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Reappraising International Business in a Digital Arena: Barriers, Strategies, and Context for Internationalization of Digital Innovations

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DEDICATION

To my maternal uncle, *Dr. Muhammad Naeemullah Naeem,* for illuminating every path I ever walked. You are the inspiration leading every step of my journey from the small town of Tando Adam to some of the world's finest universities and beyond.

&

To my dearest daughters, *Arwah Fatima* and *Aairah Fatima*, who always reenergize us to triumph over every challenge. May you both transcend all limitations to pursue your passions and live up to the legacy of your exemplary grandfather, Dr. Muhammad Naeemullah Naeem.

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ABSTRACT

This dissertation builds on the eclectic paradigm to explore internationalization strategies in the burgeoning digital economy through a rigorous empirical analysis of a unique big data archive tracking international penetrations of more than 1.5 million mobile apps across 58 countries. While traditional firms internationalize by internalizing physical assets to reap location advantages from foreign markets, many digital businesses internationalize by orchestrating networks of information flows across borders. Such digital internationalization may not be constrained by cross-national distance or lack of resources as digital businesses leverage globally disperse knowledge and innovation networks to develop scale free digital innovations and seamlessly transmit them across the world via global platforms. Incorporating such unique dynamics of digital internationalization in extant literature, I extend beyond the current research focus on firm resources and internalization of physical assets to evaluate how digital businesses internalize networks across multiple locations to virtually internationalize their scale free digital innovations. First, I argue that despite lower barriers to foreign market entries in digital world, digital internationalization is still subject to user adoption barriers that emanate from differences in user preferences. However, digital businesses may overcome user adoption barriers despite their limited resources by internalizing demand-side networks, particularly users, across countries. Next, I distinguish demand-side networks based on their potential of contributing knowledge and innovation ideas to facilitate the

internationalization of their digital innovations. I draw attention to the critical role of lead markets in a digital context by showing that establishing demand-side networks in lead markets can facilitate digital businesses in upgrading their innovations to penetrate multiple countries. Hence, I advocate expanding eclectic paradigm to incorporate demand-side networks in lead markets as important location advantages. Finally, as location of networks plays a pivotal role in setting the course of digital internationalization, I emphasize the need for categorizing countries across the world based on their network characteristics. I develop two indices, virtual distance and virtual clout, which measure how networks across countries differ from and connect with each other in the virtual world. My dissertation takes an initial but important step toward developing a more rigorous, quantifiable, and generalizable understanding of the new rules of digital internationalization by not only proposing important theoretical extensions but also subjecting them to sophisticated empirical investigations.

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INTRODUCTION

This dissertation seeks to revisit current international business (IB) frameworks on the wake of a burgeoning digital economy that engages more than 314 million individuals around the world in direct cross-border transactions (Mckinsey & Company, 2016). This is an important topic as unique dynamics of modern digital economy demand substantial extensions in traditional IB theories which largely emphasize the primacy of firm resource and capabilities that enable businesses to reap location advantages from foreign markets by internalizing overseas operations (e.g. Hymer, 1970; Johanson & Vahlne, 1997; Kirca et al., 2011; Rugman, 1990). On the other hand, several digital businesses—defined as firms engaged in development and marketing of digital innovations such as mobile apps, streaming services, social media platforms, and online software etc. (Boudreau, 2012; Shaheer & Li, 2019; Yoo et al., 2010; 2012)—internationalize by internalizing networks of information flows across borders as opposed to taking control of physical assets through foreign direct investments (Autio, 2017; Banalieva & Dhanaraj, 2018; Chen, Shaheer, Yi, & Li, 2019). These virtual information flows are largely scale free as neither transmitting a digital innovation across borders requires substantial investments nor the sheer magnitude of global users reduces the value of a digital innovation (Levinthal & Wu, 2010). As a result, digital internationalization may not be constrained by a lack of internal resources or cross-national distance as digital businesses virtually tap into globally disperse knowledge and innovation networks for developing novel digital innovations and seamlessly transmit their innovations across the

world via globally accessible platforms (Alcácer, Cantwell, & Piscitello, 2016; Brouthers, Geisser, and Rothlauf, 2016; Cavusgil & Knight, 2015; Coviello, Kano, & Liesch, 2017). These new rules for operating in cyberspace require not only a deeper theoretical investigation but also sophisticated empirical analyses to provide more rigorous, quantifiable, and generalizable understanding of digital internationalization. Responding to this important area of inquiry, my dissertation extends eclectic paradigm (Dunning, 1973; 1998; 2003) in a digital context by evaluating how digital businesses internalize networks across different locations to support the internationalization of their digital innovations. To empirically evaluate my theoretical contentions, I write several application programming interfaces (APIs) and design web robots and spiders to construct a big data archive tracking international penetrations of more than 1.5 million apps across 58 countries. The resulting dataset provides me several critical variables related to digital internationalization, such as country-wise daily downloads, revenues, rankings, daily app usage, and ratings of mobile apps.

The essays in my dissertation pursue a process of exploring normal science in a Kuhnian sense (Kuhn, 2012) by expanding the well-established eclectic paradigm to tackle the challenge of digital internationalization. The eclectic paradigm provides a sophisticated theoretical foundation for coherently integrating different lenses to develop a comprehensive understanding of the complex phenomenon of digital internationalization (Alcácer et al., 2016; Dunning, 2009; Singh & Kundu, 2002). Building on the eclectic paradigm, I explore the evolving roles of ownership, location, and internalization advantages as well as their interrelationships to propose some important extensions in the eclectic paradigm on the wake of modern digital economy.

The first essay in my dissertation, "The CAGE around Cyberspace? Internalizing Demand-side Networks to Overcome Distance in a Virtual World" builds on recent research (Banalieva & Dhanaraj, 2018) that moves beyond the traditional focus of internalization theory on markets versus hierarchies to highlight the importance of internalizing networks that reside outside organizational boundaries in broader demand environments. As one of the first papers on digital internationalization, this essay draws attention to the distinctiveness of digital internationalization by conceptualizing it as a process of foreign market penetrations in which globally available digital firms simultaneously acquire interested users across multiple countries. Despite lower foreign market entry barriers in the digital world, I argue that digital businesses still face substantial user adoption barriers as differences around nations may prevent users from adopting innovations developed by digital businesses from other countries. Moving from the traditional research focus on firm resources or alliance networks with other firms for overcoming internationalization barriers, I highlight that digital businesses may overcome user adoption barriers to internationalization by internalizing demand-side networks, particularly their users (Chandra & Coviello, 2010; Priem & Butler, 2001; Priem, Butler, & Li, 2013; Priem, Li, & Carr, 2012; Siqueira, Priem, & Parente, 2015). However, I also show that demand-side networks differ in their potential of facilitating digital internationalization based on the nature and magnitude of user adoption barriers. Hence, I draw attention to the need for further research on the relationship between the composition of demand-side networks and digital internationalization.

The second essay in my dissertation, "Revisiting Location in a Digital Age: The Interplay between Lead Markets and Capability Deployment for Internationalization of

Digital Innovations", extends the discussion in the first essay by distinguishing the location advantages digital businesses reap from demand-side networks in different countries. I advocate expanding eclectic paradigm in a digital context by incorporating lead markets (e.g., Bartlett & Ghoshal, 1990; Beise, 2001; 2004; Doz & Wilson, 2012; Prahald & Doz, 1987) as important location advantages by showing that demand-side networks in lead countries can provide knowledge and innovation ideas for upgrading the global appeal of digital innovations, which enable digital businesses in penetrating their innovations in multiple countries. I also build on prior research (Adner, 2002; Adner & Levinthal, 2001; Adner & Zemsky, 2006; Priem, Li, & Carr, 2012) to identify two important characteristics of lead markets—demand heterogeneity within a country and international connectedness with other countries—and empirically demonstrate that establishing demand-side networks in lead markets with higher demand heterogeneity or international connectedness may facilitate digital internationalization.

Finally, given that the location of demand-side networks plays a pivotal role in setting the course of digital internationalization, the third essay in my dissertation, "The Cyber Nations: Measuring Virtual Distance and Virtual Clout in a Digital Arena" transcends beyond the traditional measures of cross-national distance and cross-border trade to segregate countries based on the characteristics of their demand-side networks. My approach is consistent with prior research (Boyd & Crawford, 2012; Caprar, Devinney, Kirkman, & Caligiuri, 2015; Foster, Ghani, Jarmin, Kreuter, & Lane, 2017) that emphasize on shifting focus from analyzing cross-border flows of physical goods, capital, and people to measure virtually connected users, digital communities, and online cultures by tracking digital footprints in big data. Responding to this research gap, I use a

Big Data archive on mobile app usage across 54 countries to develop two indices, virtual distance and virtual clout. The measure of virtual distance indicates how demand-side networks across countries resemble or differ from each other based on their preferences in virtual world. Similarly, virtual clout quantifies the capacity of user networks in one country to influence innovation adoption in other countries through similarity in their technology choices. Both measures provide important variables which can be employed in future research on digital internationalization.

I conduct my research in the unique context of mobile apps at iOS platform as a canonical example of digital innovation. Mobile apps are important representatives of recent growth and rapid internationalization of digital businesses. International Data Corporation (2016) expects global downloads of mobile apps to reach 210 billion, earning annual revenues of $57 billion by 2020. As most mobile apps are scale free innovations that transfer across borders over online platforms with little or no physical investments (Boudreau, 2012; Levinthal & Wu, 2010; Mograbyan & Autio, 2017), they provide an important venue to test my research questions on digital internationalization.

As one of the first dissertations on the rising phenomenon of digital internationalization, this dissertation takes an initial but important step toward extending IB research in a digital arena. Consistent with BCG (2017), I contend that many old approaches to conducting IB activities may not provide the best opportunities for sustained growth in the era of digital globalization. Instead, as many assumptions behind traditional business theories may not hold in a digital world, a substantial refinement of current frameworks is indeed needed. Responding to the recent calls by IB community (e.g. Alcácer et al., 2016; Cavusgil & Knight, 2015; Coviello et al., 2017; Dunning, 2009;

Verbeke, Coeurderoy, & Matt, 2018), I blend ideas from network theory, technology innovation, and demand-side perspective to offer a set of theoretical extensions in eclectic paradigm. My dissertation also supplements previous work on online businesses (e.g. Bell & Loane, 2010; Kotha, Rindova, & Rothaermel, 2001; Singh & Kundu, 2002; Zaheer & Manrakhan, 2001) by rigorously testing some important propositions about digital internationalization, which have been under theoretical discussions across IB circles. I also propose digital internationalization as an important venue to extend Born Global research (Cavusgil & Knight, 2015; Knight & Cavusgil, 2004) as digital technologies offer unprecedented opportunities to entrepreneurs for tapping international markets from onset despite their lack of resources. I hope my dissertation will open the gateway for a better understanding of digital internationalization and will also encourage further research in this important but neglected direction.

INTRODUCTORY CHAPTER

WHAT IS DIGITAL ECONOMY? REEVALUATING IB FRAMEWORKS IN A DIGITAL CONTEXT

Abstract: The rise of digital economy is reshaping the traditional conceptualization of international business. Instead of being constrained by a lack of physical assets or cross-national distances, digital businesses in cyberspace cost-efficiently innovate scale free digital products and instantly distribute them to users around the world via online channels. Digital economy also brings new challenges as digital businesses face user adoption barriers, lower propensity of appropriating resource-based advantages, retaliation by traditional businesses, increased regulations by governments, and stiff competition from around the world. This introductory chapter aims at catalyzing the discussion on the intersection of traditional theories and emerging phenomenon of digital internationalization by exploring some novel venues for extending current research in a digital context.

Keywords: Digital Economy; Digital Business; Digital Internationalization; Eclectic Paradigm; Uppsala Model

INTRODUCTION

Advances in digital technologies are leading the world toward the new era of digital globalization. According to recent reports (e.g., BCG, 2017; Mckinsey & Company, 2016), cross-border flows in goods, services, and finances decline from 53% of world GDP in 2007 to only 39% in 2014. The exit of UK from the European Union, new trade policies by US administration, and backlash against open borders across several countries suggest that globalization is in retreat. At the same time, the number of people using the internet has soared from 900,000 to more than 3 billion. The number of connected digital devices are expected to increase by more than triple, to nearly 21 billion by 2020. Global data flows, which have exploded by tenfold over the past decade to 20,000 gigabits per second, are also projected to triple by 2020. Around 50% of the world's traded services are already digitized and it is estimated that by 2020, 30% of all cross-border transactions will be carried out digitally (AliResearch & Accenture, 2015; Castro & Mcquinn, 2015). Such trends indicate a drastic shift in the means of globalization, where bits and digits, instead of physical atoms, would transcend the geopolitical and socioeconomic barriers to accelerate the journey toward a digitally globalized world. Global integration will no longer occur only through physical highways as virtual data clouds will be the new roads connecting the world to an unprecedented level.

An important outcome of digital globalization is the large number of digitally powered born global firms who use modern technologies to cost effectively innovate largely scale free new products and services (Amit & Zott, 2001; Amit & Han, 2017; Boudreau, 2012; Levinthal & Wu, 2010), and attract users, hire talent, purchase input, and secure finances from multiple countries right from their inceptions (Autio, 2017;

Autio & Zander, 2016; Cavusgil & Knight, 2015). For instance, coModule, an Estonian startup, revealed its first prototype in Barcelona, received seed funding from Germany, and sourced its components from China to target customers across Europe and Asia. In fact, Mckinsey & Company (2016) reports that 80% of tech start-ups now are born global. This is possible because digital technologies and online platforms enable businesses and individuals across the globe to innovate novel products and transact over cyberspace with lower transaction costs, higher trust, and new modes of making payments such as bitcoins or Alipay (Amit & Zott, 2001; Boudreau, 2012; Chen & Kamal, 2016; Peterson, Welch, & Liesch, 2002).

An important facilitator for digital globalization is the scale free nature of many digital innovations, which enables digital businesses to act as two-sided platforms to mount over socioeconomic differences across countries (Armstrong, 2006; Levinthal & Wu, 2010; Rochet & Tirole, 2003; 2006; Ye, Priem, & Alshwer, 2012). On one hand, many digital innovations are scale free as they can expand to multiple countries with little or no marginal costs and the sheer magnitude for global expansions do not dilute the value of digital innovations. Hence, the scale free nature of digital innovations reduces the resource requirements traditionally associated with international expansions. On the other hand, digital technologies enable businesses to turn their innovations into two-sided platforms that subsidize end users through a freemium model to attract more sellers or advertisers in order to generate positive network externalities (Boudreau & Jeppesen, 2015; Casadesus-Masanell & Zhu, 2013; Rietveld, 2018; Rochet & Tirole, 2003;2006; Seamans & Zhu, 2013; Zott, Amit, & Massa, 2011). An important example is ibusiness (Chen et al., 2019; Brouthers et al., 2016), which internationalizes by the force of

building networks across countries, instead of acquiring physical assets in foreign markets. Similarly, many gaming apps are offered for free in order to build massive user networks that could attract advertisers. These novel business models may reduce the negative impact of cross-national differences in purchasing powers by making digital innovations available free of costs to all interested users around the world.

Internationalization in a digital world presents a set of fundamentally different research questions that require refinements in current entrepreneurship, strategy, and IB theories. This chapter evaluates some important theoretical frameworks in a digital context to highlight the need for extending IB research in this important arena. First, I outline various types of digital businesses, acknowledging different modes through which businesses can benefit from digital technologies. Next, I highlight some important opportunities for extending traditional frameworks—eclectic paradigm and Uppsala model—in a digital context. I conclude by outlining how my dissertation addresses some of these opportunities for extending IB theories in a digital era.

THEORY

Defining Digital Businesses

Businesses have been using digital technologies for a variety of purposes. The diverse modes for engaging with digital technologies have created a wide spectrum of organizations and business models (Mckinsey & Company, 2016), making it difficult to reach a unified definition of digital businesses. On most fundamental level, many firms incorporate digital technologies in traditional businesses in order to improve operational

efficiency, obtain finances through methods like crowdfunding, or increase sales of existing products through websites or E-mail marketing. In particular, research in IB, strategy, and entrepreneurship has largely focused on organizations who employ digital technologies for increasing their sales or reaching geographically distant customer segments (e.g., Kotha, Rindova, & Rothaermel, 2001; Singh & Kundu, 2002; Zaheer & Manrakhan, 2001). For instance, research on born global firms highlights the role of technology in connecting businesses with overseas users (e.g. Cavusgil & Knight, 2009). In the same vein, some scholars define an E-business firm as the one which generates a specific percentage of its sales through online channels (Amit & Han, 2017; Amit & Zott, 2001; Autio & Zander, 2016). However, such firms can pursue their objectives and maintain competitive advantages even without using digital infrastructures. Hence, traditional theories from strategy and IB disciplines may be largely applicable to such businesses as well.

A more relevant context for an enquiry into digital economy can be the firms whose core business is based on digital technologies. The products and value chains of these businesses rely on digital infrastructure to an extent that the very existence of these businesses would not be possible without modern digital infrastructure. These businesses may include web based businesses (Bell & Loane, 2010; Kotha et al., 2001), digital information goods (Mahnke & Venzin, 2003; Reuber & Fischer, 2009), or digital innovations like mobile apps (Boudreau, 2012; Yoo, Boland, Lyytinen, & Majchrzak, 2012). As these businesses are digitally enabled or "born digital", they are more likely to experience the novel opportunities and challenges of digital world (Boudreau, 2012; Shaheer & Li, 2019). Accordingly, I define a digital business as

"A digital business is a firm whose core value proposition is enabled by digital infrastructures"

I recognize the wide variety of businesses which will fall under my definition of digital businesses but I advocate to theoretically categorize these digital businesses based on the extent of their scale free nature (Levinthal & Wu, 2010). On one end, there may be offline products and services traded through digitally enables business models. The examples are eBay, Amazon, or shared economy firms like Uber. As the core value proposition of these businesses is directly derived from their reliance on digital technologies, they fall under my definition of digital businesses. However, such businesses are relatively non-scale free because their business expansion may rely on increased investments in physical infrastructures. Also, expanding beyond a certain limit may reduce the value of these businesses due to various problems such as a possible decline in the quality of service or issues with stock availability. For instance, expanding in emerging markets exposed sharing economy firms like AirBnB or Uber to several security and safety concerns as well as unethical behaviors by home and car owners. On the other extreme, there are fully digital businesses whose value chains do not include offline components. Many mobile apps, social media, streaming services like Netflix or YouTube, digital distribution platforms like Apple's app store, or online games may fall in this category. These businesses are largely scale free as expanding to new countries may neither require additional investments nor affect the value of their innovations. Indeed, some of them may derive their value through market expansion. For example, the value of social media platforms like the Facebook or websites relying on user generated content such as the YouTube may increase with market expansions.

