in 100 countries by surveying logistics professionals. Its goal is to measure not only the quality of the countries' gateways (e.g., ports, borders), but also the overall logistics performance in terms of infrastructure, services, border procedures and time,

and supply chain reliability. The estimation of LPI is based on six key dimensions: customs performance, infrastructure quality, ease of arranging shipments, logistics services quality, consignments tracking and tracing, and timeliness of shipments. The average physical infrastructure difference is 0.36 [-0.73, 1.83]. The index has been previously adopted by scholars doing research in cross-border trade (Martí et al., 2014). The data are sourced from the World Bank.

Control Variables

Given that our sample's firms are active in both physical and digital sales, we control for retailers' degree of *physical internationalization*. To measure this control variable, we utilize the diversification entropy measure of Jacquemin and Berry (Jacquemin and Berry, 1979). We calculate this variable as: $\sum P_{ip} \ln \left(\frac{1}{P_{ip}} \right)$, where P_{ip} is the percentage of physical store sales in country i ; and $\ln \left(\frac{1}{P_{ip}} \right)$ is the particular weight of each country. Also, to account for the retailers' *product diversification*, we utilized the same diversification entropy measure of Jacquemin and Berry (Jacquemin and Berry, 1979). This variable is calculated as: $\sum P_d \ln \left(\frac{1}{P_d} \right)$, where P_d is the percentage of sales in product category d , and $\ln \left(\frac{1}{P_d} \right)$ is the particular weight of each product category. Each retailer's product categorization was based on data collected from the Edge by Ascential database and the eight categories they assign (e.g., clothing and footwear, grocery, home, garden, etc.). We control for the firm's home-region activity by introducing *regional concentration*, which is calculated as the ratio of a firm's home-region sales to total sales (Oh and Rugman, 2012). We use the concept of the broad triad by Rugman and Verbeke (Rugman and Verbeke, 2004) to categorize a firm's sales activities into a

specific home region. We also control for firm *age*, i.e., the difference between the year of observation and the year of inception (Gaur and Delios, 2015; Du and Colovic, 2024). A logarithmic transformation is applied to normalize the distribution.

Further, we measure the firm's *leverage* as the ratio of a firm's debt to its total assets in an attempt to further control for the financial prowess of the firm (Hitt et al., 2006). We also add the firm's *fixed assets ratio*, measured as a proportion of total assets, as it is considered a crucial determinant of firm internationalization (Hashai and Delios, 2012). Furthermore, aggregate *cultural distance* and *home country GDP* (gross domestic product) are included to control for the formal and informal institutional settings (Schwens et al., 2011; Shi et al., 2017; Tower et al., 2019). The latter control variable is a useful proxy for the macroeconomic conditions in the home market, which can have implications for the retailers' internationalization processes (Swoboda et al., 2016), while the former measures the accumulated cultural distance between the retailer's home country and its host countries (Li et al., 2017; Couper et al., 2020). We calculate aggregate cultural distance as the average cultural distance between home and host countries, using the Euclidean distance (Konara and Mohr, 2019) for Hofstede's (2001) original four cultural dimensions. To capture any unobserved heterogeneity that stems from the retailer type, we add *grocery retailer*, a dummy variable taking the value 1 if the retailer primarily focuses on grocery and the value 0 otherwise (Batsakis et al., 2023b). Finally, to account for the few cases of born-digital retailers, we introduce a dummy variable that takes the value 1 if the retailer was launched as a purely digital e-commerce platform and the value 0 otherwise.

Method

Our conceptual model assumes that retail firms can digitally internationalize their business activities, improving their performance by adding a digital (i.e., e-commerce) sales channel. However, our analysis faces two selection biases: firms that internationalize may systematically differ from domestic firms, and firms capable of digital sales may possess distinct capabilities. To mitigate these sample-induced endogeneity concerns, we adopt a Heckman selection model (Heckman, 1979) that explicitly models both selection processes. In the two-step Heckman procedure, we expand the sample by including additional retail firms that have neither internationalized nor digitalized their sales channels in the examined period.

In the first stage, we create a dummy variable indicating if the retailer has recorded its first international expansion in the focal year taking the value of 1, and the value 0 otherwise. As instruments, we use home country GDP growth, trade to GDP ratio, and population (in millions). All of them are time-varying variables. The choice of these instrumental variables was made after accounting for home market demand and supply conditions that traditionally influence retailer internationalization. Further, we incorporate firm sales, age, GDP, and grocery as additional predictors. The probit model is estimated using a panel formation of 3,619 firm/year observations, where a firm will be included in the dataset until its first year of internationalization. The purpose of this stage is to generate the inverse Mills ratio, which will be used in the second stage model, where we deal with internationalized firms only. In addition, our sample is subject to sample-selection bias as we consider that retail firms can sell their product through digital channels. Yet, not all retail firms can sell their products through digital channels. We follow the same methodological approach and adopt a Heckman selection model, augmenting the dataset by adding retail firms drawn from the initial sample. The dummy dependent variable for the first stage of the Heckman selection model is assigned the value of 1

if the retailer has reported digital channel sales in the focal year and the value of 0 otherwise. As instruments, we use home country internet users and mobile phone users (as a percentage of the total population), and the local retail firms' e-commerce activity. The rationale behind the choice of these instrumental variables is that retailers' growth of digital channels can be affected by home market factors that foster consumers' digital skills and their familiarization with digital technology. On top of these three instruments, we also employ firm sales, age, GDP, and grocery as additional determinants. The probit model is estimated in a panel formation with 3,513 firm/year observations, where a firm is included in the dataset until its first year of digitalization. Once again, the purpose of this stage is to generate the inverse Mills ratio, which will be used in the second stage model (the results of the first stage model are reported in Table S1 in the supplementary document).

Given that we have generated two inverse Mills ratios, we add both as control variables in the second-stage model (Li et al., 2022a; Batsakis et al., 2023b). We lag the independent, moderating, and control variables by one year. Year dummies were also included to account for any business cycle effects. The conceptual model is depicted in Figure 2.

INSERT FIGURE 2 ABOUT HERE

RESULTS

Table 1 displays the pairwise correlations. After mean-centering the predictors, the VIFs for all first-order terms remain well below both the traditional rule-of-thumb of 10 (Baum, 2006) and the more conservative benchmark of 5 as suggested by Lindner et al (2020). The only VIFs that exceed 10 are attached to the constructed quadratic and interaction terms, which is inevitable

as higher-order terms are an algebraic product of their constituent variables and therefore perfectly correlated with them. Such multicollinearity does not introduce bias, but rather inflates standard errors, with the resulting loss of precision largely confined to the collinear variables, not contaminating the estimates for other regressors (Lindner et al., 2020). Further, the signs, magnitudes, and significance levels of all first-order coefficients remain stable when the higher-order terms are excluded. Taken together, the modest first-order correlations and the reported VIF scores in Table 1, along with the acceptable mean VIF profile in Table 2, provide convergent evidence that multicollinearity is unlikely to bias our findings.

INSERT TABLE 1 ABOUT HERE

Table 2 presents the FGLS regression results, where Model 5 is the full model that we rely on to test our hypotheses. All continuous right-hand-side variables are standardized prior to estimation. Therefore, the coefficients reported in Table 2 represent standardized effects. Our baseline hypothesis (H1) posits a U-shaped relationship between digital internationalization and MNE performance: performance decreases at low levels of digital internationalization but increases at higher levels. To test the existence of a U-shape, we follow the three-step process suggested by Haans et al. (2016). First, we assess whether the coefficients of the linear and quadratic terms are statistically significant and have the proposed signs. Our results confirm that the linear digital internationalization term is negative and statistically significant ($b = -3.041$, $p = 0.000$), while the squared term is positive and statistically significant as well ($b = 0.634$, $p = 0.000$). Thus, we meet the first condition to support a U-shaped digital internationalization and MNE performance relationship. Second, the slope must be sufficiently steep at both ends of the

data range. We find that the slope at the low end of the digital internationalization range is negative and statistically significant ($b = -3.317$, $p = 0.000$), while the slope at the high end of the variable's range is positive and statistically significant ($b = 8.683$, $p = 0.000$). Our results, thus, confirm the second condition. Third, we assess whether the turning point of the curve is located within the range of the independent variable. The curvilinear effect of the examined relationship (Figure 3) depicts that the turning point lies well within the range observed in our sample. Thus, H1 is supported.

INSERT FIGURE 3 ABOUT HERE

INSERT TABLE 2 ABOUT HERE

In hypothesis 2, we posit that firm-level international physical resources (proxied by the ratio of a retailer's selling area located abroad to its total global selling area) positively moderate the U-shaped relationship between digital internationalization and MNE performance. The reported coefficient of the interaction term support hypothesis 2, as the interaction between the squared term of digital internationalization and the linear term of retail selling space is positive and statistically significant ($b = 0.110$, $p = 0.031$). Figure 4 graphically illustrates the moderating effect of this relationship. Therefore, the relationship between digital internationalization and MNE performance becomes steeper for firms with a greater physical sales presence abroad.

Hypothesis 3 posits that the home-host physical infrastructure difference amplifies the negative digital internationalization and MNE performance relationship at low to moderate digital internationalization levels but strengthens the positive digital internationalization and MNE performance relationship at moderate to high digital internationalization levels. The

estimated results support hypothesis 3, as they show that the interaction between the squared term of digital internationalization and the linear term of physical infrastructure difference is positive and statistically significant ($b = 0.297$, $p = 0.006$). Figure 5 graphically shows that the physical infrastructure difference steepens the U-shaped curve.

INSERT FIGURE 4 AND FIGURE 5 ABOUT HERE

To further assess the shape and significance of the curvilinear relationship, we computed marginal effects across the full observed range of digital internationalization (i.e., DFSTS), along with standard errors and z-statistics (Tables S5–S7 in the Supplement). The results confirm the predicted U-shape. At low levels of digital internationalization (0–40%), the marginal effect is negative or statistically significant, reflecting the initial coordination and adaptation costs associated with early international digital expansion. Around the midpoint of the distribution, the slope becomes flatter and remains mostly non-significant, as expected near the turning point of a quadratic function. At higher digital internationalization levels ($\geq 60\%$), the marginal effect becomes positive and strongly significant, indicating that accumulated scale, learning, and integration benefits dominate. For both moderators, the high and low moderator curves remain consistent with a steepening of the U-shape. Slopes at low levels of digital internationalization are more negative, and slopes at high levels of digital internationalization are more strongly positive.

Economic significance

Since Table 2 reports standardised coefficients, we can assume that a one standard deviation of digital internationalization equals one percentage point of DFSTS. Each coefficient, therefore, tells us by how many percentage points a retailer's ROA moves when its foreign digital sales share rises by 1 percentage point.

Regarding the direct (curvilinear) effect of digital internationalization on ROA, the estimates imply that for a retailer with no foreign digital sales, a 1-percentage-point increase reduces ROA by a little over 3 percentage points – relative to the sample's baseline profitability of about 3.84% (the constant in Model 5 is 3.839). This marginal penalty persists up to the turning point, where the slope becomes zero. Beyond this threshold, the relationship reverses: at around 5 percentage points, an additional percentage point of digital internationalization adds about 3.3 ROA percentage points, and at around 8 percentage points, the gain exceeds 7.1 percentage points. Taken together, we can infer that tentative digital moves are costly, whereas deep international digital penetration can more than triple a typical retailer's profitability.

As shown already, a greater proportion of international physical resources amplifies this pattern. Retailers whose international selling space is one standard deviation above the mean experience an additional slope of -0.95 at the outset but gain +0.11 on the curvature term. In practical terms, the first 1 percentage point of digital internationalization now drags ROA down by about 4 points; however, at 8 percentage points, each additional percentage point is worth roughly 7.9 points, instead of 7.1. Large overseas store footprints, therefore, deepen the early “valley of death,” but make scaling on the right-hand side of the U considerably steeper, consistent with the idea of global integration.

A similar, but even stronger, moderating effect comes from the retailer's home-host country infrastructure differences. The interaction coefficients (−3.285 for the linear term and

+0.297 for the quadratic term) indicate that a firm based in a logistics-superior country loses about 6.3 ROA points when it adds the first 1 percentage point of digital internationalization, yet gains nearly 8.6 percentage points once it reaches 8 percentage points of digital internationalization. Superior domestic infrastructure thus steepens both sides of the curve.