Across the broad spectrum of digital businesses, I argue that fully digital businesses with scale free digital innovations may provide the most conservative tests for existing strategy, IB, and entrepreneurship theories that are largely developed in the context of firms with non-scale free produces and services. The scale free nature of modern digital technologies may question several premises of extant research such as the value of scarce resources, opportunity costs of deploying limited resources in certain locations, and impact of cross-national distance, which may provide the most fruitful venues for extending current knowledge. Therefore, I write my dissertation in the context of fully digital businesses offering scale free digital innovations, i.e. developers of mobile apps at iOS platform.

Current Theoretical Frameworks and Digital Internationalization

Several distinctive aspects of digital businesses set their internationalization trajectories and global strategies apart from traditional businesses. The ability to expand globally without physical presence, the capacity of virtually orchestrating global knowledge and innovation networks, scale free nature of most digital innovations, and reliance on digital platforms may lead to some unique patterns of internationalization, which may require extensions in current theoretical frameworks. Most importantly, I focus on one of the most comprehensive frameworks, the eclectic paradigm (Dunning, 1973; 1998; 2003), to discuss the extent to which the three important pillars of internationalization, ownership, location and internalization, are applicable to digital internationalization and in turn, how some of the distinctive ownership, location, and internalization advantages in digital age

may lead to an internationalization process that demands extensions in traditional Uppsala thinking, as also emphasized by Johanson & Vahlne (2009).

Ownership advantages for Digital Internationalization

Ownership advantages comprise of both firm-specific advantages as well as home-country specific advantages that firms can deploy to expand into foreign markets (Dunning, 1973; 1980). Whether born global firms or established multinational enterprises, IB research considers ownership advantages as critical for establishing business operations in global markets (Cantwell, Dunning, & Lundan, 2010; Knight & Cavusgil, 2004; Santangelo & Meyer, 2011; Verbeke & Yuan, 2010).

For digital internationalization, however, the role of ownership advantages is a contested enquiry. On one hand, digital businesses can access globally disperse resources and capabilities by joining knowledge and innovation networks (Alcácer, Cantwell, & Piscitello, 2016; Coviello, 2006; Cantwell, 2009; Dunning, 2009), which may reduce the relevance of many advantages emanating from the resource endowments at home countries. Indeed, the advent of digital platforms may further parallel the playing field by providing equal resource access to digital businesses from across the world (Amit & Han, 2017; Autio, 2017; Stallkamp & Schotter, 2019; Tallman, Luo, & Buckley, 2018). Nevertheless, country specific resources may not completely become irrelevant for digital businesses as geographic proximity may still play an important role in connecting businesses, users, and networks (Agrawal, Catalini, & Goldfarb, 2015; Ghemawat, 2011; Zaheer & Manrakhan, 2001). Further, liabilities of outsidership may continue impeding

businesses from tapping networks across national borders (Brouthers, Geisser, & Rothlauf, 2016; Chen, Shaheer, Yi, & Li, 2019; Johanson & Vahlne, 2009).

The significance of firm specific resources for digital globalization is another important debate. On one hand, modern technologies enable many digital businesses to cost effectively develop and market their innovations around the world with little resource based advantages (Amit & Zott, 2001; Coviello, Kano, & Liesch, 2017), which may encourages greater experimentation with different business modes and products in different countries, leading to different organizational routines, learning processes, and an overwhelming variety of innovations (Boudreau, 2012; Sun & Zhu, 2013; Zhu & Iansiti, 2012). Possibly, speed of configuring and reconfiguring resources and experimenting with innovative models may take precedence over substantial, long term, resource commitments. On the other hand, the ease of innovation and internationalization may undermine the effectiveness of many resource-based advantages as competitors may readily clone successful innovations (Amit & Zott, 2001; Autio, 2017; Boudreau, 2012; Coviello et al., 2017). An important case is Flappy bird, which lost substantial business to dozens of cloned apps that were launched just weeks after the success of Flappy bird (Bloomberg, 2014; Forbes, 2014). In addition, many digital businesses, particularly online entrepreneurs, may lack sufficient internal resources to achieve an advantage over competitors (Boudreau, 2012; Coviello et al., 2017).

A key transition in digital world can be the rising importance of external resources within ecosystem compared to internal, firm specific resources (Amit & Zott, 2001; Autio, 2017; Boudreau, 2012; Zhu & Iansiti, 2012). This can be an important departure from ownership advantages as well as resource-based view that emphasize the

need for marshalling specialized resources and capabilities (Amit & Schoemaker, 1993; Barney, 1991; Dunning, 1973; Penrose, 1959; Peteraf, 1993; Wernerfelt, 1984). Instead, as the locus of innovation in a digital context is increasingly shifting to demand environments and digital businesses are largely relying on information-based resources that have a relatively higher degree of mobility and an increased risk of value migration (Amit & Han, 2017; Amit & Zott, 2001; Autio, 2017; Singh & Kundu, 2002; Zott & Amit, 2010), I suggest that the research on digital internationalization may benefit from demand-side perspective literature that stresses the importance of widely available, even mundane resources (Priem, Butler, & Li, 2013; Priem, Li, & Carr, 2012; Fréry, Lecocq, & Warnier, 2015; Ye, Priem, & Alshwer, 2012). Hence, it is possible that the capability of managing the opportunities that reside outside organizational boundaries in broader ecosystems, particularly in demand environments, may emerge as the critical ownership advantage, instead of the internal stocks or flows of valuable and rare resources.

Location advantages for Digital Internationalization

An important contribution of eclectic paradigm was recognition of location advantages as an important driver of internationalization (Cantwell, 2009; Dunning, 1998; 2009). IB scholars have long recognized the variety of location advantages firms reap through their presence in foreign countries, which enable firms to strengthen their competitive positions in both domestic and foreign markets (Agarwal & Ramaswami, 1992; Dunning, 1995; Singh & Kundu, 2002).

In a digital context, I expect a reduction in the relative importance of several traditionally discussed location advantages. On a fundamental level, location advantages related to favorable government policies or availability of natural resources may not be relevant for many digital businesses. Instead, the location advantage of a country may be largely determined by the presence of knowledge and innovation networks (Alcácer et al., 2016; Zaheer & Manrakhan, 2001). To some extent, this is akin to Dunning (1995)'s emphasis on alliance capitalism, which stresses that the opportunities of establishing alliance networks with foreign firms is likely to be one of the most important location-bound advantages. The rise of digital platforms, however, may reduce the location-boundedness of interfirm alliances as platforms connect businesses—such as developers of digital innovations, advertising platforms, and toolkits providers—from across the world and govern interfirm relationships through globally standardized protocols, instead of national institutional systems (Amit & Han, 2017; Autio, 2017; Stallkamp & Schotter, 2019; Tallman, Luo, & Buckley, 2018). On the other hand, digital businesses also extract tacit knowledge and critical innovation ideas through their interaction with demand-side networks (Cavusgil & Knight, 2015; Chandra & Coviello, 2010; Coviello, Kano, & Liesch, 2017; Kriz & Welch, 2018; Moreau, Franke, & von Hippel, 2018). Such knowledge may be highly location-bound as demand-side networks across countries may substantially differ in their ability of contributing useful ideas to digital businesses (e.g., Chen et al., 2019; Fischer & Reuber, 2004; Reuber & Fischer, 2005; Siqueira, Priem, & Parente, 2015; Venkataraman, van de Ven, Buckeye, & Hudson, 1990). For instance, Porter (1990) posits that countries with sophisticated users are more likely to contribute in improving business offerings. Hence, I advocate the need to move beyond the current

focus on supply-side location advantages such as low cost production, natural resources, or innovation clusters to expand Dunning (1998)'s taxonomy of location advantages to also encompass demand-side location advantages, particularly in digital contexts. Recognizing such demand-side location advantages may have important implications for the eclectic paradigm. Given the challenges of appropriating resource-based advantages in the digital arena, the type of location with which a digital business interacts may emerge as an important advantage for digital businesses, which may be harder to replicate by competitors.

Internalization for Digital Internationalization

A large portion of IB literature largely treats the internalization decision as a question of efficiency as firms seek the most efficient ways to expand into foreign markets by evaluating the relative transactions costs of using markets versus hierarchies (Buckley & Casson, 1976; Coase, 1937; Hennart, 1982; Williamson, 1975). With the rise of E-commerce firms, scholars (e.g., Singh & Kundu, 2002) explore the role of networks for internationalization of online businesses as many firms start entering foreign markets by establishing networks, instead of acquiring physical assets. Recent research conducted in the context of digital businesses (Banalieva & Dhanaraj, 2018) moves one step farther by explicitly expanding internalization theory to also include networks as third governance form in internalization theory framework. This is a much needed theoretical development given the increasing reliance of digital businesses on orchestrating networks, instead of

internalizing physical assets, for their internationalization (Alcácer et al., 2016; Coviello et al., 2017).

I suggest that the introduction of networks as the third leg of internalization theory may reshape internalization decisions from efficiency or cost reduction strategies to critical components for the competitive positions of digital businesses. Banalieva & Dhanaraj (2018) offer several cases of digital businesses as well as traditional firms who achieve competitive positions by orchestrating networks. Differences in the size and composition of networks established by different digital businesses may also distinguish the tacit knowledge and innovation ideas received by different digital businesses, leading to differences in innovations, strategies, and internationalization patterns of digital businesses. Such competitive heterogeneity built on the internalization of certain networks may also be harder to imitate as newcomers may lack sufficient interactions with networks and may also face the liability of outsidership (Adner & Zemsky, 2006; Brouthers et al., 2016; Coviello, 2006; Chen et al., 2019; Priem, 2007; Zander & Zander, 2005). This, however, leads to the critical questions about the parameters to segregate different networks and criteria for digital business to evaluate and choose the networks they should join. I expect it to be a fruitful area for future research.

The Interrelationship of Ownership, Location and Internalization

Above discussion highlights several extensions in traditional conceptualizations of ownership, location, and internalization advantages, which may also influence their interrelationships. While Dunning (1998) regards all three pillars of eclectic paradigm

equally critical for internationalization, Dunning (1973) specifically regards ownership advantage as the prerequisite, which enables firms to target certain location advantages and also influence the decisions between markets and hierarchies. I suggest that the calculus may evolve in a digital context as digital businesses, first and foremost, may face the decision to internalize certain networks, which may pave the way for their preferential access to tacit knowledge and innovation ideas. While digital businesses can employ a variety of parameters to distinguish possible networks they can join, an initial step can be an explicit evaluation of the location of networks, particularly demand-side networks. Furthermore, as digital businesses can access global networks from the inception, home markets may not necessarily provide the most suitable starting points. Instead, digital businesses may start by joining networks at locations best matching their strategic objectives. In this sense, location and internalization decisions may play a primary role in determining the ownership advantages a digital business will enjoy, as opposed to the type of ownership advantages that traditionally determine the location and internalization choices.

Based on above discussion, I expect the interrelationship of three pillars in the eclectic paradigm to evolve in a digital context, which may offer new strategic paths to digital businesses. In particular, the evolving calculus of three pillars may have important implications for the internationalization trajectories of digital businesses, which may demand extensions in traditional Uppsala thinking, as I discuss below.

Uppsala Model for Digital Internationalization

The changing role of ownership, location, and internalization may alter the internationalization process digital businesses are likely to follow. Mainly, many digital businesses internationalize by default just by joining global platforms instead of getting deterred by liability of foreignness and cross-national distance (Autio, 2017; Santangelo & Meyer, 2017). The digitally connected consumers, devices, and machines are creating market segments that transcend national borders and digital technologies are letting businesses target these segments with their scale free digital innovations without the need for constructing large-scale operations in multiple countries. In fact, digital technologies are fast replacing the complex supply chains and production systems, making it much easier for even smaller firms from around the world to compete in a global market with little resources. Therefore, digital businesses may not select foreign markets but penetrate into multiple countries through user adoption and diffusion based processes (Brouthers et al., 2016; Rogers, 2003).

Given the relative ease of internationalization, digital businesses may not follow the prescription of Uppsala model by internationalizing from low distance countries to high distance countries. Instead, given the variations in location advantages across countries, digital businesses may tap the most suitable networks for their innovations with relatively less regard to distance. Digital businesses may also put into question the role of organizational resources and foreign market commitments, which are important assumptions behind Uppsala model and are considered critical in IB research (Benito & Welch, 1994; Meyer & Thaijongrak, 2013; Pedersen & Shaver, 2011; Peng, 2001). As digital technologies enable faster and cost-efficient transfer of firm specific assets to

international markets (Autio & Zander, 2016; Brouthers et al., 2016), start-ups may establish international businesses without committing substantial resources to foreign markets. The reduced risk of internationalization may have important implications about the role of psychic distance, firm specific resources, and managerial cognitions for internationalization trajectories of digital firms. Hence, IB research may shift its focus to evaluate how digital businesses can accelerate user adoption in multiple countries to capitalize on unprecedented globalization opportunities in cyberspace.

The changing role of distance in a digital world may also reduce the relevance of many traditional measures of distance, such as political distance or financial distance. Instead, the main barrier for digital internationalization is likely to be the user's reluctance of adopting foreign innovations, also termed as user adoption barriers (Shaheer & Li, 2019). While some traditional measures, such as cultural distance, may still maintain their explanatory power as they are close proxies for differences in preferences and behaviors of people across countries, an important research area is to directly capture differences in user preferences to develop new indices of virtual distance. Nevertheless, some legal and political barriers may still be important. For example, restrictions by foreign governments (e.g., the case of Uber and Airbnb) or retaliation by traditional businesses (Coviello et al., 2017; Shaheer & Li, 2019) may impede internationalization of digital businesses. It definitely needs further research to evaluate the extent to which existing measures of distance are likely to capture internationalization barriers in digital contexts.

Another important development in the digital world can be a shift from cross-country distance to country clouts (Chen et al., 2019; Van Everdingen, Fok, &

Stremersch, 2009) for explaining digital internationalization. As digital technologies enable people across countries to form supranational communities based on shared interests, countries play an important role in influencing other countries in adoption of innovations (Hofstede, Wedel, & Steenkamp, 2002; Van Alstyne & Brynjolfsson, 2005). In this sense, digital businesses may internationalize from high clout countries to other countries, instead of penetrating countries that are at lower distance from each other. Hence, virtual clout of a country may emerge as another location advantage, which may determine the ownership advantage and subsequent internationalization trajectories. However, empirical measures of country clouts in a virtual world still need to be developed, which could enable researcher to analyze these novel internationalization paths.

CONCLUSION

A concrete understanding of digital globalization is becoming the new source of global competitive advantage for both established businesses and born global entrepreneurial ventures. Companies that have learned how to carve out markets in this digitally connected world are building global businesses at an astonishing speed. For instance, Uber penetrated more than 80 countries in just six years, with little investment in physical assets, by reaching digitally connected consumers through its global platform. Pokémon Go was being played in almost 150 countries and generated nearly $1 billion in global revenue within six months after its launch. Netflix penetrated more than 190 countries in just seven years with its digital streaming service. In fact, the rapid growth of digital

technologies and online platforms has started making national borders and traditional country-based business models redundant. As of now, goods worth $700 billion are traded through Alibaba and Amazon—an amount that represents a compound annual growth rate of more than 33% since 2012 (Mckinsey & Company, 2016).

In this rapidly changing world, many old approaches to conducting IB activities may not provide the best recipes for sustained growth (BCG, 2017). The digital globalization calls for not only new theoretical angles but also new matrices to understand and quantify the trends and patterns in the digital world. Instead of tracking cross-border flows of physical goods, financial capital, and people, it is becoming increasingly important to measure connected consumers, digital communities, online cultures, and digital flow of data and ideas. This dissertation takes an important step by addressing the pressing need for evaluating some important dimensions of digital internationalization. With a focus on demand-side networks and virtual connections across countries, I seek to uncover some distinctive aspects of digital internationalization, which may contribute in expanding IB theories in a digital context.

ESSAY 1

THE CAGE AROUND CYBERSPACE? INTERNALIZING DEMAND-SIDE NETWORKS TO OVERCOME DISTANCE IN A VIRTUAL WORLD

Abstract: How mobile apps internationalize in cyberspace and what strategies can they utilize to facilitate their internationalization? By examining factors affecting the internationalization speed of 127 apps that were launched in iOS App Store in the last quarter of 2014, we find that despite the availability of these mobile apps to international users via global platforms, the speed of international penetration is still subject to cultural, administrative, geographic, and economic (CAGE) distances. However, our results also suggest that app developers may partially overcome CAGE distances by internalizing demand-side networks, particularly end users. Our study not only helps enhance the understanding of the rising phenomenon of digital internationalization, but also extends internalization theory to incorporate the unique dynamics of a digital context.

Keywords: Mobile apps, Digital innovations, CAGE Distance Framework, Internalization, Demand-side networks, Demand-side strategies

INTRODUCTION

Over the past decades, the rapid progress in information technology is accelerating the trend toward increased globalization (Cavusgil & Knight, 2015; Coviello, Kano, & Liesch, 2017). Instead of trading goods and services based on physical atoms, digital businesses link the world via bits and digits. According to International Data Corporation (2016), there are nearly 156 billion mobile apps downloaded in 2015, generating $34.2 billion in revenues. The new shift in means of globalization has not only changed how people around the world connect to each other, but may also challenge some of the basic assumptions held in traditional international business (IB) research.