Sensitivity analysis

To verify the stability of our baseline estimates, we performed three complementary sensitivity analyses.

Alternative measure of digital internationalization. The DFSTS ratio does not indicate either the breadth of markets served or the relative importance of each one. To address this limitation, we re-estimated the model using Blau's heterogeneity index, which explicitly captures both the number of foreign markets and their revenue weights (Boone et al., 2019; Li et al., 2022b). This is calculated as: $DI = 1 - \sum_{i=1}^M p_i^2$, where M is the total number of foreign markets served by the retailer through digital sales and p_i is the proportion of the firm's total digital sales that comes from market i . The index ranges from 0 (complete concentration) to a theoretical maximum of $1 - \frac{1}{M}$ (perfectly even distribution across all markets). Results (Table S2, supplementary document) fully support all three hypotheses.

Composite moderator for physical assets. Because both moderating variables, i.e., international physical retail space (firm-level) and national physical infrastructure (country-level), reflect tangible, location-bound assets, we combined them into a single latent construct. A principal-component factor analysis yielded one factor with an eigenvalue greater than 1, which we used as the moderator in place of the two separate terms. Model estimates with this

composite factor (Table S3, supplementary document) remain virtually unchanged, reinforcing our theoretical arguments.

Broad performance metric. Our main model relies on ROA because it is sensitive to operational leverage and asset efficiency – two dimensions likely to be affected by digital expansion. Nonetheless, digital internationalization could also influence return on sales (ROS) or return on equity (ROE). Following Delios and Beamish (1999), we created a single latent performance factor (with an eigenvalue greater than 1), that loads on ROA, ROS, and ROE (extracted via principal-component analysis). Substituting this factor for ROA (Table S4, supplementary document) leaves the core results intact, indicating that the performance effects we document in the main model are not measure-specific.

Across all three robustness tests, the substantive conclusions of the study remain unchanged, highlighting the robustness of our findings.

DISCUSSION

This study makes several theoretical contributions to international strategy research and the digital internationalization literature (Hanelt et al., 2021; Menz et al., 2021). First, we extend the IR framework – traditionally applied in the context of physical internationalization – to digital internationalization by demonstrating how digital-physical integration creates cross-domain (i.e., physical and digital) coordination challenges that are not captured in traditional single-domain frameworks. Second, we show that country-level infrastructure differences present central boundary conditions for the main relationship because they create systematic (dis)advantages in digital internationalization capability transfer. While digitalization is widely recognized as a global megatrend that has fundamentally transformed the business world and beyond (Li et al.,

2019), prior scholarship has paid insufficient attention to how physical assets shape digital internationalization performance (Hazlehurst and Brouthers, 2018).

Drawing upon the IR framework, our findings reveal a curvilinear pattern in the digital internationalization-performance relationship, driven by the evolving cost-benefit dynamics of both integration and responsiveness: At low to moderate levels of digital internationalization, both responsiveness and integration costs exceed their respective benefits, as firms must adapt to diverse digital contexts while managing fragmented systems across only a few markets. At moderate to high levels of digital internationalization, both integration and responsiveness benefits outweigh costs as MNEs have accumulated international digital capabilities and achieved sufficient scale to capture synergies. This U-shaped pattern provides a foundation for understanding how the moderators of international physical presence and differences in the physical infrastructure of home and host countries amplify these IR dynamics. By studying digital internationalization, our work helps establish a connection between the digital and the physical space and, in doing so, contributes to extending the important IR framework to the digital domain, capturing the fundamental challenges and benefits of digital internationalization for MNEs.

International physical presence steepens both sides of the U-curve by amplifying coordination costs at low to moderate levels of digital internationalization, while enhancing integration benefits at moderate to high levels. At low to moderate levels of digital internationalization, greater international physical presence increases coordination complexity as firms must align digital and physical operations across multiple markets without sufficient digital scale to justify the investment. Firms must synchronize inventory visibility, pricing, and customer data across channels, creating friction that negatively impacts performance. By

contrast, at moderate to high levels of digital internationalization, MNEs have developed capabilities to utilize their extensive international physical presence more effectively, leveraging stores as fulfillment hubs and creating globally coordinated ‘phygital’ strategies (Prior, 2021). This increases early costs while accelerating later benefits, explaining why international physical presence steepens the entire U-shaped relationship rather than simply shifting it.

Our work also established central boundary conditions by showing that home-host country physical infrastructure difference has opposing effects at different stages of digital internationalization. At low to moderate levels, this difference counterintuitively increases responsiveness costs. MNEs from countries with a strong physical infrastructure tend to develop digital capabilities that are calibrated to high-infrastructure environments, leading to a systematic overestimation of host country capabilities and costly adaptation requirements. Each incremental expansion into infrastructure-constrained markets heightens responsiveness costs disproportionately, steepening the downward slope of the U-curve. However, as firms accumulate international experience and reach moderate to high levels of digital internationalization, this mechanism reverses. At high digital internationalization levels, MNEs from advanced infrastructure countries become more effective at leveraging their superior digital and logistics capabilities developed across diverse markets. Infrastructure difference thus transforms from a liability into a capability multiplier, steepening the upward slope of the U-curve. Hence, our work reveals the importance of the external infrastructure environment in amplifying both the positive and negative influences of digital internationalization. As a result, our research offers a contingency perspective and advances our understanding of how international physical presence at the firm-level and country-level infrastructure differences affect the relationship between digital internationalization and MNE performance.

Strategic Implications

Our work has important managerial implications, particularly regarding how firm performance depends on digital internationalization sales strategy execution across different stages. While digital sales channels at lower levels of internationalization can prove costly, building an extensive international digital presence can eventually be highly beneficial. For example, Walmart, a going-digital retail MNE with extensive international physical presence in more than 20 countries, has benefitted from rapid digital channel sales growth through a smartphone app that has become one of the most downloaded e-commerce smartphone applications (Techcrunch, 2019). Interestingly, when entering India, a country with physical infrastructure weaknesses, Walmart adopted a digital channel entry strategy by acquiring Flipkart, the country's largest online retailer, which was familiar with local logistics idiosyncrasies (Walmart, 2018). However, the company is still enhancing its physical store locations (CNBC, 2023). Further, Inditex, parent company of Zara, has managed to “turn its stores into mini-distribution hubs — merging its online and bricks and mortar presence” (FT.com, 2021) and currently generates more than 25 percent of its sales from digital channels. Amazon has also strategically expanded its physical presence internationally through Whole Foods acquisitions and Amazon Go stores, leveraging digital expertise to enhance physical retail experiences while using stores as fulfillment hubs for its digital operations (Butler, 2021; Varma et al., 2024).

In addition, managers need to be aware that an extensive international physical presence and physical infrastructure difference between home and host countries can affect the success of international digital strategies, creating expectations and capabilities that are both detrimental and beneficial. Managers should not disregard the benefits of physicalization when expanding

their firms' digital footprint internationally. They should also be cautious about high levels of infrastructure misalignment between home and host country and aim at being more locally responsive to each host country's idiosyncratic characteristics. To achieve this, MNEs would need to conduct systematic research, which would result in entering markets with similar physical infrastructures or adapting their digital entry strategy according to each market's idiosyncratic characteristics – a relatively costlier process.

To deal with the complexities of digital internationalization, managers should prioritize access to local market capabilities, especially in the early phase of digital internationalization. At low levels of digital internationalization, firms often experience weak performance due to a limited understanding of host market digital contexts and customer behaviors. To overcome this, MNEs should invest in market research, digital training, and local partnerships to accelerate adaptation. Indeed, much quicker adaptation can be achieved by joining local digital platforms and hiring local talent. This may reduce the costs and time associated with entering new digital markets. As MNEs advance to higher levels of digital internationalization, they can realign their strategies to build scalable digital capabilities, such as adaptable IT systems and modular digital solutions, enabling the efficient transfer of digital business models across multiple international markets.

The strategic bundling of physical and digital channels is also of critical importance. When extensive international physical presence is combined with advanced digital channels, it can create an enhanced 'phygital' customer experience that combines the convenience of online shopping with the trust and familiarity of physical touchpoints. Decision-makers involved in the process of penetrating and growing international markets through digital channels should not neglect the importance of physical stores since the latter can facilitate digital internationalization,

acting as hubs for services such as click and collect, immersive product demonstrations, and return points, all of which support digital sales and improve customer loyalty. Further, firms should consider infrastructure dissimilarities between their home and host markets. MNEs originating from countries with advanced physical infrastructure must adapt their strategies when entering markets with weaker physical infrastructure, such as underdeveloped logistics systems, avoiding taken-for-granted assumptions and over-reliance on the host market's physical infrastructure. Aligning a firm's strategy on logistics and digital entry strategies to host market conditions while leveraging home-country expertise can help mitigate diminishing returns and enhance performance at higher levels of digital internationalization. Managers involved in the execution of digital internationalization should systematically assess external factors related to physical infrastructure and adjust their digital and physical strategies accordingly, taking into account the idiosyncrasies of the host market, thereby optimizing the synergies between these two channels.

Limitations and Future Research

This study also has limitations that provide avenues for future research. First, our work examines one specific aspect of digital internationalization, albeit an important one: the internationalization of digital sales channels. While digital sales channels have revolutionized the retail industry and, to some extent, substituted physical channels, digitalization can have additional implications. For example, digital communication technologies can also help reduce administrative costs and increase communication and trust abroad (Nauhaus et al., 2021). Further, digital technologies can even transform business models and create fundamentally new ones (Lawton, 2001), such as platform businesses (Jacobides et al., 2018; Lanzolla and Markides, 2021; Snihur and Markman,

2023) that offer an interface between different groups of users and benefit from network externalities (Monaghan et al., 2020; Stallkamp and Schotter, 2021). The advent of artificial intelligence (AI) provides even more profound means to reshape business models (Khanagha et al., 2025; Zhou et al., 2025). We neither examine other aspects of digitalization beyond e-commerce, as we do not have the necessary data, nor do we exclusively explore the influence of platform businesses (Hänninen and Smedlund, 2021). Future work should examine other aspects of digital internationalization, the effect of digitalization on MNEs' entry mode choice, and the digital internationalization and MNE performance relationship for platform businesses.

Second, we focus on physical infrastructure at the country and firm-level as moderators of digital internationalization, rather than examining digital infrastructure dimensions such as cloud computing capabilities, platform architectures, or cross-border IT integration. Future research should investigate how digital infrastructure, both at the firm and country levels, interacts with physical infrastructure to influence digital internationalization outcomes. Studies could also examine whether the mechanisms we identify hold in contexts where digital infrastructure varies significantly across markets, or whether digital infrastructure differences create similar dynamic cost-benefit reversals as we found for physical infrastructure.

Third, our findings are most applicable to firms operating in (1) asset-intensive industries where physical presence matters, (2) markets with sufficient digital infrastructure to support e-commerce, and (3) contexts where integration benefits can realistically outweigh responsiveness costs. Future research should also explore purely service-based MNEs, or industries with extreme local adaptation requirements. Future research could also explore how different institutional factors moderate the IR dynamics of the digital internationalization and MNE performance relationship (Geleilate et al., 2016; Zhou et al., 2022).

Fourth, our sample consists of the largest firms in the global retail industry. While this context is well-suited for our research and the described mechanisms may have broader applicability to other firms, further studies could investigate whether the digital internationalization and MNE performance relationship is consistent across firms in diverse industries, particularly those that internationalize for reasons other than seeking new markets, and whether there are any systematic variations. Finally, future studies could explicitly compare born-digital and going-digital retail firms to examine how digital maturity affects the cost–benefit IR dynamics across different stages of digital internationalization. As the number of internationally active born-digital retailers grows year on year, such comparative analyses can provide richer insights into firm-level heterogeneity in relation to both the shape and steepness of the U-curve.