One of the key premises of the extant IB literature is that internationalization is an intentional strategic decision. No matter the stage model (Johanson & Vahlne, 1977) or the born global research (Knight & Cavusgil, 2004), scholars tend to assume that firms can choose their destinations and appropriate entry modes. However, the internationalization of digital innovations follows a different trajectory. Instead of being deterred by entry barriers or suffering the lack of ownership advantages, many digital innovations become instantly available to users around the world through globally accessible platforms such as iOS App Store and Google Play. In this sense, internationalization is inevitable and inescapable for these digital innovations, regardless of their intention or choices.

The global availability of digital innovations poses some intriguing research questions about the role of cross-national distance in a digital world. First, whether digital innovations exemplify the so-called “death of distance”, or cross-national distance,

particularly cultural, administrative, geographic, and economic (CAGE) distances (Ghemawat, 2001), still imposes challenges in the cyberspace. Second, if the latter is true, given that most digital businesses are subject to the liability of smallness, how would they internalize the knowledge networks that reside outside organizational boundaries in broader ecosystems (Alcácer, Cantwell, & Piscitello, 2016; Banalieva & Dhanaraj, 2018) to overcome the barriers of cross-national distance? In particular, we build on demand-side perspective (Priem, Butler, & Li, 2013; Priem, Li, & Carr, 2012; Siqueira, Priem, & Parente, 2015) to evaluate the impact of internalizing demand-side networks, particularly users, on internationalization of digital innovations.

To answer these questions, we examine a unique dataset of mobile apps at iOS platform. By tracking penetration of 127 apps across 50 countries, we find that CAGE distances delay the international penetration of mobile apps. However, our analysis also reveals that digital businesses can internalize demand-side networks to partially overcome CAGE distances.

Our research makes some important contributions to IB literature. First, we stress the need for rethinking the internationalization process on the wake of modern technologies. While most research treats internationalization as a firm-led process of international market entries, the emergence of digital innovations shifts the view of internationalization as a process of user adoption and market penetration, in which CAGE distances act as user adoption barriers. The distinction between entry barriers and adoption barriers implies that the internationalization of digital innovations is better reflected by their penetrations into foreign markets, not merely by availability on global platforms.

Second, we contribute to the long debate about the impact of distance in an era of digital globalization (e.g., Friedman, 2005; Ghemawat, 2013; Mckinsey & Company, 2016). We demonstrate that cross-national distance maintains its importance as a critical user adoption barrier to internationalization in cyberspace. Instead of focusing on the influence of distance on firms' entry decisions, we find that distance can also deter users from quickly adopting a digital innovation. Hence, we highlight an important dimension of cross-national distance, which has been largely overlooked by the extant research.

Third, we shed new light on the digital internationalization research by introducing the demand-side perspective. Prior scholars have largely considered emphasized the role of firm resources or its position in networks of other organizations for internationalization (Coviello, 2006; Dunning, 1973; Johanson & Vahlne, 2009). However, we build on demand-side perspective (Priem et al., 2013; Priem et al., 2012; Siqueira et al., 2015) and recent research on digital internationalization (Alcácer et al., 2016; Banalieva & Dhanaraj, 2018; Chandra & Coviello, 2010; Coviello et al., 2017) to propose that digital businesses can go beyond the existing firm boundaries to internalize demand-side networks for overcoming distance despite their lack of resources. We also propose two strategies for internalizing demand-side networks and examine the conditions under which each demand-side internalization strategy affects the international penetrations of digital innovations. Hence, our study takes an important step in extending the demand-side perspective in the field of IB.

LITERATURE REVIEW

Over the past decades, a key feature of globalization has been digitalization. The world-wide digital infrastructure of computers, mobile devices, broadband network connections, and advanced application platforms has made the world more connected. With the availability of these new infrastructures, mobile apps have become a ubiquitous feature of everyday life, as they enable users to perform various functions on their smartphones, such as playing games, accessing social networks, reading e-books, or watching videos (Ghose & Han, 2014). Mobile apps are considered as an important form of "digital innovation" (Boudreau, 2012; Boudreau & Jeppesen, 2015), which can be defined as embedded software that enables capabilities into physical objects to produce novel products (Yoo, Henfridsson, & Lyytinen, 2010).

The rise of digital innovations has started attracting substantial research attention. In particular, scholars are investigating how digital innovations are reshaping management of information systems (Yoo et al., 2010), leading organizational changes (Lee & Berente, 2012; Yoo, Boland, Lyytinen, & Majchrzak, 2012) and redefining innovation trajectories (Boudreau, 2012). Still, most research is exploring digital innovations from a technology perspective, while contributing little to our understanding about the impact of digital innovations on strategy, entrepreneurship, and particularly IB.

The internationalization of digital innovations may not be effectively explained through the traditional lens of IB research. Internationalization has been considered as an intentional strategy that involves large scales of resource investment in foreign markets. During the process, firms need to assess the attractiveness of each potential target market

and choose the most effective entry mode in order to exploit the opportunities presented in foreign countries (Johanson & Vahlne, 1977). On the contrary, most digital innovations are launched on globally accessible platforms such as iOS App Store and Google Play. The affiliation with global platforms grants digital innovations an instant access to users across the world without incurring the historically incurred costs for entering these foreign markets (Brouthers, Geisser, & Rothlauf, 2016; Kotha, Rindova, & Rothaermel, 2001).

The global presence of digital innovations, however, may not necessarily translate into adoption by users located overseas. According to the extant research, digital innovations, like most other products, possess various cultural, intellectual, and aesthetic elements that appeal to users with specific needs, tastes, and preferences (Potts, Cunningham, Hartley, & Ormerod, 2008; Varian, Farrell, & Shapiro, 2004). As user preferences differ widely across countries, the penetration of digital innovations may also vary across countries depending upon the match between the attributes of digital innovations and preferences of users in particular countries. Therefore, the challenge for digital innovations is to gain acceptance and adoption by users around the world in order to be truly international.

While digital innovations enjoy a global presence through their affiliation with global platforms, they may not possess necessary resources and capabilities that can help them gain acceptance and adoption by overseas users. Although several scholars argue that e-commerce firms, benefitting from low production cost in cyberspace, can customize their innovations to the unique needs of overseas users (Amit & Zott, 2001; Kotha et al., 2001; Lynch & Beck, 2001), this may not apply to mobile app developers. It

is because such an endeavor requires an adequate understanding of foreign markets (Ghemawat, 2013; Singh & Kundu, 2002), which may be difficult to develop for these small digital businesses. Most mobile app developers may not have financial resources to afford these costly initiatives due to their small size (Boudreau, 2012). Under these resource constraints, international strategies of many digital innovations may not follow the prescription of prior research, such as hiring foreign employees or board members, establishing connections with foreign partners, or conducting international market research to better understand and meet the requirements of foreign markets (e.g., Cuervo-Cazurra, Maloney, & Manrakhan, 2007; London & Hart, 2004).

Digital businesses, however, may compensate for their lack of internal resources by internalizing knowledge and innovation networks that reside outside organizational boundaries in broader ecosystems. With the rise of digital technologies, recent research (Banalieva & Dhanaraj, 2018) proposes expanding the traditional internalization theory to include networks as third form of governance, in addition to markets and hierarchies. Given that several digital businesses do not maintain control of physical assets but tap into globally disperse knowledge and innovation networks to achieve their business objectives (Alcácer et al., 2016; Coviello et al., 2017), networks offer the novel form of internalization that is particularly relevant in a digital context.

We build on the emerging stream of research on the demand-side perspective (Priem et al., 2013; Priem et al., 2012; Siqueira et al., 2015) to offer some new insights on internalization of demand-side networks. As several scholars (e.g. Adner & Levinthal, 2001; Adner & Zemsky, 2006; Priem, 2007) indicate, traditional research tends to emphasize the role of supply-side factors, such as resources and capabilities, for creating

customer value and achieving business objectives. Most research on networks also focus on supply-side networks formed among organizations (Coviello, 2006; Johanson & Vahlne, 2009). Such conceptualization treats users as passive recipients of value created by businesses and limits the role of user merely to the sources of revenues. Demand-side perspective, on the other hand, advocates a paradigm shift away from the producer-centered model and assigns a more central role to users in the process of innovation and value creation (Chatterji & Fabrizio, 2014; Priem et al., 2013; Siqueira et al., 2015; Von Hippel, 2005). Demand-side research stresses the importance of both supply and demand-side factors in innovation and value creation activities, suggesting that firms can achieve their strategic objectives by capitalizing on various demand-side opportunities that reside outside organizational boundaries in their demand environments (Adner & Snow, 2010; Dhanaraj & Parkhe, 2006; Di Stefano, Gambardella, & Verona, 2012). In particular, demand-side scholars recognize users as important demand-side factors who can actively participate in each activity of value chain to complement business efforts (Priem et al., 2012; Von Hippel, 1994).

Integrating the demand-side perspective with research on network internalization, we suggest that digital businesses can internalize demand-side networks to achieve their business objectives. Internalizing demand-side networks may also be more convenient for digital businesses. As Piskorski (2014) noted, Internet is primarily a communication medium, where people can strengthen their existing relationships and also establish new connections. The social nature of Internet may enable and empower users to engage in business operations to further help extend business objectives. Furthermore, as digital technologies are connecting businesses with users around the world by radically reducing

communication and coordination costs (Chesbrough, 2006; Von Hippel, 2005), it has become more convenient for digital businesses to embrace opportunities that involve users to construct creative solutions to better advance their business goals. Especially in an international context, demand-side networks from different nations can contribute heterogeneous knowledge about various countries and cultures which digital businesses can utilize in overcoming cross-national distance and accelerating the internationalization of their innovations. However, current research provides little empirical evidence regarding the effectiveness of demand-side networks and how they may affect the internationalization of digital innovations.

In developing the research hypotheses below, we begin by describing how cross-national distance potentially affects the international penetrations of digital innovations. Next, we highlight two strategies for internalizing demand-side networks through which digital innovations can potentially overcome the barrier of cross-national distance.

HYPOTHESES

Cross-national Distance

Despite the easy global visibility and accessibility of digital innovations on the existing global platform, the adoption of digital innovations may still be subject to the liability of foreignness (Zaheer, 1995). Cross-national distance may affect the speed of international penetration of digital innovations for three major reasons. First, cross-national distance may increase the difficulty of communicating the value of digital innovations to overseas users, which may reduce international penetration speed of even high quality digital

innovations. As Chen & Hennart (2002) argue, market communication is a highly culture-specific process, which needs expertise in local contexts. Simply translating product descriptions or promotional messages into foreign languages is not sufficient because users in different countries may misinterpret the content of the message (Chidlow, Plakoyiannaki, & Welch, 2014; Hewett, Roth, & Roth, 2003; Hite & Fraser, 1988). Thus, there is a possibility that their overseas users may misunderstand the intended value proposition of the digital innovations, which may cause the failure to adopt foreign innovations.

Second, creating value for overseas users is likely to be challenging for digital businesses when cross-national distance is high. As digital businesses are likely to be more familiar with preferences of their home country users, their innovations may closely match the needs of home country users, which will, in turn, accelerate the penetration of digital innovations in the home countries, or countries with similar user preferences. However, as Kim & Jensen (2014) argue, increasing cross-national distance may lead to substantial divergence in user needs and preferences between the home and focal markets. Therefore, digital innovations, developed in the context of home countries, may appear more foreign, less relevant and even offensive to users in a distant country.

Finally, the unique nature of the digital innovation industry may further decelerate the penetration of digital innovations in distant countries. A higher cross-national distance is likely to provide greater information advantages for firms that are more familiar with the needs of local users (Hewett et al., 2003; Zaheer, 1995). As most digital innovations are not patented and can be easily replicated by competitors (Boudreau & Jeppesen, 2015), host country developers can capitalize on their information advantages

by replicating successful digital innovations from foreign countries and modifying them according to the local tastes and preferences. In the presence of local clones, users may become more reluctant to adopt digital innovations from distant countries, which may further delay the international penetration of digital innovations.

In sum, while cross-national distance may not impede digital innovations from establishing their presence in foreign markets, it can still decelerate the adoption and penetration of digital innovations in foreign countries. Therefore, we hypothesize that

H1: Higher cross-national distance slows the penetration speed of a digital innovation in a focal market.

We propose that digital innovations can overcome cross-national distances by internalizing their demand-side networks. This is an important area of inquiry as there is little understanding about the specific methods of internalizing demand-side networks to achieve organizational objectives such as overcoming distance. In this paper, we identify and focus on two demand-side internalization strategies through which digital businesses may involve their users to overcome the barriers of cross-national distance.

First, digital businesses may use demand-side networks as spokespeople for publicizing innovations to new users (Aral & Walker, 2011; Rogers, 2003), which may help them overcome the communication barrier imposed by cross-national distance on international penetration of their digital innovations. We term the first demand-side internalization strategy as "social sharing strategy" to refer to the business practices that encourage current users to post their personal usage of digital innovation on their online

social media profiles such as Facebook, Instagram, or Twitter, etc. As argued by Piskorski (2014), such social sharing enables users to strengthen their current relationships by sharing their life activities with relatives and friends while indirectly generating publicity for digital innovations and accelerating their international market penetrations.

The second demand-side internalization strategy, labeled as "virtual community strategy", enables digital businesses to use demand-side networks as contributors or complementors (Eckhardt, 2016; Piskorski, 2014), which may create value for overseas users despite higher cross-national distance. Virtual community strategy brings together users with similar interests and provides tools to support interactions among users through digital technology. Such virtual communities help users establish new relationships with each other, whereas the interactions among these networks create enriched content for digital innovations (Boudreu & Jeppesen, 2015; Jeppesen & Frederiksen, 2006).

Next, we elaborate on the effectiveness of these demand-side internalization strategies in facilitating the internationalization process of digital innovations. In particular, we explore whether these strategies can contribute to overcoming cross-national distances and accelerate the internationalization speed of digital innovations.

Social Sharing Strategy and Cross-national Distance

We propose that a social sharing strategy may help digital innovations overcome cross-national distances by reaching prospective users in foreign countries and effectively

communicating the value of digital innovations to them. First, by pursuing a social sharing strategy, digital businesses can effectively reach a target market segment in overseas markets through social contagion. As Brouthers et al. (2016) indicate, demand-side networks in one market may have contacts with potential users in foreign markets. These links and connections are gradually developed over the passage of time, through travel, education, and common values and language, but can be further maintained and enhanced through social media. Social sharing strategy may motivate many of these well-connected users to share their use of a digital innovation on their social networks which may, in turn, expose the digital innovations to a more geographically diversified user group. Furthermore, several studies indicate that social networks are based on homophily, e.g. people tend to connect with people with similar interests (Aral & Walker, 2011; Mollica, Gray, & Trevino, 2003). Accordingly, current demand-side networks of a digital innovation may be connected to several prospective users sharing similar preferences, hereby broadcasting the value of digital innovation to the ideal target market segment in a focal country through their social networks.

Second, social sharing strategy may also relieve digital businesses from the need of mastering local cultures in order to communicate with users from distant countries. Several studies confirm that users share their usages of products on social networks due to their social desires of connecting with others, gaining personal attention and connoting status (Ho & Dempsey, 2010). These motivations may persuade users to personalize their social posts with attractive messages written in appropriate languages, following the cultural norms and values of people on their networks. As a result, pursuing a social sharing strategy may generate an abundance of promotional messages for digital

innovations created by their demand-side networks, which are tailored for heterogeneous users around the world (Bampo, Ewing, Mather, Stewart, & Wallace, 2008). Furthermore, these user generated messages may be more effective in pursuing new users and also carry higher credibility. As several scholars indicate, users are likely to rely on their friends for recommendations as they deem them more trustworthy (Schulze, Schöler, & Skiera, 2014). In a digital world, where people are bombarded with a variety of digital innovations, observing the usage of a digital innovation by their friends may send a more convincing signal about the quality and usefulness of a digital innovation (Aral & Walker, 2011), especially when cross-national distance hinder users from appreciating the value of foreign innovations on their own. Hence, a social sharing strategy may weaken the influence of cross-national distance not only by customizing promotional messages, but also by improving their persuasiveness. Based on these arguments, we predict

> H2: Pursuing a social sharing strategy will positively moderate the relationship between cross-national distance and the penetration speed of a digital innovation.

Virtual Community Strategy and Cross-national Distance

Virtual community strategy corresponds to the concept of coproduction, which stresses that collaboration between producers and demand-side networks can create higher value (Desarbo, Jedidi, & Sinha, 2001; Prahalad & Ramaswamy, 2000; Ramirez, 1999). Von Hippel (1994) specifies two important conditions for pursuing a coproduction strategy. First, users must be segmented into small and heterogeneous groups so that producers cannot fulfill the large variety of user needs. Second, the knowledge of user needs must

be "sticky"—that is, costly to transfer from users to producers. Information stickiness is higher when knowledge is tacit and producers lack sufficient absorptive capacities to accurately understand user needs. Under these conditions, Von Hippel (2001) argues that coproduction initiatives, such as user communities, may have an advantage over producer–centered systems because users in communities can collaborate to fulfill their needs without relying on producers.

Following Von Hippel (1994; 2001), we argue that digital businesses can pursue a virtual community strategy to overcome cross-national distance. Recent research emphasizes the importance of understanding user needs and offering relevant content to attract users in cyberspace (Gnyawali, Fan, & Penner, 2010; Viard & Economides, 2015). However, increasing cross-national distance magnifies the problem of information stickiness that compromises the ability of digital innovations to produce relevant content for users from different countries. Virtual community strategy may alleviate the need for understanding and adapting to heterogeneous user needs (Jeppesen & Frederiksen, 2006; Von Hippel, 2001), enabling digital innovations to use their demand-side networks for the production of diverse content which meets the needs for more user segments around the world (Faraj, Jarvenpaa, & Majchrzak, 2011). Offering a richer content may improve the perceived usefulness of digital innovations even in distant countries which, in turn, attenuate the impact of distance on adoption of digital innovations.