Lastly, a meaningful comparison between born- and going-digital firms is not possible due to the small number of born-digital retailers in our sample. Because of their scalable digital infrastructures, born-digital firms (such as Amazon) may have lower early-stage responsiveness costs. On the other hand, the challenges of integrating digital and physical operations, as well as legacy systems, drive up costs for traditional retailers like Walmart. Future research should specifically compare how digital maturity influences the cost-benefit IR dynamics across digital internationalization stages as born-digital retailers continue to expand their operations. This could reveal heterogeneity in the U-curve's shape and steepness.

Conclusion

Building on the IR framework to study the digital internationalization and MNE performance relationship, our work reveals the various challenges and opportunities that connecting digital

and physical internationalization strategies offer. The central argument of our study is confirmed in that digital internationalization is associated with both negative and positive returns to the internationalizing firm, depending on the level of digital internationalization, resulting in a U-shaped relationship, which is further contingent on the international physical presence and comparative physical infrastructure difference between the MNE's home and host countries. Our results demonstrate the importance of understanding the IR dynamics of digital channel strategy when examining international diversification. While offering a nuanced understanding of the digital internationalization and MNE performance linkage in the global retail context, our research also opens up novel research avenues to help connect digital technologies, firm-level physical presence, and country-level infrastructures differences, and internationalization through the IR lens.

NOTES

[1] Physical infrastructure refers to “the level of development and quality of ports, airports, roads, and rail infrastructure” as well as “the level of efficiency of customs and domestic transport that is reflected in the time, cost, and number of documents necessary for export and import procedures” (Portugal-Perez and Wilson, 2012).

[2] <https://www.ifrs.org/issued-standards/list-of-standards/ias-38-intangible-assets/>.

Declaration of generative AI and AI-assisted technologies in the writing process

While preparing this work, the authors used Grammarly to improve language and readability. After using this software, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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Table 1. Pairwise correlations and descriptive statistics.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	ROA	1.00														
2	Digital internationalization	0.04	1.00													
3	International retail selling space ratio	0.10	0.02	1.00												
4	Physical infrastructure difference	-0.03	-0.04	0.42	1.00											
5	Product diversification	-0.06	0.02	0.03	0.10	1.00										
6	Regional concentration	0.04	-0.39	-0.18	-0.30	0.06	1.00									
7	Age (logged)	-0.01	-0.04	0.07	0.08	0.18	0.04	1.00								
8	Leverage	0.04	0.07	-0.12	-0.01	0.04	-0.03	0.08	1.00							
9	Fixed assets ratio	-0.09	-0.17	0.19	0.06	-0.03	-0.03	0.11	0.03	1.00						
10	GDP (logged)	0.04	0.08	-0.02	-0.10	-0.18	-0.12	-0.01	-0.07	0.09	1.00					
11	Cultural distance	0.14	-0.04	0.35	0.20	-0.09	-0.29	0.01	-0.26	0.14	0.31	1.00				
12	IMR1	-0.03	-0.09	0.07	0.03	-0.09	0.08	-0.02	0.01	0.12	-0.11	-0.07	1.00			
13	IMR2	-0.01	-0.18	-0.03	-0.01	-0.08	0.18	-0.01	0.07	0.16	-0.54	-0.26	0.45	1.00		
14	Grocery	-0.03	-0.15	-0.06	-0.03	-0.08	0.19	0.08	0.03	0.24	-0.29	-0.20	0.59	0.75	1.00	
15	Born-digital	-0.03	0.64	-0.08	-0.07	-0.10	-0.19	-0.13	0.00	-0.25	0.08	-0.04	-0.07	-0.12	-0.11	1.00
	VIF	-	2.09	1.38	1.43	1.16	1.51	1.10	1.11	1.26	1.76	1.51	1.60	3.21	3.03	1.84
	Mean	7.85	2.30	0.22	0.27	0.21	90.75	3.32	37.17	54.30	28.74	12.28	0.11	0.24	0.48	0.03
	Std. dev.	13.47	10.57	0.35	0.39	0.32	21.07	0.95	32.36	18.57	1.69	29.19	1.07	0.97	0.50	0.17
	Min	-183.53	0.00	-0.73	0.00	0.00	0.00	0.00	-307.17	6.85	22.88	0.00	-1.88	-2.58	0.00	0.00
	Max	57.72	100.00	1.83	1.00	1.44	100.00	5.85	87.84	97.96	30.56	183.45	5.87	4.04	1.00	1.00

Note: Values above |0.07| are significant at the 5% level;

Table 2. Feasible generalized least squares estimates on the effect of Digital internationalization on firm performance (ROA).

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Ceof.	<i>pval</i>	Ceof.	<i>pval</i>	Ceof.	<i>pval</i>	Ceof.	<i>pval</i>	Ceof.	<i>pval</i>
	(s.e.)		(s.e.)		(s.e.)		(s.e.)		(s.e.)	
Product diversification	-0.464	0.005	-0.559	0.001	-0.559	0.001	-0.558	0.001	-0.551	0.001
	(0.164)		(0.164)		(0.163)		(0.164)		(0.164)	
Regional concentration	0.389	0.167	-0.112	0.793	-0.100	0.804	-0.296	0.401	-0.272	0.446
	(0.281)		(0.428)		(0.404)		(0.352)		(0.357)	
Age (logged)	0.113	0.423	0.112	0.372	0.142	0.238	0.085	0.456	0.101	0.373
	(0.141)		(0.126)		(0.121)		(0.114)		(0.113)	
Leverage	0.553	0.050	0.644	0.018	0.684	0.011	0.649	0.012	0.658	0.011
	(0.282)		(0.272)		(0.268)		(0.260)		(0.260)	
Fixed assets ratio	-1.043	0.000	-1.101	0.000	-1.114	0.000	-1.159	0.000	-1.149	0.000
	(0.178)		(0.173)		(0.173)		(0.170)		(0.170)	
GDP (logged)	0.071	0.768	0.262	0.293	0.302	0.218	0.237	0.333	0.234	0.338
	(0.239)		(0.249)		(0.245)		(0.245)		(0.244)	
Cultural distance	2.875	0.000	2.370	0.000	2.335	0.000	2.372	0.000	2.402	0.000
	(0.330)		(0.354)		(0.349)		(0.343)		(0.345)	
IMR1	-0.348	0.128	-0.541	0.018	-0.582	0.012	-0.610	0.009	-0.618	0.008
	(0.229)		(0.228)		(0.231)		(0.235)		(0.234)	
IMR2	-0.033	0.918	-0.150	0.617	-0.188	0.525	-0.293	0.321	-0.340	0.244
	(0.318)		(0.300)		(0.295)		(0.296)		(0.292)	
Grocery	1.220	0.052	1.721	0.007	1.938	0.002	2.096	0.001	2.209	0.000
	(0.627)		(0.639)		(0.635)		(0.630)		(0.627)	
Born-digital	-3.593	0.055	-6.105	0.000	-6.929	0.000	-7.301	0.000	-7.502	0.000
	(1.875)		(1.303)		(1.365)		(1.447)		(1.481)	