In addition, virtual community strategy may also turn the problems of cross-national distance and user heterogeneity into opportunities. Instead of concentrating on value creating activities at developer end, virtual community strategy enables digital innovations to draw from the expertise of globally dispersed demand-side networks.

Consequently, a higher cross-national distance and heterogeneous user base may help digital innovations create more enriched and versatile content to attract even more users. Furthermore, virtual community strategy may also create positive network externalities as participation of diverse demand-side networks may make a digital innovation more attractive for new users with varying preferences (Amit & Zott, 2001; Gambardella, Raasch, & Von Hippel, 2016; Katz & Shapiro, 1985). Participation by demand-side networks from distant countries may enhance the amount and versatility of resources available to all users, further increasing the value of digital innovations for everyone (Gnyawali, Fan, & Penner, 2010). Therefore, we hypothesize

> H3: Pursuing a virtual community strategy will positively moderate the relationship between cross-national distance and the penetration speed of a digital innovation.

METHODS

Research Context

To test our hypotheses, we examine the international penetration of a specific type of digital innovations—mobile apps. Mobile apps can be defined as software that enables users to perform various functions on smartphones (Ghose & Han, 2014). According to several scholars (e.g. Boudreau, 2012; Boudreau & Jeppesen, 2015; Yoo et al., 2012), digitally available software like mobile apps provides an important context to examine various aspects of digital innovations and online entrepreneurship.

Mobile apps are now being used worldwide to perform a variety of tasks. An average smartphone user downloads 40 apps, actively uses 15 of them and spends 82% of

mobile minutes on apps (Gupta, 2013). International Data Corporation (2016) expects worldwide annual downloads of mobile apps to reach 210 billion, earning annual revenues of $57 billion by 2020. This is an especially striking number considering that total revenues app developers earned during the first five years of apps history amounted to just $15 billion (Forbes, 2015).

Mobile apps are available to users through a variety of App stores. App stores are multi-sided platforms that connect innovators of mobile apps, the so called app publishers or developers, with app users who can download mobile apps for free or at a fee (Boudreau, 2012; Eckhardt, 2016). The model received acclaim in 2008 when Apple, Inc. launched Apple's App Store (later renamed iOS in 2010) for iPhone users. With only 500 apps at its launch, iOS surpassed a staggering 300,000 apps by 2010 (Lardinois, 2010). Soon after, various competing smartphone platforms such as Google Android and RIM (Blackberry) followed. However, iOS still remains the world's largest app store in terms of revenues and second largest in terms of downloads. Apple announced in the 2016 worldwide developer conference that iOS hosted more than 2 million apps, served 130 billion cumulative downloads and earned more than $50 billion in revenues.

For the purpose of our study, we limit our attention to mobile apps available in the health and fitness category of iOS app store[1]. Focusing on a specific category and app store offers us several important advantages. First, previous research has confirmed the

[1] iOS app store categorizes mobile apps into 25 categories such as games, books, health and fitness, social networking etc. An app can register into one main category and can also select another category as its subcategory. While imperfections exist in these categorization schemes, in several ways it compares favorably to schemes that are commonly used to group related products and innovations in management and entrepreneurship research, such as industry and patent class (Agarwal & Bayus, 2004; Eckhardt, 2016).

existence of various systematic differences across app categories and stores (Ghose & Han, 2014). Restricting our sample to only one category and store may mitigate the influence of such heterogeneity on our results. Second, as iOS is one of the world's most prominent App platforms, our sample grants us the opportunity to trace an app's international activities and provides adequate grounds to generalize our findings. Third, users of other major app stores based on Android, such as Google Play, can download the same apps from many different stores, making it difficult to track the penetration of an app in a given country. On the contrary, iPhone and iPad users can only download or purchase apps from iOS App Store, which enables us to more accurately track the level of adoption of an app in a focal country.

Our decision to focus on mobile apps in the health and fitness category is partially motivated by data availability issues. We note that there are significant data availability challenges regarding mobile apps, constraining research in this context. At the time of conducting this study, we were successful in acquiring a proprietary dataset on iOS apps in the health and fitness category, providing us with some critical variables for deeply investigating our research questions. Nevertheless, the health and fitness category provides us a suitable context to examine the internationalization of digital innovations. It is one of the fastest growing categories, in which the number of apps has grown by 100% in just 2.5 years and revenues are expected to grow more than 10 fold, from $2.4 billion in 2013 to $26 billion by the end of 2017 (research2guidance, 2014). This rapid growth and intensely competitive environment, fueled by growth in both numbers of users and app developers, provides us with an ideal context to examine internationalization patterns of newly launched digital innovations. Furthermore, health and fitness is a diverse

category, covering 24 subcategories ranging from games and sports to magazines, social networking and lifestyle. This diversity helps us generalize our results on a broader context.

Sample and Data Sources

We used a variety of data sources to construct a longitudinal, cross country database on the internationalization of iOS mobile apps in the health and fitness category of iOS app store. First, we acquired a proprietary dataset providing detailed information on the daily performance of mobile apps across 50 countries for the period October 2014 to December 2015. The complete dataset includes country wise rankings, downloads and revenues for 4,583 top ranked apps, accounting for more than 80% of downloads and revenues earned by the iOS health and fitness category across 50 countries during our study period. To further ascertain the reliability of our data, we verified country wise revenues and downloads of top 20 apps in our acquired data using databases of two other providers of mobile app data. We did not find any noticeable discrepancies among the datasets.

We supplemented our acquired dataset with a number of variables from publicly available data sources. We wrote various API programs (Application Programming Interface) to set up data crawlers and web robots on a number of websites that store information related to iOS mobile apps. These crawlers and web robots gathered a number of important variables such as languages offered by apps in each country, home country and experience of app developers with iOS. Finally, we merged our data with country level variables obtained from world development indicators by World Bank and institutional distance variables provided by Berry, Guillen, & Zhou (2010).

For our study, we decided to use a sample of only newly launched apps so that we could track their country wise penetration from inception. Based on our criteria of international penetration (defined and discussed later in a subsequent section), we found in our data that new apps penetrate into 75% of the 50 countries within 180 days since their launch. Accordingly, we picked all apps that were launched in the last quarter of 2014 to track the internationalization trajectories of mobile apps for at least 12 months since their launch. Our base sample comprised of 127 apps from 13 subcategories, tracked on a daily basis across 50 countries. A few apps were not available in all 50 countries due to the fact that some governments impose restrictions on certain types of apps or developers decide to avoid some countries. After merging our data with cross-national distance variables, we obtained a final sample of 5,757 app-country observations.

Dependent Variable

Our dependent variable is time to penetration, which is calculated as the time (in days) that an app took to penetrate in a focal country since its launch. In our sample, we obtained the event of penetration for 2,025 app-country observations. We truncated all other observations that could not penetrate in a focal market before our cutoff point (December 31, 2015).

We follow prior research to define international penetration as the possession of a product by a substantial number of users in a focal country (Agarwal & Bayus, 2002; Chandrasekaran & Tellis, 2008; Golder & Tellis, 1997). Most digital innovations are instantly available worldwide from their launch and many of them are free to download.

Therefore, traditional measures, such as establishment of foreign operation or FDI (Arregle, Miller, Hitt, & Beamish, 2013; Hashai, 2011), acquisition of first few customers (Autio, Sapienza, & Almeida, 2000; Yu, Gilbert, & Oviatt, 2011) and exports (Cassiman & Golovko, 2011; Nadkarni & Perez, 2007) may not effectively reflect the internationalization process of digital innovations. The construct of international penetration is a more appropriate measure in our context, because it measures not only the availability of a digital innovation, but also its adoption in a focal market. Our measure is also consistent with the IT literature that emphasizes the actual usage of an innovation as a key performance metric (e.g., Iacovou, Benbasat, & Dexter, 1995).

We leverage a unique property of the iOS ecosystem to identify the cutoff point of a successful penetration of an app in a focal country. iPhone displays Top 150 highly downloaded apps in each category using a proprietary formula based mainly on app downloads (Ghose & Han, 2014). Breaking into this highly visible and downloaded zone reflects an adequate level of penetration in a focal market (Garg & Telang, 2013; Kajanan, Pervin, Ramasubbu, Dutta, & Datta, 2012). Accordingly, we consider an app to penetrate into a focal country when it was ranked among top 150 for the first time in that particular country. To ensure the robustness of our results, we also used several alternate criteria for measuring international penetration. The main results are robust to these alternate specifications.

Independent Variables and Moderators

Cross-national Distance: We measure cross-national distance between home country of an app and each focal country. As recognized by various scholars, cross-national distance

is a construct with multiple dimensions that capture different types of distance between countries (Berry et al., 2010; Ghemawat, 2001). Accordingly, prior research has operationalized cross-national distance through a variety of measures such as psychic distance (e.g., Evans & Mavondo, 2002; Johanson & Vahlne, 1977), cultural distance (e.g. Kogut & Singh, 1988), and geographic distance (e.g., Baaij & Slangen, 2013) etc. In this study, we follow Ghemawat's (2001) CAGE index, to assess whether Cultural, Administrative, Geographic and Economic distances will affect the internationalization speed of mobile apps. Although CAGE (like all other distance measures) is an imperfect proxy to capture the true complexities involved in cross border activities (Berry et al., 2010), recent studies on cross-national distance appreciate the comprehensiveness of CAGE measures and increasing employ the index in empirical work (Campbell, Eden, & Miller, 2012; Zhou & Guillen, 2015). We also follow this approach by operationalizing cross-national distance through the four dimensions of CAGE framework.

We measure Cultural, Administrative, Geographic and Economic distance between countries by using the cross-national distance scores provided by Berry et al. (2010). The data provides dyadic country comparison scores for these four cross-national distances. Particularly, cultural distance reflects the differences in cultural values across countries (Hofstede, 1980). Administrative distance refers to differences in colonial ties, language, religion, and the legal system (Ghemawat, 2001). Geographic distance captures the great circle distance between geographical centers of countries. Economic distance, deals with differences in key economic indicators such as income levels (GDP per capita), inflation rates and intensity of foreign trade. All of these dimensions reflect

differences among people across countries in terms of values, preferences, purchasing power, and openness to external influences.

Moderators: To identify whether an app employs social sharing and/or virtual community strategies, we employ two coders, who independently reviewed mobile app descriptions, screenshots, app websites, social media pages (if available) and user reviews. Both coders separately checked all the apps in the sample to identify the ones that encourage users to share their app related achievements or performance on their social media profiles. Such apps were classified as having a social sharing strategy. Similarly, coders searched and identified apps that offer community related features. As observed in prior studies (e.g. Hagel & Armstrong, 1997), user communities can be established through a variety of methods such as creating discussion boards, encouraging members to form collaborative teams, or enabling users to post comments. Coders classified any app as using virtual community strategy if it employs at least one of the above mentioned techniques. To further ascertain their coding, coders also downloaded and used mobile apps to check the presence (or absence) of social sharing or virtual community features. Since coding required judgment only on the presence or absence of a specific criterion, it was relatively easy to do with little potential for coder's subjective biases significantly influencing the coding. The disagreements were discussed until both coders agreed on the proper coding.

Based on this extensive coding exercise, we developed our two moderators, each representing a specific demand-side internalization strategy. The first moderator, social sharing strategy, assigns the value of 1 to any app that enables users to post their interaction with the app on their online social networks. Our second moderator, virtual

community strategy, takes the value of 1 for any app that allows its users to engage in social interactions with each other. We found 37 apps pursuing a social sharing strategy and 19 apps using a virtual community strategy. We found only 9 apps employing both strategies.

Control Variables: We control for a comprehensive set of variables in our estimation. Among app level variables, we first control for app price. The variable indicates actual prices of all paid apps in US dollars and assigns a value of zero to all free apps. The price of an app may have an important impact on app penetration (Eckhardt, 2016; Ghose & Han, 2014) because free or lower priced apps can attract more downloads and quickly rise into top rankings.

We also control for trial promotion, a binary variable that takes the value of 1 if an app offers a free trial before purchase. This is an important variable, because several studies recognize the importance of free trials (also termed as a freemium model) in earning a higher number of downloads (Ghose & Han, 2014; Liu, Au, & Choi, 2014).

In addition, we use number of SDKs (software development kits) in a mobile app as a proxy to measure the sophistication and quality of an app. SDKs act as digital artifacts that introduce various features and functionalities into mobile apps (Jung, Baek, & Li, 2012). App developers add or creatively recombine SDKs to introduce innovative features in their apps (Boudreau, 2012; Yoo et al., 2010). Number of SDKs is a more fine grained proxy of app quality as compared to the traditional measures, such as app size in megabytes used in prior studies (e.g. Ghose & Han, 2014). In an unreported regression however, we used app size instead of number of SDKs and obtained consistent results.

Furthermore, as iOS allows developers to incorporate multiple languages in their apps to facilitate user adoption in foreign countries, we control for language match, a binary variable indicating whether an app offers at least one language that matches one of the official languages of the focal country.

We also control for multihoming, defined as the tendency of hosting an app on multiple app stores (Hossain & Morgan, 2013). We created a dummy variable for multihoming indicating whether an app is also available on Google Play store, the other most prominent app store aside from iOS.

We also take into account the social media presence of an app as a proxy to measure the marketing efforts by an app. Social media has received increased prominence as a cost effective tool for advertising and promoting online businesses and digital innovations (Brouthers et al., 2016). We operationalize social media presence as a dummy variable indicating whether an app or its developer has a social media page on either Facebook or Twitter. We focus on Facebook and Twitter because the global reach of these social platforms is most likely to expose an app to overseas users.

Moreover, we focus on specialized apps in our sample, whose scope is limited to certain geographic regions. Such regional specialization may improve the attractiveness of apps for users in certain geographic areas, but such apps are less likely to succeed in other markets. We use a binary variable that takes the value of 1 for specialized apps.

In addition, we recognize that prior experience of app developers can have important consequences for the penetration of apps. Mobile app industry is a relatively new industry where most stakeholders are still in the learning phase (Li, Goh, & Cavusoglu, 2013). Most app developers accumulate experience with the passage of time

as they better understand programming techniques on their particular app stores, and interact with more customers to better understand their preferences and needs. Therefore, we control for developer experience, which is measured by the number of years since a developer first launched an app on iOS.

We also control for two important category-country level variables, market size and category concentration. We use the complete dataset of 4,583 apps to calculate these two variables for the health and fitness category in each country for the month an app was launched. We measure our first category-country level variable, market size, as the total revenues earned by all apps in the health and fitness category in a focal country. Market size reflects the attractiveness of a focal country, which may motivate greater customization of products and services to the unique tastes and preferences of a focal country (Rothaermel, Kotha, & Steensma, 2006). A larger market also provides a more open environment, in which many digital innovations can penetrate and coexist (Henisz & Zelner, 2001).

Our second category-country level variable, category concentration, describes the share of revenues earned by the ten leading apps in the health and fitness category in each country. We follow Eisenhardt & Schoonhoven (1990) to calculate this variable. First, we select top 10 apps that earned highest revenues in focal country in a particular month. Next, we divide the revenues of top 10 apps by the total revenues earned by all apps in a focal country for the same time period. Category concentration is an important indicator of overall competitiveness in a given subcategory. Highly concentrated categories are characterized by a relatively few large players holding significant shares of the total market, whereas categories with lower levels of concentration are characterized by a

greater number of firms with smaller market shares (Basdeo, Smith, Grimm, Rindova, Derfus, 2006). Prior research treats higher industry concentration as an important entry barrier that can limit new entrants' ability to penetrate into a focal country (e.g., Mudambi & Zahra, 2007).

Finally, we include mutually exclusive binary variables that indicate the subcategory of each app, and also control fixed effects of the home country of each app.

Statistical Approach

The purpose of our study is to identify the determinants of the length of time taken by digital innovations to penetrate into a focal country. To explore our research question, we follow previous research on penetration, takeoff and diffusion (e.g. Chandrasekaran & Tellis, 2008; Galang, 2012; Tellis, Stremersch, & Yin, 2003; Van Everdingen, Fok, & Stremersch, 2009) to use a hazard model with an accelerated failure time (AFT) specification. AFT models are used to express the impact of independent variables on time to an event. Hence, positive coefficients are being associated with later penetration and negative coefficients indicate earlier penetration. This connects directly with our hypotheses as they are constructed in terms of speed to penetration.

AFT models also make it possible to include right censored apps that have not penetrated until the end of our observation period. In this study, the ability to use such observations is crucial, because 63% observations are right censored in our sample. However, left censoring did not pose a problem as we tracked all apps from their respective launch dates.

We estimated the AFT model with multiple-record data and multiple events, in which the model considers that individuals (apps) experience different events (penetration into different countries) during the time span under analysis. Our observations are at the app-country level. Each observation is included only once, either at the time the app penetrated into a focal country or at December 31, 2015 if not penetrated within our timeframe.

We run our AFT model using a random effects approach (frailty model) and assuming a hazard function with a Weibull distribution. The relative mathematical simplicity and flexibility of Weibull distribution has made it among the more popularly used parametric hazard models (Blomkvist, Kappen, & Zander, 2010; Klein & Moeschberger, 2003). Weibull specification is also suitable in our research context because app penetration rates may vary systematically with time under observation, changing monotonically with the age of apps.

Results

Table 1.1 reports the descriptive statistics and correlations between the variables, except for subcategory and home country dummies. Table 1 indicates little correlation among variables, indicating that multicollinearity may not be a problem. In addition, we used linear regression collinearity diagnostics to check the value of the variance inflation factor (VIF) for all independent variables and interaction terms. Our VIF value was 4.5, well below the rule-of-thumb cutoff of 10 (Neter, Wasserman, and Kutner, 1985).

Table 1.2 presents the results for the AFT model with Weibull specification. Model 1 includes only control variables. In Model 2, we add our four measures of cross-

national distance. In Model 3, we separately include the main effects of social sharing and virtual community strategies. In Model 4, we interact our first moderator, social sharing strategy, with each measure of cross-national distance. Similarly in Model 5, we interact our second moderator, virtual community strategy, with our measures of distance. Model 6 presents the full model. The model fit, as indicated by Chi-Square and Log likelihood, shows improvement in each subsequent model.

The results for the control variables provide some interesting insights. With respect to app-level controls, we find statistically significant and economically strong impact for trial promotions, No. of SDKs, and language match on our dependent variable, time to penetration. In addition, we followed Elfenbein & Knott (2015) to calculate economic significance of our results. When all other variables are held at their means, we find that offering trial promotion reduces time to penetration by about 84 percent (P-value=0.027) for the average app. Language match also has a substantial economic impact. Offering the language of a focal country reduces time to penetration by about 53 percent (P-value=0.000) for the average app. Furthermore, adding more SDKs also helps app penetration: particularly an increase of 1 standard deviation in No. of SDKs decreases time to penetration by about 37 percent (P-value=0.021) for the average app.

With respect to our hypotheses, Model 2 in Table 1.2 shows that Hypothesis 1 is supported. The coefficients for cultural, geographic and economic distances are statistically significant and positive. Thus, we find that cross-national distance increases the time to penetration. The economic significance of these estimates is substantial as well: one standard deviation increase in cultural, geographic and economic distances is

associated with the increase of time to penetration by 14% (p-value=0.001), 20% (p-value=0.000) and 11% (p-value=0.003) respectively.

We report tests for social sharing and virtual community strategies in Model 3. Each of these strategies shows a negative sign and also attains statistical significance. We also find these two strategies to have substantial economic impact. Holding all variables on their means, a social sharing strategy reduces time to penetration by more than 55 percent (P-value=0.048) whereas a virtual community strategy reduces time to penetration by more than 74 percent (P-value=0.003) for the average app.

Model 4 tests Hypothesis 2 by including the interaction terms between social sharing strategy and our four indicators of cross-national distance. We find that three out of four interaction terms are negative and significant—only the interaction term involving geographic distance is not significant. Consistent with Hypothesis 2 and as plotted in Figure 1.1[2], this finding indicates that the relationship between cross-national distance and time to penetration is less positive for apps that pursue a social sharing strategy. Hypothesis 2 is, therefore, supported.

Model 5 tests our Hypothesis 3 about the moderating impact of a virtual community strategy. Only one interaction term between virtual community strategy and economic distance is negative and significant—none of the other three interaction terms is significant. Against the predictions in Hypothesis 3, we find virtual community

[2] Figure 1.1 and Figure 1.2 represent cumulative hazard of international penetration with the passage of time. These figures are for illustration purpose only and they are not adjusted for any control variables. For the sake of simplicity, we first standardize all four measures of distances and later, we add these standardized scores to create a comprehensive variable of cross-national distance. We use this comprehensive measure of distance in Figure 1.1 and Figure 1.2 to illustrate our interaction effects.

strategy to have only limited impact on time to penetration when cross-national distance is high. These results are further illustrated in Figure 1.2.

While each of our hypotheses (with the exception of Hypothesis 3) finds support in isolation, we also report the full model in Model 6 that tests all hypotheses simultaneously. The model indicates that all relationships that are significant in isolation maintain their significance in combination.

Robustness Tests

To examine the robustness of our results, we conducted a series of additional tests. First, as our criterion for international penetration is slightly unconventional, we fit several additional models under different measures of penetration. On most fundamental level, we used top 25, top 50, top 100, top 200 and top 250 rankings as cutoff points to define penetration into focal countries. We also defined international penetration on the basis of app downloads in a focal country. Our data indicates that an app usually captures a download share of at least 0.5% in a focal market within its respective subcategory in the month when it ranks among the top 150. Using this alternate criterion, we consider an app to penetrate into a focal market in the first month when it achieved at least 0.5% download share in that particular country. Under all these alternate specifications, the results were qualitatively consistent in terms of signs and significances.

We conducted additional regressions on different subsamples of our data. We examined a sample after excluding the home countries of mobile apps, which led to 5,632 observations. Furthermore, we ran our analyses after excluding specialized apps, as these apps may have restricted geographic scopes. We found consistent results in both

subsamples. We also accounted for any unobservable differences among countries that may affect the international penetration of digital innovations. In an unreported regression, we estimated all models with focal country fixed effects and obtained similar results.

Finally, we ascertain that our results are not driven by our choice of Weibull model. We fit several other parametric regressions models utilizing alternative hazard function distributions, log-logistic, exponential and log-normal distributions, as well as semiparametric hazard regressions, the Cox model. As results under all specifications are nearly identical in sign and significance, we only reported results based on Weibull model.

DISCUSSION

In this article, we seek to expand internationalization theories to encompass the novel context of digital innovations. Our focus on digital innovations sheds new light on internationalization in the virtual business landscape. Deviating from past research that tends to treat internationalization as a series of market entry decisions and stress the importance of proprietary resources in the internationalization process (Johanson & Vahlne, 1977; Knight & Cavusgil, 2004; Peng, 2001), we investigate a different set of research questions to better incorporate the unique characteristics of digital innovations. First, we explore the challenges that impede the international penetrations of digital innovations despite their global availability. Second, we evaluate the impact of demand-side internalization strategies on the speed of internationalization of digital innovations. Our results suggest that cross-national distance still exists as an important user adoption

barrier for internationalization of digital innovations. Moreover, the foregoing analysis reveals that demand-side internalization strategies, although effective for penetrating in domestic markets as well as foreign markets with lower distance, exhibit limited effectiveness in overcoming user adoption barriers imposed by CAGE distances. Instead, the impact of different demand-side internalization strategies is contingent upon the magnitude and nature of cross-national distance.

Our findings contribute to several literature streams. On conceptual front, our study extends the recent research on internalization of networks (Banalieva & Dhanaraj, 2018) from the lens of demand-side perspective (Priem, 2007; Priem et al., 2012). While there is a theoretical recognition about the value of internalizing networks, little research segregates the specific strategies for internalization and empirically evaluate their impact. We build on demand-side perspective to offer two specific strategies for internalizing demand-side networks and also demonstrate their role in internationalization of digital innovations. Part of our evidence coincides with theoretical predictions in demand-side perspective, as we find that both social sharing and virtual community strategies accelerate the international penetration of digital innovations. These results imply that demand-side networks can complement or substitute internal resources (Adner & Snow, 2010; Priem et al., 2013; Ye, Priem, & Alshwer, 2012). However, when cross-national distance is high, we find that only social sharing strategy accelerates the international penetration of digital innovations, whereas the virtual community strategy appears to play a limited role. Our study indicates that the effectiveness of demand-side strategies can vary across countries, stressing the distinction between mainstream strategy and global strategy (e.g. Ghemawat, 2003; Wright & Ricks, 1994) and emphasizing the need to

further extend the demand-side perspective in international contexts (Siqueira et al., 2015).

The limited effectiveness of virtual communities is counterintuitive, given the prior research emphasis on using users, coproduction and prosumption (Baldwin & Von Hippel, 2011; Bogers, Afuah, & Bastian, 2010; Von Hippel, 2005). Theoretically, virtual communities may encourage heterophily, e.g. communication among non-similar individuals to allow information flow among diverse groups (Buchan, Johnson, & Croson, 2006; Rogers, 2003; Stahl, Tung, Kostova, & Zellmer-Bruhn, 2016). However, such synergistic benefits may not materialize when cross-national distances are high (Ghoshal, 1987; Goerzen & Beamish, 2005). Instead, heterophilious interactions may result into cultural frictions, conflicts and miscommunications (Roth, Kostova, & Dakhli, 2011; Shenkar, Luo, & Yeheskel, 2008), deterring users from engaging in virtual communities. In this sense, our results imply that the Tower of Babel effect still exists in cyberspace in such a way that cross-national distances may prevent disperse demand-side networks across countries into a large global community. However, we find virtual community to be an effective strategy when economic distance is high. These findings provide some evidence that differences in languages, cultural values, and religions may create friction, inhibiting the formation of heterophilious virtual communities (Ghoshal, 1987; Shenkar et al., 2008). However, differences in economic prosperities among nations may create opportunities for heterophilious interactions without creating communication barriers. This finding is particularly interesting as there is an increased desire to know which specific dimensions play a key role in determining their relationship when people from different nations come in contact (Beugelsdijk, Kostova,

Kunst, Spadafora, & van Essen, 2018; Javidan, House, Dorfman, Hanges, & De Luque, 2006; Leung, Bhagat, Buchan, Erez, & Gibson, 2005). Based on our results, we suggest that economic differences may facilitate the development of synergistic relationships among diverse groups whereas cultural, administrative, and geographic differences may still impede cross national interactions.

Our study also contributes to the prominent debate about the "death of distance" (Berry, Guillén, & Hendi, 2014; Cairncross, 1997; Friedman, 2005; Ghemawat, 2013; Leung et al., 2005). We provide empirical evidence that cross-national distance impedes penetration of digital innovations. Nevertheless, we also find that for digital innovations, the time to penetrate into international markets has reduced from multiple years to a few weeks. This shortened time to penetration, however, does not deem distance irrelevant, because the probability of penetrating into a new country exponentially decreases with the age of a digital innovation. For instance, the average time to penetration into a country is 113 days in our sample and we find that apps penetrate into 75% countries within 6 months and 90% countries within 10 months after their launch.

An interesting finding of our study is the difficulty of overcoming geographic distance in the cyberspace. This finding is surprising as many scholars expect geographic distance to have lessened importance in a digital world (Amit & Zott, 2001; Brouthers et al., 2016). Our results, on the contrary, indicate that geographic distance still poses challenges for digital innovations and can be difficult to overcome by utilizing social sharing and virtual community strategies. This may be due to the fact that geographic distance will reduce face to face interactions and cultural awareness among countries (Burtch, Ghose, & Wattal, 2014). Even if two geographically distant countries have little

cultural, administrative, or economic differences, such lack of awareness can inhibit people from appreciating and adjusting to these differences, as well as from forming social networks. Such insensitivity to mutual differences can barricade the penetration of digital innovations and also compromise the effectiveness of social sharing or virtual community strategies. This finding echoes a recent study by Agrawal, Catalini, & Goldfarb (2015), who surprisingly found that investors are geographically bound in partaking in digital crowdfunding platforms. The role of geographic distance in a digital world is slightly counterintuitive, but presents intriguing puzzles, which warrant further research attention.

The importance of cross-national distance for digital innovations may help portrait the business landscape in a digital future. Prior research recognizes the presence of heterogeneous and dispersed niche interests across countries (Speck & Roy, 2008). However, the emergence of Information Technology may deepen these differences through greater customization of products to unique tastes of nations, racial groups and even individuals (Kim & Jensen, 2004). The infinite segmentation of market led by technological progress will allow local digital imitators to fill in subtle niches, which in turn enhances the difficulty for a digital innovation to penetrate a focal country. In this case, technology may not result in the "death of distance," but trigger more intense competitions, making internationalization even harder in cyberspace.

Our final contribution is to outline some major differences in the internationalization process of digital innovations. We stress the need to conceptualize the internationalization of digital innovations in terms of adoptions and penetrations instead of market entry. We concur with Brouthers et al., (2016) that diffusion based

user-adoption theories (Rogers, 2003) such as diffusion of innovation theory (DIT) may be helpful in explaining the internationalization in a digital world. However, as most diffusion theories have been developed in the context of industrial innovations, they may encounter certain limitations in the context of digital innovations (Yoo et al., 2012). In particular, DIT treats innovation as static and unproblematic objects that are developed through capital intensive processes and diffused into homogeneous adopters (Rogers, 2003). On the contrary, digital innovations are low cost innovations that are highly dynamic, volatile, and emergent, subject to continuous updates and span across multiple heterogeneous communities (Boudreau, 2012; Yoo et al., 2012). Nevertheless, the rich framework of DIT can provide an alternative lens in extending our understanding of digital innovations, whereas unique properties of digital innovations can contribute to further refinement of DIT theories.

Our research also entails some limitations. As we explore two nascent topics, digital innovations and internalization of networks from a demand-side perspective, we face various challenges in terms of data availability and lack of relevant literature. For instance, the data in our study is limited to only one category, health and fitness, in iOS app store. In relation to our research question, however, we do not expect a substantial change in results if the sample were drawn from different categories or App stores. Still, caution should be exercised when applying our findings to other contexts.

Further, we limit our focus to only two demand-side internalization strategies. While these two strategies have received substantial importance in literature, we acknowledge the large variety of techniques for internalizing user networks such as sharing economy and open innovation. Although these strategies are outside the scope of

our data and current study, future research may explore more ways of demand-side bricolages and assess their effectiveness in both domestic and international contexts.

In addition, our measures of cross-national distance are originally developed in the context of traditional internationalization theories with the objectives of assessing the impact of distance on corporate decision making (Berry et al., 2010). Similar measures have also been utilized in research, which studies market penetration and takeoffs (e.g. Chandrasekaran & Tellis, 2008; Van Everdingen et al., 2009; Kim & Jensen, 2014; Tellis et al., 2003). However, with the development of digital technology, more and more firms are engaged in digital innovations, which become instantly available to international users through joining global platforms (Brouthers et al., 2016). Scholars may need to draw from research on cultural studies, anthropology and sociology to develop novel measures for capturing differences in user adoption patterns across countries, instead of focusing on distance measures based on firm perceptions.

Overall, we have taken only a small, indicative first step toward better understanding the internationalization of digital innovations. We hope that our research will encourage scholars to further investigate the rising phenomenon and to refine strategic management and IB theories to encompass the uniqueness of digital arena.

Table 1.1
Descriptive Statistics and Correlation Table

#	Variable	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Time to penetration	112.99	115.01	1	442																
2	App price	1.29	4.4	0	59.99	0.05															
3	Trial promotion	0.06	0.24	0	1	-0.04	-0.08														
4	No. of SDKs	1.14	2.41	0	12	-0.18	-0.09	0.26													
5	Language match	0.34	0.47	0	1	-0.01	-0.02	0.03	0.09												
6	Multihoming	0.29	0.45	0	1	-0.02	-0.11	0.05	0	0.03											
7	Social media presence	0.64	0.48	0	1	-0.08	0.13	0.19	0.14	-0.04	0.02										
8	Specialized apps	0.03	0.18	0	1	0.01	-0.05	-0.05	0.09	-0.03	0.18	0.14									
9	Developer experience	1.3	1.67	0	6.08	-0.17	0.07	0.08	-0.02	0	-0.04	0.17	0								
10	Market size	11.13	1.47	7.58	16.3	-0.02	0.01	-0.01	0	0.26	-0.01	0	0	0							
11	Category concentration	0.02	0.02	0	0.2	0.01	0	0	0	-0.05	0	0.01	0	0	0.24						
12	Cultural distance	0.17	0.17	0	1.62	0.02	0	-0.02	-0.03	-0.15	0.02	0	0.01	0	-0.16	0.12					
13	Administrative distance	0.16	0.19	0	1.58	-0.03	-0.01	0.01	-0.01	-0.21	-0.04	0.02	-0.02	0.01	-0.17	-0.11	-0.06				
14	Geographic distance	0.81	0.42	0	1.98	0.09	0.01	0	-0.05	0.03	0.05	0.03	0.02	0	-0.07	-0.05	0.1	-0.05			
15	Economic distance	0.10	0.10	0	0.44	0.05	0	-0.02	-0.03	0.08	0.06	0.01	0.01	0.02	-0.2	-0.08	0.07	-0.11	0.27		
16	Social sharing strategy	0.29	0.46	0	1	-0.12	-0.07	0.04	0.02	0.02	0.06	0	-0.12	-0.13	-0.03	-0.01	-0.04	0.06	-0.08	-0.04	
17	Virtual community strategy	0.14	0.35	0	1	-0.11	-0.09	0.17	0.15	-0.06	0.07	0.15	-0.07	-0.08	0.01	0	-0.02	0.01	0.02	-0.04	0.16

Note: There are 2,025 app-country observations for variable 1 (which excludes right truncated observations) and 5,757 app-country observations for variables 2–18.