Table 2. (Continued)

Digital internationalization	-0.961 (0.730)	<i>0.094</i>	-0.878 (0.656)	<i>0.091</i>	-3.050 (0.773)	<i>0.000</i>	-3.041 (0.767)	<i>0.000</i>
Digital internationalization squared (H1)	0.302 (0.086)	<i>0.000</i>	0.292 (0.082)	<i>0.000</i>	0.628 (0.111)	<i>0.000</i>	0.634 (0.112)	<i>0.000</i>
International retail selling space ratio	-0.195 (0.107)	<i>0.067</i>	-0.514 (0.143)	<i>0.000</i>	-0.236 (0.103)	<i>0.023</i>	-0.400 (0.138)	<i>0.004</i>
Physical infrastructure difference	0.588 (0.190)	<i>0.002</i>	0.622 (0.184)	<i>0.001</i>	-0.093 (0.258)	<i>0.718</i>	0.037 (0.262)	<i>0.888</i>
Digital internationalization x International retail selling space ratio			-1.714 (0.502)	<i>0.001</i>			-0.950 (0.483)	<i>0.025</i>
Digital internationalization squared x International retail selling space ratio (H2)			0.193 (0.062)	<i>0.001</i>			0.110 (0.059)	<i>0.031</i>
Digital internationalization x Retail selling space Physical infrastructure difference					-4.027 (0.920)	<i>0.000</i>	-3.285 (0.968)	<i>0.001</i>
Digital internationalization squared x Physical infrastructure difference (H3)					0.382 (0.113)	<i>0.001</i>	0.297 (0.117)	<i>0.006</i>
Constant	5.421 (0.565)	<i>0.000</i>	4.788 (0.581)	<i>0.000</i>	4.567 (0.566)	<i>0.000</i>	3.945 (0.572)	<i>0.000</i>
Wald chi2	200.99	<i>0.000</i>	318.02	<i>0.000</i>	312.59	<i>0.000</i>	378.89	<i>0.000</i>
Mean VIF	1.82		2.71		3.09		6.28	

Notes: FGLS estimator that is robust to first-order panel-specific autocorrelation (AR1) and heteroskedasticity; Standardized coefficients are reported; standard errors are reported in parentheses; p-values are reported in italics; 1-tailed tests for hypothesized effects of independent and moderating variables are reported; all models include year dummies; number of observations = 1,632; number of firms = 208.

Figure 1. The costs and benefits of responsiveness and integration.

Responsiveness / Integration		Low Integration	High Integration
Low Responsiveness	Low DI:	<ul style="list-style-type: none"> Limited adaptation to local digital contexts Minimal standardization benefits (small digital footprint) Coordination frictions between isolated digital units 	<ul style="list-style-type: none"> Front-loaded coordination costs of connecting few markets Difficulty in amortizing integration investments (low scale) Fragmented system interoperability
		Net effect: Dominated by start-up costs → negative marginal returns	Net effect: Marginal benefits less than marginal costs → negative marginal effect
	High DI:	<ul style="list-style-type: none"> Reapplication and transferability of baseline digital assets across markets Early signs of cross-market learning 	<ul style="list-style-type: none"> Scalable digital platforms create economies of scale Data harmonization enhances global visibility Cross-market analytics accelerate integration learning
		Net effect: Slightly improving but still limited benefits	Net effect: Positive marginal gains → early upward movement in U-shape
High Responsiveness	Low DI:	<ul style="list-style-type: none"> Significant adaptation costs (local content, payments, regulatory configurations) Limited reapplication and fungibility of local solutions across markets Multimarket coordination challenges 	<ul style="list-style-type: none"> Dual pressure of local adaptation and global coordination System complexity high with little scale benefits Institutional distance intensifies frictions
		Net effect: High responsiveness costs dominate → downward slope of U	Net effect: Strong negative marginal effects → bottom of U-shape
	High DI:	<ul style="list-style-type: none"> Accumulated market knowledge reduces marginal adaptation costs Reusable local digital routines Enhanced contextual agility 	<ul style="list-style-type: none"> Integration and responsiveness mutually reinforcing Global–local orchestration capabilities scale Digital and physical channels coordinated efficiently
		Net effect: Neutral to moderately positive	Net effect: Marginal benefits exceed costs → strong positive slope of U

Figure 2. Conceptual model.