Table 1.2
Explaining Factors influencing the Time to Penetration

Variables	Model 1 Control variables	Model 2 Distance Main effects	Model 3 Internalization Main effect	Model 4 Social sharing Interaction effect	Model 5 Virtual community Interaction effect	Model 6 Full model
App price	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Trial promotion	-1.81*	-1.81*	-1.58*	-1.57*	-1.57*	-1.56*
	(0.82)	(0.82)	(0.69)	(0.69)	(0.69)	(0.69)
No. of SDKs	-0.19*	-0.18*	-0.15*	-0.15*	-0.15*	-0.15*
	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Language match	-0.76***	-0.84***	-0.84***	-0.81***	-0.83***	-0.80***
	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)	(0.08)
Multihoming	0.28	0.29	0.42	0.40	0.43	0.41
	(0.42)	(0.42)	(0.37)	(0.37)	(0.37)	(0.37)
Social media presence	-0.02	-0.04	0.16	0.16	0.16	0.16
	(0.43)	(0.43)	(0.39)	(0.39)	(0.39)	(0.39)
Specialized apps	1.11	1.08	0.53	0.53	0.53	0.53
	(1.08)	(1.09)	(0.97)	(0.98)	(0.97)	(0.97)
Developer experience	-0.08	-0.08	-0.15	-0.15	-0.15	-0.15
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Market size	0.06*	0.09***	0.09***	0.10***	0.09***	0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Category concentration	0.46	0.07	0.06	0.19	-0.07	0.08
	(1.44)	(1.44)	(1.44)	(1.44)	(1.44)	(1.44)
Cultural distance		0.79***	0.78***	1.25***	0.73**	1.19***
		(0.23)	(0.23)	(0.34)	(0.24)	(0.34)
Administrative distance		-0.16	-0.16	0.35	-0.17	0.34
		(0.18)	(0.18)	(0.25)	(0.19)	(0.25)
Geographic distance		0.43***	0.43***	0.32**	0.40***	0.30**
		(0.08)	(0.08)	(0.11)	(0.09)	(0.11)
Economic distance		1.01**	1.01**	2.86***	1.44***	3.06***
		(0.34)	(0.34)	(0.51)	(0.38)	(0.52)
Social sharing strategy			-0.80*	-0.28	-0.81*	-0.28
			(0.40)	(0.43)	(0.40)	(0.43)
Virtual community strategy			-1.35**	-1.34**	-1.33**	-1.42**
			(0.45)	(0.45)	(0.49)	(0.49)
Social sharing strategy * Cultural distance				-0.95*		-0.98*
				(0.44)		(0.44)
Social sharing strategy* Administrative distance				-0.90**		-0.94**
				(0.34)		(0.34)
Social sharing strategy* Geographic distance				0.13		0.12
				(0.16)		(0.16)
Social sharing strategy* Economic distance				-3.50***		-3.28***
				(0.66)		(0.67)
Virtual community strategy* Cultural distance					0.45	0.67
					(0.71)	(0.71)
Virtual community strategy* Administrative distance					-0.03	0.07
					(0.45)	(0.45)
Virtual community strategy* Geographic distance					0.21	0.19
					(0.22)	(0.22)
Virtual community strategy* Economic distance					-2.49**	-1.82*
					(0.83)	(0.83)
Constant	4.59*	3.76+	4.36*	3.85*	4.35*	3.86*
	(1.93)	(1.94)	(1.81)	(1.81)	(1.80)	(1.81)
Control for app home country	Yes	Yes	Yes	Yes	Yes	Yes
Control for app subcategory	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,757	5,757	5,757	5,757	5,757	5,757
Number of groups	127	127	127	127	127	127
Log likelihood	-5809	-5776	-5768	-5749	-5764	-5746
$\chi 2$	200	266	281	319	290	326

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

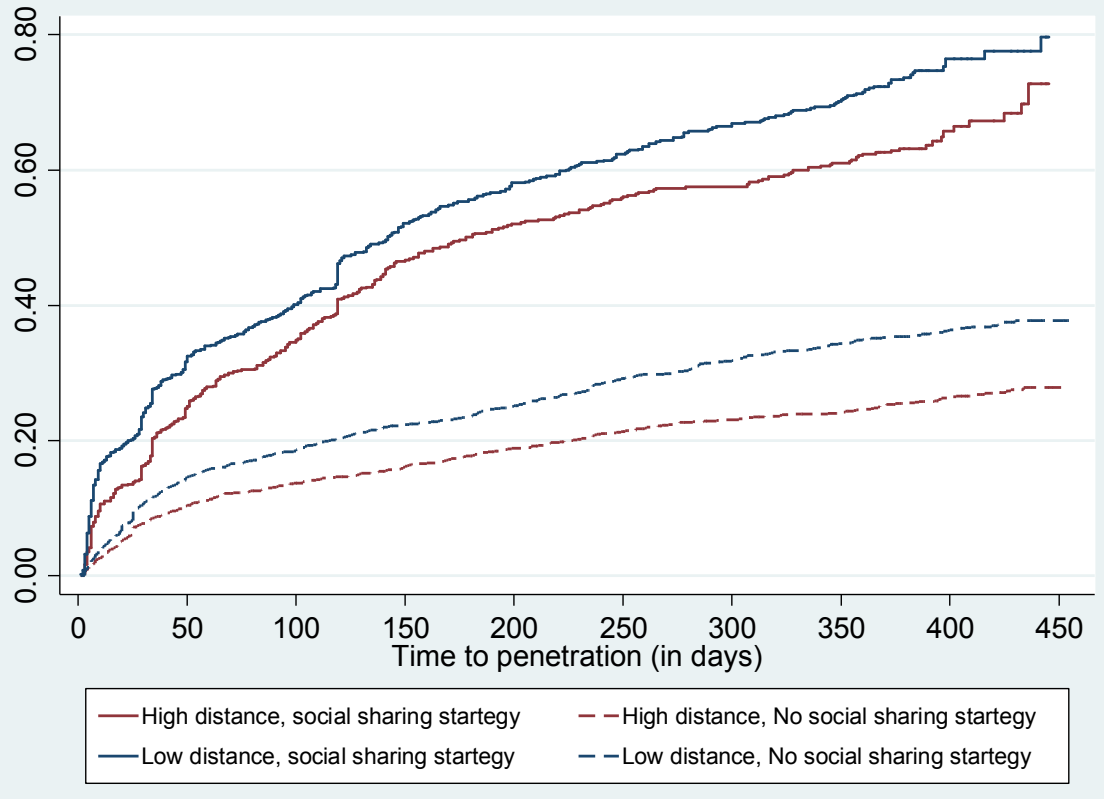

Figure 1.1
Impact of Social Sharing Strategy on Cross-national Distance

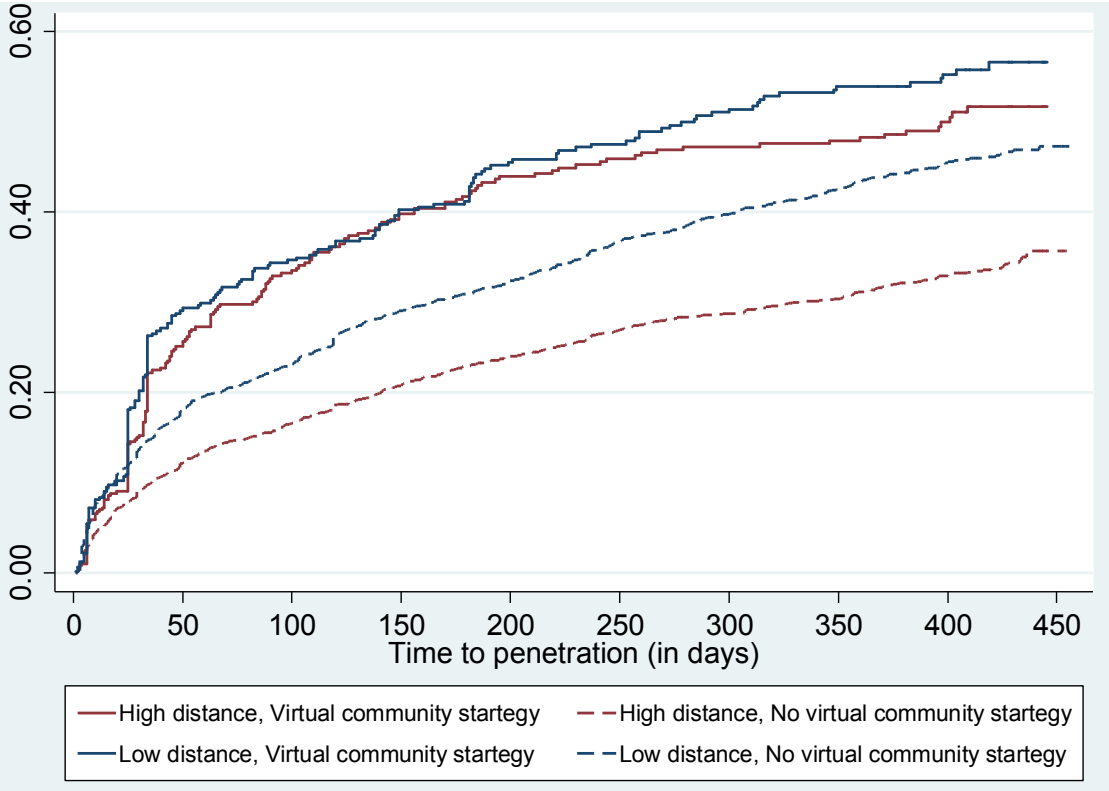

Figure 1.2
Impact of Virtual Community Strategy on Cross-national Distance

ESSAY 2

REVISITING LOCATION IN A DIGITAL AGE: THE INTERPLAY BETWEEN LEAD MARKETS AND CAPABILITY DEPLOYMENT FOR INTERNATIONALIZATION OF DIGITAL INNOVATIONS

Abstract: While firms reap critical location advantages from countries offering innovation clusters and alliance partners, many digital businesses now source and synthesize knowledge and innovation ideas from their demand-side networks to upgrade and internationalize their digital innovations. However, it is unclear that demand-side networks at which locations can facilitate digital businesses in improving their innovations to appeal multiple countries? We employ a lead market lens to argue that countries with higher demand heterogeneity and international connectedness are likely to act as lead markets as establishing demand-side networks in such countries may facilitate digital businesses in improving the global appeal of their innovations. Hence, we advocate the need to expand the current taxonomy of location advantages to include lead markets as important demand-side location advantages for digital arena. We further argue that establishing demand-side networks in lead markets may not obviate the need to deploy adequate capabilities. In particular, digital businesses may deploy their technological and marketing capabilities to benefit from heterogeneous lead markets and marketing capabilities to take advantage of internationally connected lead markets. We

find empirical support for our arguments by analyzing international penetrations of 1,910 gaming apps at IOS platform across 57 countries over a period of two years.

Keywords: Digital Internationalization; Location Advantage; Lead Market; Capability Deployment; Mobile Apps

INTRODUCTION

Research in international business (IB) has long recognized the tendency of firms to pursue knowledge-based location advantages by maintaining presence in countries hosting innovation clusters and alliance partners with advanced capabilities (Dunning, 1998; 2009; Cantwell, 2009). With the advent of modern digital economy however, the locus of innovation is shifting from firms to demand-side networks, particularly end users (Boudreau, 2012; Cavusgil & Knight, 2015; Coviello, Kano, & Liesch, 2017; Moreau, Franke, & von Hippel, 2018). Scholars (e.g., Autio, Nambisan, Thomas, & Wright, 2018; Chandra & Coviello, 2010; Kriz & Welch, 2018; Shaheer & Li, 2019) increasingly draw attention to digital businesses that develop digital innovations without knowing the whole design and extensively rely on their demand-side networks for interactively evolving their digital innovations to satisfy current users and also expand to new countries. As demand-side networks play a pivotal role in shaping the appeal of digital innovations to other markets, we propose that digital businesses may reap critical location advantages from lead countries where demand-side networks, instead of alliance partners, could offer the knowledge and innovation ideas for upgrading innovations to appeal multiple countries. While an extensive literature in marketing already focuses on lead markets that generate cross-border social signals to facilitate international diffusion of innovations (e.g., Putsis, 1987; Tellis, Stremersch, & Yin 2003; Van Everdingen, Fok, & Stremersch, 2009), little research explores the strategic implications of lead markets by investigating the characteristics that enable demand-side networks in some countries to contribute in upgrading innovations to penetrate multiple countries.

We expand research on location advantages in a digital context from a lead market lens by proposing two important characteristics that turn some countries into lead markets (e.g., Bartlett & Ghoshal, 1990; Beise, 2001; 2004; Doz & Wilson, 2012; Prahald & Doz, 1987) by enabling them to facilitate digital businesses in internationalization of their digital innovations. First, we propose higher demand heterogeneity within countries as an important lead market characteristic, which may allow digital innovations to interact with diverse demand-side networks and evolve into superior and versatile technologies with a global appeal. Second, we argue that preferences of demand-side networks in a lead market may overlap with preferences in several countries—what we term as international connectedness of a lead market with other countries—which may induce digital business to incorporate innovation attributes that may also appeal to other countries with similar preferences. Hence, we contend that establishing demand-side networks in lead markets with either higher demand heterogeneity or higher international connectedness may offer critical location advantages to digital businesses for subsequent internationalization of their digital innovations.

The importance of orchestrating demand-side networks in lead markets, however, may not obscure the need for deploying suitable capabilities to exploit these location advantages (Dunning & Lundan, 2008). As argued by Alcácer, Cantwell, & Piscitello (2016), digital businesses require substantial capabilities to discover and integrate the knowledge from external sources, which might dissipate and get lost otherwise. In particular, we propose that digital businesses need to deploy their technological and marketing capabilities in order to rapidly decipher the knowledge from demand-side

networks in lead markets, act quickly to upgrade their innovations, and speedily promote the improved innovations to new countries, particularly as the window available to gather and exploit knowledge is getting shorter on face of extensive competition in digital age (Autio & Zander, 2016; Zaheer, & Manrakhan, 2001).

We empirically test our arguments by tracking 1,910 newly launched gaming apps in 57 countries over a period of two years. Keeping our unit of analysis on app level, we conduct a fine grained analysis that takes into account specific countries in which an app established demand-side networks as well as the capabilities app developer deployed to support the particular app. We find that establishing demand-side networks in countries with higher demand heterogeneity and international connectedness may facilitate app penetrations in other countries, implying that app developers can leverage some countries as lead markets for app internationalization. We also show that deploying appropriate capabilities may substantially enhance the location advantages of lead markets. In particular, app developers may deploy their technological and marketing capabilities to take advantage of lead markets with higher demand heterogeneity and marketing capabilities to benefit from internationally connected lead markets.

Our paper contributes to the recent discussion about the role of location in digital era (e.g. Alcácer et al., 2016; Duning, 2009; Cantwell, 2009) by evaluating the novel location advantages offered by demand-side networks in lead markets. While IB research largely focuses on supply-side location advantages such as low cost production, natural resources or innovation clusters, the increasing capacity of digital businesses to leverage demand-side networks across countries stresses the need to expand Dunning (1998)'s taxonomy of location advantages to also encompass demand-side location

advantages in lead markets. Indeed, as global platforms permit digital innovations to establish demand-side networks anywhere in the world right from their inception (Coviello et al., 2017; Shaheer & Li, 2019), we suggest that digital businesses may pursue the new strategic imperative of first penetrating their innovations in demand-side networks of those lead markets that match their capabilities. An important example is the Finnish firm, Supercell, which penetrates its games first in institutionally distant but sophisticated gaming markets of North America (Kerr, Jones, & Brownell, 2016; Squires, 2015). We expect demand-side location advantages in lead markets to substantially enrich digital internationalization literature.

We also contribute to the emerging research stream on digital internationalization by blending the traditional wisdom about internal capabilities with novel theoretical frameworks about demand-side networks. We explore a central question that how some digital innovations manage to stand apart their competing technologies to attract users from multiple countries. We investigate this question by theorizing how deployment of certain capabilities in conjunction with location advantages in lead markets can lead to differences in app attributes and resulting internationalization trajectories. Hence, we contend that the interplay between internal capabilities and location advantages can offer important theoretical mechanisms to more comprehensively explain digital internationalization.

Finally, we contribute to IB research (e.g. Grappi, Romani, & Bagozzi, 2018; Siqueira, Priem, & Parente, 2015; Shaheer & Li, 2019; Zhang, Zhong, & Makino, 2015) that seeks to incorporate the role of demand-side factors in IB literature. By demonstrating that not all demand-side networks contribute equally to digital

internationalization, we stress the need to go beyond recognizing the importance of demand-side perspective (DSP) and develop a more fine-grained understanding of DSP in IB by evaluating the pros and cons of different demand-side opportunities. We hope our study will encourage researchers to further integrate DSP literature in IB research.

LITERATURE REVIEW

Digital Innovations and Demand-side Networks

The rise of digital economy is regarded as one of the most important winds of change that is driving substantial extensions in current strategy and IB frameworks (Cavusgil & Knight, 2015; Eden, 2016; Mckinsey & Company, 2016). An important transition in digital era is global proliferation of digital innovations, which can be defined as reprogrammable software developed through recombination of digital components in layered, modular architectures to create new value for users (Boudreau, 2012; Dattée, Alexy, & Autio, 2018; Lusch & Nambisan, 2015; Zittrain, 2005). Some distinctive characteristics of digital innovations include generativity and reprogrammability, which afford digital businesses the flexibility to continuously evolve their innovations based on the interaction of digital innovations with demand-side networks (Autio, Nambisan, Thomas, & Wright, 2018; Moreau, Franke, & von Hippel, 2018). As prior research posits (Autio, 2017; Garud, Jain, & Tuertscher, 2008; Kriz & Welch, 2018; Qiu, Gopal, & Hann, 2017; Yoo, Boland, Lyytinen, & Majchrzak, 2012), each digital innovation can be characterized as a new-to-the-world technology whose developers (i.e. digital businesses) rarely possesses sufficient ex-ante knowledge as to what characteristics will

increase the chances of its adoption. Instead, digital businesses develop digital innovation without fully knowing the whole design and rely on knowledge and innovation ideas extracted from demand-side networks to continuously reiterate their innovations—as reflected in sheer volume of new versions, upgrades, and added functionalities—to better address market needs (Huang, Henfridsson, Liu, & Newell, 2017; Kallinikos, Aaltonen, & Marton, 2013; Lee & Berente, 2012; (e.g., Autio, 2017; Chandra & Coviello, 2010; Kallinikos, Aaltonen, & Marton, 2013). Hence, demand-side networks play a pivotal role in shaping the attributes of digital innovations to satisfy the requirements of current and new markets (Amit & Han, 2017; Chandra & Coviello, 2010; Tilson, Lyytinen, & Sørensen, 2010).

Several scholars (e.g. Bijker & Hughes, 2012; Chandra & Coviello, 2010; Kriz & Welch, 2018; Moreau et al., 2018) have started recognizing that innovating in a digital era has turned into a social process in which digital businesses and demand-side networks jointly shape digital innovations to satisfy current markets and also appeal new countries. Although a vast literature already acknowledges the benefits of engaging and co-creating with demand-side networks (e.g. Prahalad & Ramaswamy, 2004; Shah & Tripsas, 2007; von Hippel, 2005), businesses in more traditional industries face substantial limitations in connecting with users and quickly upgrading their products (Autio et al., 2018). Digital businesses, on the other hand, can meticulously capture even minute details of the interaction between their innovations and demand-side networks and instantly upgrade their innovations to address market needs (Boudreau, 2012; Kohler, Fueller, Matzler, Stieger, & Füller, 2011; Yoo et al., 2012). For instance, the demand-side networks established by the leading game developer, Zynga, generate many

petabytes of daily data, which guide Zynga to update its games several times a day (Goldberg & Schifrin, 2016; Piskorski & Chen, 2010). Such opportunities are not limited to large firms anymore. In apps industry for example, platforms as well as several third parties offer sophisticated behavioral tracking, machine learning, and artificial intelligence toolkits for free, which are now installed in almost every mobile app, enabling even small, indie app developers to effectively take advantage of their demand-side networks (Bergvall-Kåreborn, Björn, & Chincholle, 2011; Boudreau & Jeppesen, 2015; Safedk, 2018; Ye & Kankanhalli, 2018). Such extensive engagement with demand-side networks also provides a privileged access to knowledge and innovation ideas, which may not be replicated by competitors due to time compression economies as well as casual ambiguities about critical market needs (Adner & Snow, 2010; Priem, 2007; Priem, Butler, & Li, 2013; Zander & Zander, 2005).

The Location Advantage of Lead Markets for Digital Internationalization

Given the critical role of demand-side networks in digital arena, we advocate recognizing demand-side networks in lead markets as important location advantages as they provide digital businesses the knowledge and innovation ideas to facilitate the internationalization of their innovations. Prior research (Dunning, 1998; Graham, 1978; Hamel & Prahalad, 1985) has long acknowledged intellectual capital and knowledge-intensive strategic assets as important location advantages. Dunning (1995) specifically emphasizes the rise of alliance capitalism, stressing that establishing alliance networks with foreign firms are essential to harness location-bound knowledge-based assets. On

the wake of modern technologies, Zaheer & Manrakhan (2001) further argue that firms can leverage information technology to virtually access the location-bound assets of partner firms and even establish "virtual multinationals". The advent of digital platforms, however, may possibly reduce the location-boundedness of interfirm alliances by connecting businesses—such as developers of digital innovations, advertising platforms and toolkits providers—from across the world and governing interfirm relationships through globally standardized protocols, instead of national institutional systems (Amit & Han, 2017; Autio, 2017; Stallkamp & Schotter, 2019; Tallman, Luo & Buckley, 2018). However, the knowledge digital businesses may extract from demand-side networks may still be highly location-bound because demand environments and market preferences substantially vary across countries (e.g., Kim & Jensen, 2014; Lynch & Beck, 2001; Shaheer & Li, 2019; Steenkamp & Geyskens, 2006). Accordingly, interacting with and addressing to demand-side networks in different countries may lead to substantial differences in innovation attributes (e.g., Kohler et al., 2018; Kriz & Welch, 2018; Moreau et al., 2018). As New York Times (2012) mentions, video games closely reflect the cultures and preferences of countries in which they are played. Adner & Levinthal (2001) also posit that understanding technological evolution requires researchers to adequately characterize the nature of the demand environment in which the technology evolves. In the context of digital internationalization specifically, the attributes digital innovations acquire through interactions with demand-side networks may determine their subsequent internationalization trajectories depending upon the match between innovation characteristics and market needs in other countries. It leads us to the critical

questions that demand-side networks in which locations are more likely to aid digital business in upgrading their innovations to appeal multiple countries?

We extend research on location advantages in a digital context by identifying two important characteristics that enable some countries to act as lead markets (e.g., Bartlett & Ghoshal, 1990; Beise, 2001; 2004; Doz & Wilson, 2012; Prahald & Doz, 1987) by facilitating digital businesses in internationalization of their innovations. The lead market hypothesis suggests that lead markets are not necessarily the inventing or early adopting countries (e.g., Antonelli, 1986; Gatignon, Elishberg, Robertson, 1989; Takada & Jain, 1991), but their characteristics increase the probability that innovations favored locally will subsequently penetrate in other countries (Bartlett & Ghoshal, 1990; Beise & Gemünden, 2004; Porter, 1990; Takeuchi & Porter, 1986). Scholars (Bartlett & Ghoshal, 1989; 2002; Beise, 2004; Porter, 1986) argue that improving innovations to match lead market requirements may help firms in developing globally dominant designs that win the allegiance of most countries. Despite the strategic importance of lead markets, the research on lead markets has been predominately undertaken by marketing scholars who seek to explain cross-national diffusion of innovations from lead to lag markets based on the ability of lead markets to generate social signals through demonstration effect, set global trends, and spread cross-border word-of-mouth (e.g., Chandrasekaran & Tellis, 2008; Tellis et al., 2003; Putsis, Balasubramanian, Kaplan, & Sen, 1997; Van Everdingen et al., 2009). Although a few scholars propose some lead market characteristics that may contribute in improving the global appeal of innovations (Beise, 2001; Beise & Cleff, 2004; Beise & Gemünden, 2004), many of these factors, such as economies of scale, cost reduction opportunities, or governmental and public support for exports, may have little

relevance for digital businesses. It indicates the need to extend current lead market literature to identify the relevant dimensions of lead markets which may facilitate internationalization in a digital arena. In particular, as digital innovations largely evolve in response to local demand-side networks, we argue that demand environment of a country may play a pivotal role in determining its lead market status.

We propose that digital businesses can reap important location advantages to facilitate internationalization of their digital innovations by establishing demand-side networks in lead markets characterized by higher demand heterogeneity within countries or international connectedness with other countries. Prior research (e.g. Bartlett & Ghoshal, 1986; Beise, 2004; Deaton & Muellbauer, 1980; Kim & Jensen, 2014) posits that countries adopt different innovations because of differences in budget constraints, different prices across countries, and different tastes and preferences in the demand environments. While budgetary constraints or prices may not be major impediments to internationalization due to the prevalence of freemium model in digital arena (Armstrong, 2006; Boudreau, 2012; Eckhardt, 2016; Rietveld, 2018; Rochet & Tirole, 2003;2006), recent research (Brouthers, Geisser, & Rothlauf, 2016; Ghemawat, 2011; 2018; Shaheer & Li, 2019) indicates that the most relevant challenge for digital internationalization is circumventing cross-national differences in tastes and preferences to develop globally appealing digital innovations. For overcoming such heterogeneity, extant literature (Adner, 2002; Adner & Levinthal, 2001; Adner & Zemsky, 2006; Priem, Li, & Carr, 2012) proposes two important characteristics of demand environments that induce technologies to evolve in a way to simultaneously satisfy multiple markets. First, some demand environments can enable innovations to evolve into superior technologies that

could mask the differences across markets through their superior quality. Second, some demand environments bear strong preference overlaps with multiple markets and innovations that evolve to satisfy these markets also fit in several other markets with similar preferences. Corresponding with these features of demand environments, we propose two lead market characteristics—demand heterogeneity and international connectedness—which, we hypothesize, will facilitate digital businesses in internationalizing their innovations. In particular, we argue that interacting with diverse demand-side networks in countries with higher demand heterogeneity may enable digital businesses to evolve high quality innovations that could satisfy the large variety of needs in other countries. On the other hand, demand-side networks in internationally connected countries may contribute in developing innovations that fit the demand environments of multiple countries with similar preferences (e.g., Chen, Shaheer, Yi, & Li, 2019; Schilling, 2002; Shenkar & Bayus, 2003; Vernon, 1979). Below, we develop formal hypotheses to outline the impact of these lead market characteristics on internationalization of digital innovations.

Lead Markets with Demand Heterogeneity

While IB research largely focuses on differences across countries, researchers also recognize the importance of heterogeneity within a country which, at times, can be an important source of innovation and value creation (Adner & Levinthal, 2001; Van Alstyne & Brynjolfsson, 2005; Venaik & Midgley, 2015). Given that a heterogeneous country inhibits a variety of consumption patterns (Hofstede, Wedel, & Steenkamp,

2002; Mowery, 1995; Sakakibara & Porter, 2001), establishing, retaining, and growing a demand-side network may require digital innovations to simultaneously upgrade on multiple fronts to accommodate heterogeneity of preferences. The resulting innovations may deliver superior quality on multiple dimensions and also offer versatility of features and functionalities, which may increase the ability of locally preferred innovations to appeal diverse countries (Beise & Cleff, 2004; Porter, 1990).

Establishing demand-side network in a heterogeneous lead market may also improve the novelty of a digital innovation as digital businesses may need to coherently blend multiple preferences to develop an innovation with wider appeal. As users in heterogeneous countries are fragmented in many small niches, akin to a long tail, businesses can leverage demand-side synergies by creatively fusing diverse features to attract core users from multiple segments (Ye, Priem, & Alshwer, 2012). Such creative re-combinations and performance improvements may blur underlying market heterogeneities across countries who tend to switch from nation-specific innovations to converge into superior ones (Adner, 2002; Adner & Levinthal, 2001; Bartlett & Ghoshal, 1989; Beise & Gemünden, 2004; Porter, 1986). For instance, the global success of role playing games targeting North American markets can be partly explained by demand heterogeneities in target markets, which led developers to combine diverse elements such as action, stealth, and story-telling in a single game to suit varying demands within and across countries (Beck & Wade, 2006; Boellstorff, Nardi, Pearce, & Tayor, 2012; Pagulayan, Keeker, Wixon, Romero, & Fuller, 2003; The Guardian, 2006). Interacting with heterogeneous demand-side networks within one country may also minimize the side effects of market separations, as tapping demand-side networks across geographic

boundaries can inhibit innovation appeal (Shaheer & Li, 2019; Xie & Li, 2015). In this sense, heterogeneous lead markets may act as global laboratories that support digital businesses in discovering and addressing globally latent needs through superior innovations. Accordingly, we hypothesize that

> H1: Digital innovations establishing demand-side network in lead markets with higher demand heterogeneity are more likely to penetrate target countries.

Lead Markets with International Connectedness

We conceptualize international connectedness of a country as the number of countries with which the country's preferences overlap. As recent research on global integration in digital age argues (Hofstede et al., 2002; Van Alstyne & Brynjolfsson, 2005), people in cyberspace often surpass geographic boundaries to morph into special interest communities that not only connect globally disperse networks of users but also influence their choices, such as adoption of a particular digital innovation. In this web of cross-national networks, a country may enjoy a more central or internationally connected position when its demand-side networks share similar preferences with demand-side networks in a higher number of countries (Chen et al., 2019; Gatignon, Gotteland, & Haon, 2015; Van Everdingen et al., 2009).

We extend the social homogeneity literature (Borgatti & Foster, 2003; Borgatti & Halgin, 2011) in the context of digital internationalization to propose two mechanisms—apprentice process and osmotic process—through which penetrating in demand-side

networks of internationally connected lead markets may facilitate subsequent penetrations of digital innovations in other countries. The apprentice process has been extensively emphasized in marketing literature in which countries actively seek and disseminate information to facilitate the diffusion of innovations from lead to lag markets (e.g. Kumar & Krishnan, 2002; Putsis et al., 1997; Takada & Jain, 1991). As homogeneity of preferences has been found to substantially enhance interpersonal communication between countries (Gatignon & Robertson, 1989; Hofstede et al., 2002; Mitra & Golder, 2002; Rogers, 2003; Van Alstyne & Brynjolfsson, 2005), demand-side networks in internationally connected countries may serve as effective medium to spread the word to several countries with similar preferences. In other words, internationally connected countries may act as opinion leaders (Chen et al., 2019; Van Everdingen et al., 2009) that may aid innovations in expediting their cross-national diffusion.

We also draw attention to the other more subtle, but highly critical role of osmotic process in which cross-national diffusions may not rely on intercountry word-of mouth but the inherent appeal of digital innovations to similar countries due to preference overlaps. As argued in prior research (Beise, 2004; Kim & Jensen, 2014), similarities across countries ensure that the match between markets preferences and product attributes that accounts for success in one country is preserved in other, similar countries. Hence, consistent with Vernon (1979), we argue that interacting with demand-side networks in internationally connected countries may help digital businesses in exploiting cross-national similarities as they gradually evolve their innovations to appeal several countries with homogenous needs. Indeed, we posit that the osmotic process may act as a precursor to apprentice process as innovations may not generate a positive word-of-

mouth unless they successfully adapt to market requirements in internationally connected countries.

Based on above arguments, we expect that penetrating in and evolving with demand-side networks of an internationally connected country may improve the inherent appeal of digital innovations to other countries and also spread positive word-of-mouth. Hence,

> H2: Digital innovations establishing demand-side network in lead markets with higher international connectedness are more likely to penetrate target countries.

The Need for Capability Deployment

While demand-side networks in lead markets offer important location advantages, it may not be assumed that digital business penetrating their innovations in lead markets will also deploy suitable capabilities to take advantage of lead markets. As argued by Bartlett & Ghoshal (1990), the benefits a business can draw from lead markets are contingent on how effectively the business deploys appropriate capabilities. This traditional wisdom is also valid in a digital context. As several scholars recognize (Alcácer et al., 2016; Wareham, Fox, & Giner, 2014; Zaheer & Manrakhan, 2001), even though the generativity of digital innovations is typically associated with self-reinforcement, deployment of suitable capabilities is essential to process the knowledge and harness any advantages from interactions with demand environments. Hence, evaluating the impact of

any location advantages from lead markets requires an adequate assessment of relevant capabilities a digital business deploys to extract these benefits.

In this paper, we argue that digital businesses need to deploy their technological capabilities and marketing capabilities to exploit the location advantages of lead markets. Following the recommendations of prior research (e.g., Barney, 1986; 1991; Barney & Arikan, 2001; Collis & Montgomery, 1995; Priem & Butler, 2001; Sirmon, Hitt, & Ireland, 2007; Weigelt, 2013), we move beyond considering the technological or marketing acumen of a digital business and assuming that the business will apply its capabilities on all of its digital innovations. Instead, we focus on technological and marketing capabilities a digital business actually deploys to support a digital innovation. Our focus on technological and marketing capabilities emanates from the emphasis of prior research on deployment of sensing or market scanning capabilities that could gather and synthesize the input from demand-side networks in lead markets (Bartlett & Ghoshal, 1990; Zaheer & Manrakhan, 2001), innovation capabilities to incorporate the knowledge and innovation ideas in improved innovation (Cantwell, 2009; Hamel & Prahald, 1996; von Hippel, 2005), and marketing capabilities to spread the improved innovation to new countries (Cavusgil & Knight, 2015; Erramilli, Agarwal, & Kim, 1997; Kotabe, Srinivasan, & Aulakh, 2002). In a digital world, deploying technological capabilities is essential for both monitoring the interaction of innovations with demand-side networks and incorporating market feedback for upgrading innovations whereas marketing capabilities are needed to publicize the product to new countries. Below, we hypothesize how these two capabilities may enhance the benefits digital businesses may reap from lead markets.

Technological and Marketing Capabilities in Heterogeneous Lead Markets

While heterogeneous lead markets may provide a conducive environment for evolving digital innovations into globally superior technologies, digital businesses may need to deploy their technological capabilities to successfully incorporate the challenging demands of such markets as well as marketing capabilities to adequately publicize the improved innovations to new countries. Primarily, a distinguishing feature of digital era is virtually infinite expanse of development possibilities as developers can creatively recombine freely available technological artifacts or toolkits to develop innovation with versatile functionalities and features, which may simultaneously satisfy multiple segments in heterogeneous countries (Boudreau, 2010; 2012; Stoneman, 2010; von Hippel & Katz, 2002). However, it is essential to deploy substantial technological capabilities to gather and synthesize the traces of user interactions that get increasingly complicated in heterogeneous markets. Even chief creative officers at highly resourceful gaming app developers like King Digital Entertainment, makers of several global hits including Candy Crush Saga, complain about the level of technological sophistication required to extract value from interactions with highly heterogeneous demand-side networks (Rayport, Sola, Gabrieli, & Corsi, 2019). Deploying technological expertise is also critical to equip digital innovation with diverse technologies in order to coherently incorporate the versatile requirements of heterogeneous markets (Alcácer et al., 2016; Huang et al., 2017; Kotabe et al., 2002; Zaheer & Manrakhan, 2001). Indeed, deploying technological capabilities may be essential to even sustain in heterogeneous lead markets as lower technological acumen may fail businesses against their competitors before they

could sufficiently interact with heterogeneous demand-side networks to reap any benefits (Erramilli et al., 1997; Schubert, Baier, & Rammer, 2018; Tseng, Tansuhaj, Hallagan, & McCullough, 2007). On the other hand, successfully deploying technological capabilities to combine diverse toolkits may not only help sustain the digital innovation against competitors in heterogeneous markets but also protect the innovation against copycats who seek to copy and modify innovations to the tastes of foreign markets and prevent the penetration of original innovations in new countries (Autio et al., 2018; Shaheer & Li, 2019; Wang, Li, & Singh, 2018).

Despite successfully evolving their digital innovations into potential global hits, digital businesses may still need to deploy their marketing capabilities to spread the improved innovation in other countries. On one hand, heterogeneous countries may not necessarily have the most extensive communication networks with other countries to initiate an apprentice process of global diffusion through positive word-of-mouth, which could substitute for marketing capabilities in some conditions. In addition, as the ease of innovation in a digital arena is flooding the cyberspace with millions of digital innovations, it is rare that users find a particular digital innovation out of an ocean of competitors (eMarketer, 2015; Boudreau, 2012; Eckhardt, 2016; Tiongson, 2015). In fact, there is usually a strong distinction between innovations that may be potentially attractive to users and innovations that users know and seek (Business of apps, 2018; Tseng et al., 2007; Li, Bresnahan, & Yin, 2016). Given that users rarely discover and adopt high quality innovations on their own, marketing investments become essential to exploit the potential of an improved innovation. Finally, addressing the diverse needs of heterogeneous countries may result into several unique functionalities and deploying

marketing capabilities may be essential to educate users in other countries about such novel aspects of digital innovations (Kim & Jensen, 2014; Rogers, 2003; Srivastava, Fahey, & Christensen, 2001). Based on above arguments, we hypothesize that.

H3a: Digital innovations establishing demand-side network in lead markets with higher demand heterogeneity are more likely to penetrate target countries if higher technological capabilities are deployed to support them.

H3b: Digital innovations establishing demand-side network in lead markets with higher demand heterogeneity are more likely to penetrate target countries if higher marketing capabilities are deployed to support them.