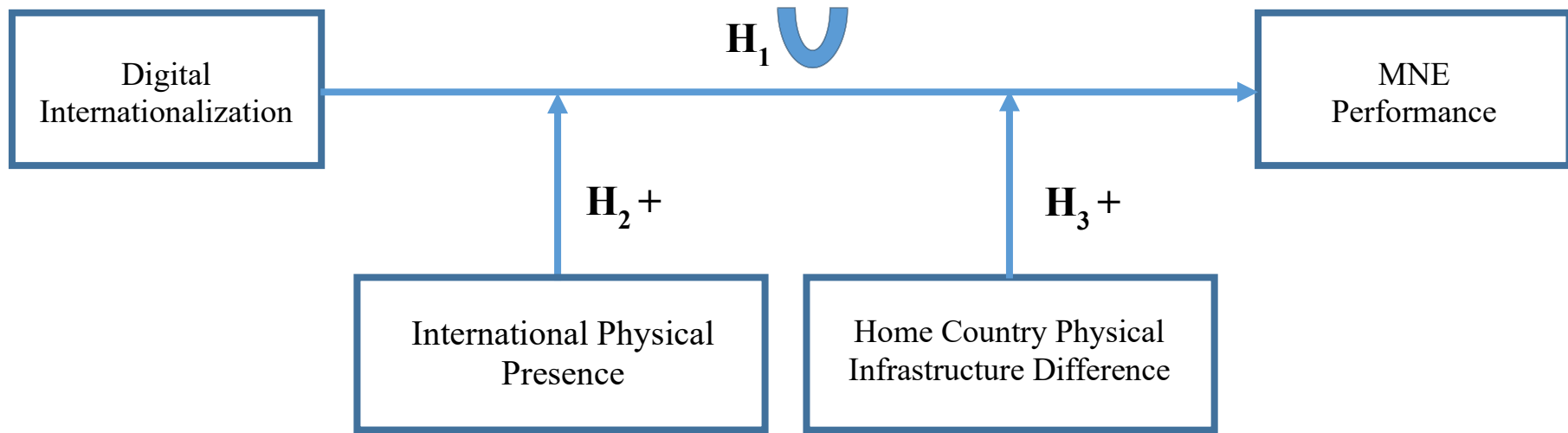
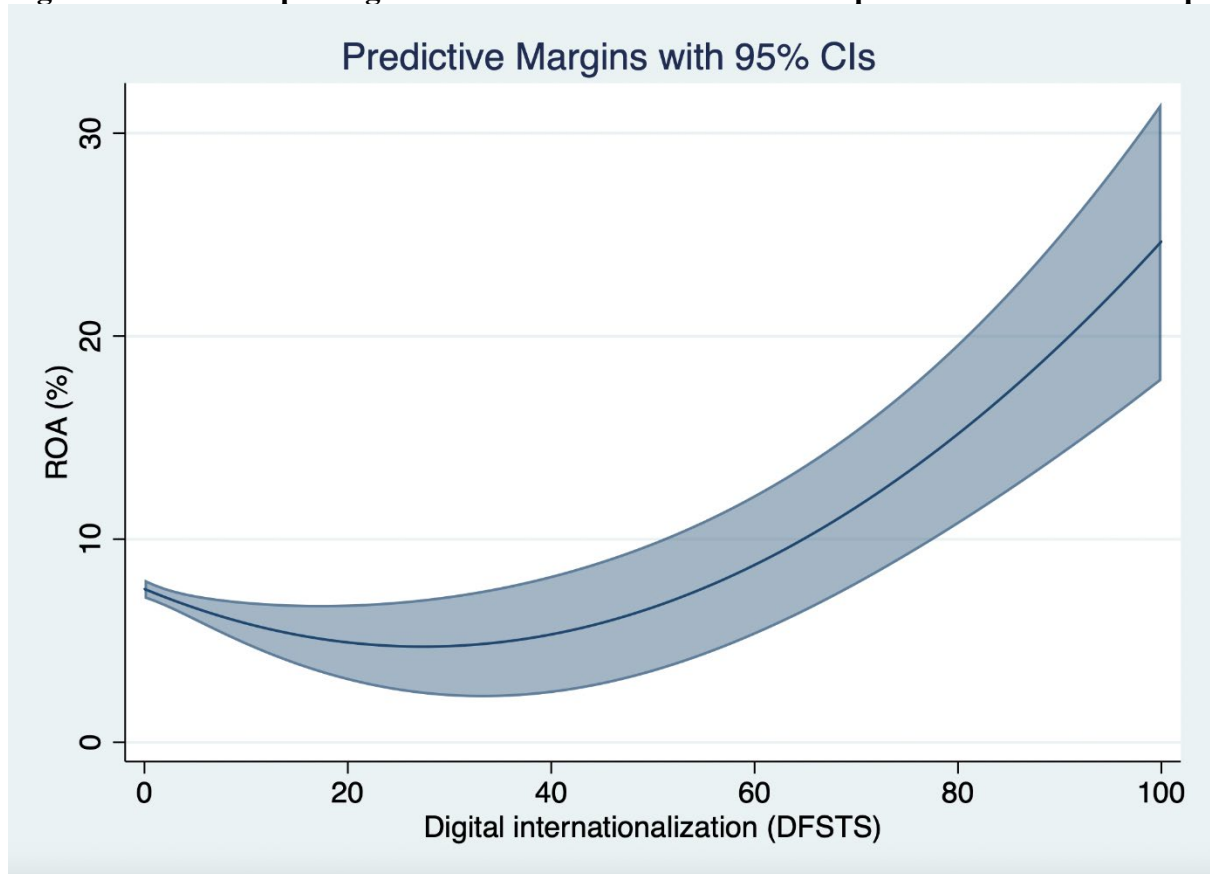
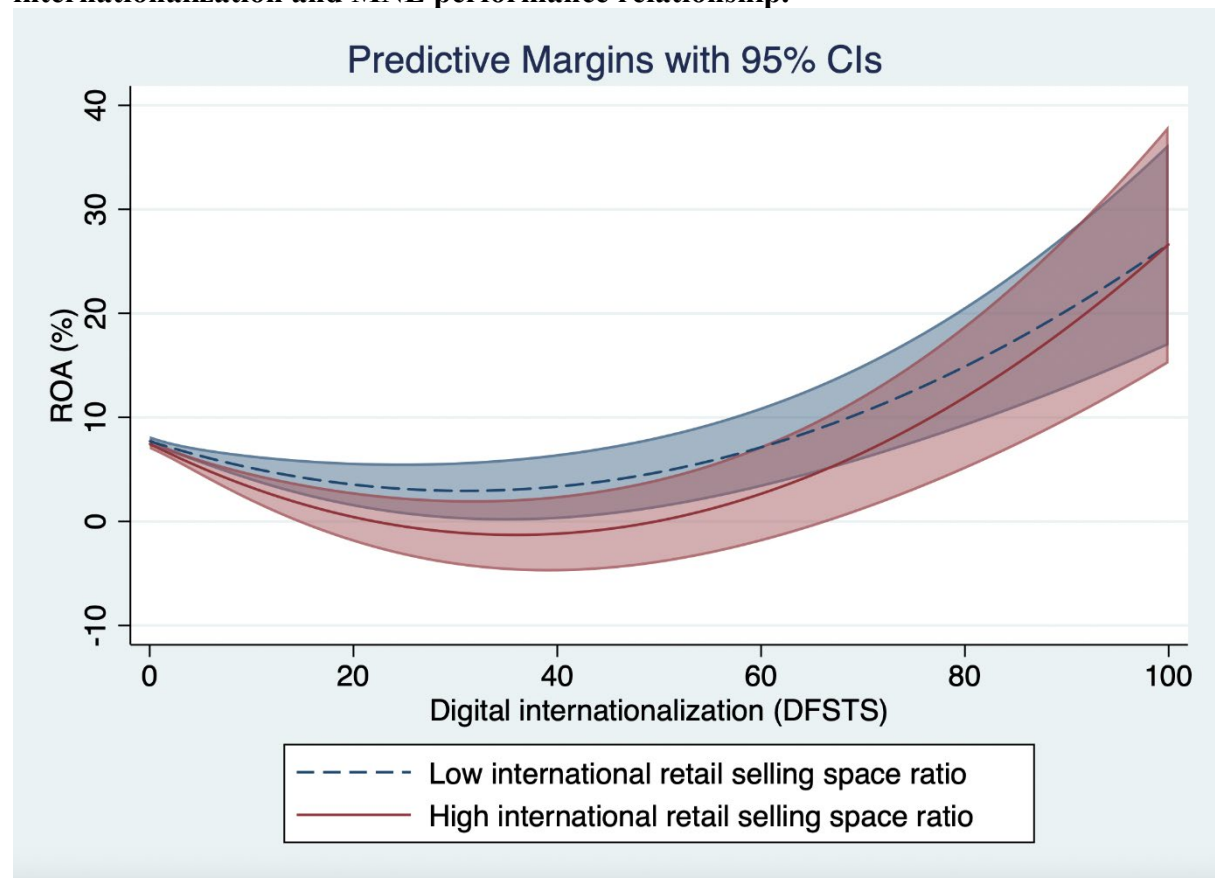


Figure 3. The U-shaped digital internationalization and MNE performance relationship.



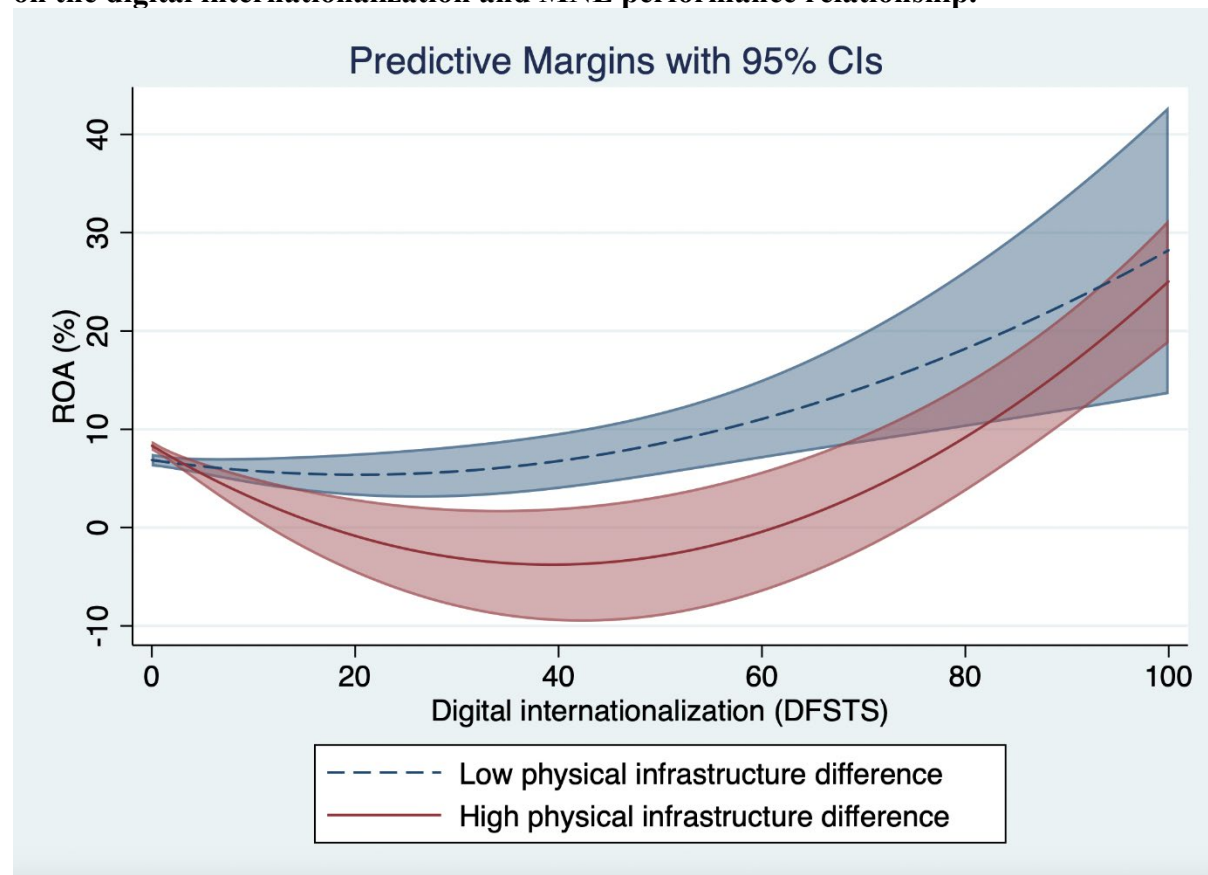
Note: Predicted values are plotted using the raw (unstandardized) DFSTS scale (0–100) to aid interpretability

Figure 4. The moderating effect of international physical presence on the digital internationalization and MNE performance relationship.



Note: Predicted values are plotted using the raw (unstandardized) DFSTS scale (0–100) to aid interpretability

Figure 5. The moderating effect of home-host country physical infrastructure difference on the digital internationalization and MNE performance relationship.



Note: Predicted values are plotted using the raw (unstandardized) DFSTS scale (0–100) to aid interpretability



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