Technological and Marketing Capabilities in Internationally Connected Lead Markets

We argue that deploying both technological and marketing capabilities may enable digital businesses to augment the benefits they may reap by establishing demand-side networks in internationally connected lead markets. On a basic level, deploying technological capabilities should be helpful for evolving the digital innovation to meet the requirements of an internationally connected country, even when the country is not necessarily the most demanding or sophisticated market. A more important challenge is the likelihood of facing stiff competition in internationally connected lead markets. Just like internationally connected markets may evolve a digital innovation to appeal multiple countries, they may also attract competitors evolved in the contexts of other countries with similar preferences. On face of such competition, it may be critical to deploy

technological capabilities for sustaining against rivals by better meeting market requirements, especially in winner-takes-all races in which successful innovations may dominate a larger cluster of similar countries (Schubert et al., 2018).

Deploying marketing capabilities to support further internationalization may offer several synergistic benefits to digital businesses whose innovations establish demand-side networks in internationally connected countries. Digital businesses may exploit similarities in preferences across countries by utilizing their marketing skills and advertising campaigns developed in the context of internationally connected markets in other similar countries with relatively little local adaptations (Erramilli et al., 1997; Hennart, 1991; Tseng et al., 2007). In addition, as developing innovations in the context of internationally connected countries may not necessarily lead to technologically sophisticated technologies that are harder to imitate, marketing skills to quickly spread the innovation in other countries may provide a stronger defense against imitators (Shaheer & Li, 2019; Tseng et al., 2007). For instance, some highly resourceful app developers, such as Zynga, created huge global hits in the past simply by cloning high quality games from other studios and beating the originals with bigger advertising budgets (Business Insider, 2010). This indicates the importance of deploying marketing capabilities to support an upgraded innovation, particularly in fast-moving technological environments where time-to-market is critical (Cuervo-Cazurra & Narula, 2015; Schubert et al., 2018). Finally, coupling the positive word-of-mouth generated by internationally connected countries with marketing investments may substantially improve the visibility of digital innovations across multiple countries, which may expediently convert the

positive publicity from internationally connected lead markets into penetrations across new countries. Accordingly, we hypothesize that

H4a: Digital innovations establishing demand-side network in lead markets with higher international connectedness are more likely to penetrate target countries if higher technological capabilities are deployed to support them.

H4b: Digital innovations establishing demand-side network in lead markets with higher international connectedness are more likely to penetrate target countries if higher marketing capabilities are deployed to support them.

METHODS

Sample

We conduct our research in the unique context of gaming apps at Apple's app store. Mobile apps are perhaps the most prevalent form of digital innovations which are regularly used by billions of people around the world every day (e.g. Boudreau, 2012; Ghose & Han, 2014; Gupta, 2013). Several studies (e.g., Chen et al., 2019; Eckhardt, 2016; Kapoor & Agarwal, 2017; Shaheer & Li, 2019) recognize the context of mobile apps as an important venue to extend research on strategic management, platform governance, and digital internationalization.

Our focus on gaming apps provides us a suitable context to examine internationalization patterns in a digital context as games predominately rely on digital channels to reach their users. On the other hand, many apps in other categories require

users to purchase offline components, which makes these apps relatively closer to traditional businesses. Nonetheless, gaming represents a diverse category that includes 18 subcategories, appealing different user needs and segments. This diversity may help generalize our results to a broader context.

Similar to prior research (e.g., Chen et al., 2019; Shaheer & Li, 2019), we keep our unit of analysis as an individual gaming app. As several scholars (Barney, 1986; Barney & Arikan, 2001; Priem & Butler, 2001; Sirmon et al., 2007; Weigelt, 2013) recognize, not all innovations by a firm may receive support from firm capabilities or firm presence in certain locations (e.g., lead markets) and therefore, researchers need to consider the actual deployment of any advantages that support an innovation. Conducting our analysis at app level enable us to take into account actual resource deployment, impact of penetration in lead markets and subsequent international penetrations for each individual app. Nevertheless, we include several control variables to incorporate the important characteristics of app developers in our empirical analysis.

We acquire a longitudinal, cross-country database on mobile apps in games category at Apple's app store. The dataset includes all gaming apps that have been active in Apple's app store during the period 2016 to 2017. This rich dataset provides detailed information on daily performance of mobile apps across 57 countries, including country wise rankings, downloads, and revenues. As only a few apps claim an overwhelming majority of users (Garg & Telang, 2013; Ghose & Han, 2014), we follow the approach similar to Kapoor & Agarwal (2017) to construct a more manageable but also comprehensive dataset that could include most of the actively used apps at Apple's app store. First, we generate a list of top 1500 apps in each of 57 countries for the period

January 2015 to January 2017. We use app ranking on 15th of every month and only include those apps that appear in rankings at least three times. Following these criteria, we construct a sample of 7,291 apps that account for more than 90% of downloads, ratings, daily active users and revenues in games category at Apple's app store across 57 countries during our study period.

For this study, we decide to focus on only newly launched apps so that we could track their country wise penetrations since their inception. We draw an unbalanced sample of apps that were launched since January, 2017. We obtain a sample comprising of 1,910 apps from 18 subcategories, tracked on daily basis across 57 countries till December, 2017. We cumulate the indicators of daily performance such as daily downloads to set the data on monthly basis to construct a dataset of 1,243,207 observations. In each row, we include dependent variable at month t and lag all time varying independent and control variables by one month (e.g. t-1) to mitigate the problem of simultaneity.

Dependent Variable

Our dependent variable is time to penetration, which is calculated as the time (in months) that an app took to penetrate in a focal country since its launch. In our sample, we obtain the event of penetration for 39,180 app-country observations. We truncate all other observations where an app could not penetrate in a focal market till our cutoff point (December 31, 2017).

Similar to prior research (Chen et al., 2019; Shaheer et al., 2018), we define international penetration as the possession of a digital innovation by a substantial number of users in a focal country, as reflected in the appearance of an app in top 150 rank at Apple's app store. Prior research (e.g., Garg & Telang, 2013; Ghose & Han, 2014; Kapoor & Agarwal, 2017) indicates that breaking into the highly visible zone of top ranked apps reflects an adequate level of penetration in a focal market. To ensure the robustness of our results, we also use several alternate criteria for defining international penetration. We use top 50, top 100, top 200, and top 250 rankings as cutoff points to define penetrations. As results were qualitatively consistent in terms of signs and significances under all these alternate criteria, we present and discuss only the results obtained under our main specification.

Lead Market Characteristics

For the purpose of this study, we focus on two characteristics of lead markets, demand heterogeneity and international connectedness. In the context of mobile apps, demand heterogeneity in a country may refer to the extent to which apps across different categories are actively used in a country, which reflects the variety of consumption patterns the focal country inhibits. As Adner & Snow (2010) also posits, the heterogeneity of a market is better revealed by differences in observed choices.

To construct our variable of demand heterogeneity, we calculate a demand heterogeneity score for each country in our sample in the specific context of gaming apps at Apple's app store using the complete dataset of 7,291 apps across 18

subcategories. First, we take total downloads in a country for each subcategory. Next, we sum the squares of download shares of each subcategory in each country. Finally, we subtract the resulting value from 1 to facilitate the interpretation of results. Thus, a higher score indicates countries with higher demand heterogeneity where demand-side networks actively play games from several subcategories. Using these country level scores, we calculate the time varying variable, demand heterogeneity, which measures the average demand heterogeneity of all countries in which an app was ranked among top 150 at the month t-1. Getting ranked among top 150 in a particular month in a focal country indicates a substantial level of interaction with demand-side networks of a country during that month, which may contribute in shaping app attributes and influence subsequent app penetrations in other countries. Our approach follows prior research (e.g., Chen et al., 2019), which finds that getting ranked in a country enables an app to reap any advantages from that country, which may influence app internationalization in subsequent time periods.

Our second lead market characteristic, international connectedness, indicates average international connectedness scores of countries in which an app was ranked among top 150 in the month t-1. To construct this variable, we calculate international connectedness score for each country following recent research on the measurement of similarities across categories, countries, and user segments, broadly referred as social homogeneity literature (Aral & Walker, 2011; Borgatti & Halgin, 2011; Hidalgo, Klinger, Barabási, & Hausmann, 2007; Liu-Thompkins, 2012). Consistent with this important research stream on measuring similarities, we argue that countries who use similar apps like other countries can be conceptualized as having ties with each other.

The greater the number of ties, the more similar the country is with other nations in terms of preference overlaps. According to recent research (Liu-Thompkins, 2012; McPherson, Lovin, & Cook, 2001; Phillips, Northcraft, & Neale, 2006; Watts, 2003), such an approach is more accurate to assess similarities compared to traditionally employed approaches based on demographic and socioeconomic variables. Especially in virtual world, such demographic variables become less relevant as users in cyberspace connect with other users based on similar interests and such online interactions have important impact on driving user choices (Chen et al., 2019; Reuber & Fischer, 1997; Shaheer & Li, 2019; Van Alstyne & Brynjolfsson, 2005).

We develop a measure of international connectedness for each country in our sample following Chen et al. (2019). We gather top 1500 apps ranked across 57 countries. To keep data manageable, we draw a sample consistent with the approach by Kapoor & Agarwal (2017). We generate a list of top 1500 apps in each of 57 countries for the period January 2015 to January 2017 that were ranked on 15th of every month. We include only those apps in our sample that appeared in rankings at least three times. We obtain a sample of 49,361 apps ranked at least three times in at least one of the 57 countries during the period January, 2015 to December, 2017. In our sample, we find that country pairs, on average, have 12,548 apps that were ranked in both countries. Using this information, we consider a focal country to have a tie, or preference overlap, with another country if the number of common apps between focal country and another country exceeds by at least 1 standard deviation from the mean (i.e. 16,879 apps). This approach is similar to prior research (e.g., Chen et al., 2019; Kali & Reyes, 2007), which recommends considering two countries to have a tie only when the magnitude of

relationships is above a threshold. Using this criterion, we generate a network of intercountry ties and calculate normalized weighted degree centrality (Freeman, 1978) to quantify the international connectedness score for each country in our sample. We find a low correlation of 0.18 between country-wise market competitiveness scores and international connectedness scores, which indicates that both variables are indeed capturing two different aspects of lead markets. Similar to our variable, demand heterogeneity, we create a time varying variable, international connectedness, which indicates the average international connectedness of all countries in which an app was ranked among top 150 at the month t-1. Following the recommendation of prior research (Golub & Van Loan, 2013; Kalnins, 2018; Kwon, Halebian, & Hagedoom, 2016; Mitchell, 1991), we orthogonalize both variables, international connectedness and demand heterogeneity, using a modified Gram–Schmidt procedure to mitigate multicollinearity and improve the validity and stability of our empirical models.

Technological and Marketing Capabilities

In our empirical model, we include time varying variables measuring the deployment of technological capabilities and marketing capabilities in each app of our sample in each month. To operationalize technological capabilities that a digital business invested in an app, we take advantage of an important component of apps industry, software development kits (SDKs). The ecosystem of mobile app SDKs represents one of the world's most sophisticated innovation networks in which app stores and several third parties offer thousands of SDKs that enable even small, indie developers to transform

their ideas into novel mobile apps just by creatively recombining multiple SDKs (Boudreau & Jeppesen, 2015; Bresnahan and Greenstein, 2014; MacCormack, Rusnak, & Baldwin, 2006; Nieborg & Van der Graaf, 2008; Prochnow, 2009; von Hippel, 2005; Yoo et al., 2012). SDKs are automated programs comprising of libraries, debuggers, and handset emulators, among other useful development tools that can be customized and incorporated into apps to introduce different app functionalities (Boudreau, 2012; Holzer, & Ondrus, 2011; Kareborn, Bjorn, & Chincholle, 2011; Safedk, 2018). SDKs are divided into multiple categories that embed different functions in an app. A description of different SDK categories is provided in Table 2.1.

With sufficient technological capabilities, SDK configurations can enable the whole innovation process from design to distribution (Amit & Han, 2017; Autio, 2017; Jung, Baek, & Lee, 2012; Kareborn et al., 2011; Moreau et al., 2018). As several strategy scholars argue (Amit & Schoemaker, 1993; Barney, 1991; Fleming, 2001; Fréry, Lecocq, & Warnier, 2015; Penrose, 1959; Peteraf, 1993), many technological innovations are products of creative re-combinations of existing technologies to develop new applications. Researchers and industry wisdom also suggest that creative recombination of diverse SDKs is an important drivers for app ratings and performance but app developers are likely to be cognitively bounded and may not have deep knowledge about thousands of SDKs available across different categories. (e.g., Amit & Zott, 2001; Carnabuci & Operti, 2013; Inukollu, Keshamoni, Kang, & Inukollu, 2014; Kareborn et al., 2011; Safedk, 2018; Tian, Nagappan, Lo, & Hassan, 2015; Yayavaram & Ahuja, 2008). Combining multiple SDK classes in one app also leads to additional challenges as many SDKs may not synchronize well, particularly with SDKs in other

classes. Hence, the ability of an app developer to combine SDKs from different classes may represent an important capability, which may bring richness and diversity in an app and also provide greater flexibility to evolve through user interactions (Holzer & Ondrus, 2011; Kareborn et al., 2011).

Given the important role played by diverse SDKs in an app, we operationalize our variable, technological capabilities, through a Herfindahl-Hirschman Index (HHI) to determine the diversity of SDKs embedded in an app. To facilitate the interpretation of results, we subtract each HHI score from 1. The resulting variable indicates the diversity of SDKs embedded in an app. A higher score reflects higher diversity and therefore, deployment of superior technological capabilities. As app developers may continuously add and remove SDKs from apps as they evolve through user interactions to improve app performance, we calculate this variable as a time varying one, measuring the diversity of SDKs in an app at the beginning of each month.

Next, we measure marketing capabilities deployed in an app as worldwide advertising expenses incurred by an app in each month to acquire users around the world. Given that only a small minority of people use search function at Apple's app store, apps acquire an overwhelming majority of users through advertising campaigns whose costs are largely determined based on targeted countries and are mostly charged when a user downloads the app (eMarketer, 2015; Business of apps, 2018; Tiongson, 2015; Wang et al., 2018). Hence, we calculate marketing capabilities by multiplying country wise cost per download with downloads of an app in each country. Our approach is validated by industry wisdom as analysts frequently multiply downloads and cost per download to estimate app advertising expenses in a country or to forecast future advertising

requirements. Similar variables have also been used in prior research (e.g. Shaheer & Li, 2019). We calculate this variable as a time varying one, indicating the amount an app spent on advertising around the world in a particular month t.

Control Variables

We control for a comprehensive set of variables in our estimation. Among app level variables, we first control for app size, measured in gigabytes. App size is used as a proxy to reflect the sophistication and quality of an app (Ghose & Han, 2014). Apps with larger sizes are likely to have more features and graphics, which could reflect the functionality and influence on user adoptions.

We also control for app age in months to control for the experience of app publisher with a particular app. This is an important variable as the time period after app launch may influence the knowledge of app developer about user needs.

In addition, we control for multihoming, defined as the tendency of app developers to host their apps on multiple app platforms (Hossain & Morgan, 2013). To create this variable, we track whether each app in our sample is also present on Google Play store (the other most prominent apps platform aside from Apple's app store). We also collect app launch dates at Google Play store for all apps that were multihoming at Google Play. Based on this data, we create a time varying dummy variable, indicating whether an app was available on Google Play store in a month or not.

Next, we control for age restriction, a dummy variable which takes the value of 1 if the app is restricted for any age group. Age restrictions may impact app penetrations in certain countries where apps are predominately used by certain age groups.

Another important factor that may influence app penetrations is the perceived quality of an app in the eyes of its current users. Therefore, we control for app ratings, a time variant variable that reflects weighted average ratings an app received in month t-1. This variable ranges between one and five because Apple's app store allows its users to rate an app on a scale of one to five whereas five represents the best possible score.

In addition, we recognize that prior experience of app developers can have important consequences for the penetration of apps. Mobile apps industry is relatively new and most stakeholders are still in the learning phase (Li, Goh, & Cavusoglu, 2013). Developers accumulate experience with the passage of time as they better understand programming techniques on their particular app stores and interact with more customers to better understand their preferences and needs. Therefore, we control for developer experience, a time varying variable measuring the number of apps a developer launched till a particular month.

We also acknowledge that financial assets of app developers may have an important impact on an app, in terms of quality or marketing. Hence, we control for developer finances, measured as the revenues an app developer earned in last 12 months.

Another important developer level variable is the prior experience of an app developer in a focal country. We control for this effect by including developer

downloads, a time varying variable measuring the total number of downloads a publisher received in a focal country in last 12 months till the month t-1.

We also control for three important subcategory-country level variables, subcategory size, subcategory concentration and category engagement. We use the complete dataset of 7,291 apps to calculate these variables for each subcategory in the games category in each country for each month. We measure our first subcategory-country level variable, subcategory size, as the total downloads earned by all apps in the subcategory in a focal country. This variable reflects the attractiveness of a focal country, which may motivate greater customization to the unique tastes and preferences of a country (Rothaermel, Kotha, & Steensma, 2006). A larger market also provides a more open environment, in which many apps may penetrate and coexist.

Our second subcategory-country level variable, subcategory concentration, takes an entropy measure as we sum the squares of download shares of all apps in each subcategory. Subcategory concentration is an important indicator of overall competitiveness. Highly concentrated subcategories are characterized by relatively few large players holding significant shares of the total market, whereas subcategories with lower levels of concentration are characterized by greater number of apps with smaller market shares. Prior research treats higher concentration as an important barrier that can limit new entrants' ability to penetrate a focal country (e.g., Mudambi & Zahra, 2007).

Our third subcategory-country level variable, subcategory engagement, takes into account the average number of users who use an app every day. This

measure reflects the interest of each focal country in a particular subcategory, which may have important implications for the penetrations of newly launched apps.

Furthermore, we recognize that systematic differences across countries may affect our results as country specific characteristic can influence some countries to adopt an app earlier than others. Hence, we follow prior research (Chandrasekaran & Tellis, 2008; Tellis, Stremersch, & Yin, 2003; Van Everdingen et al., 2009) to control for some important country level variables that have been found to influence the takeoff of new products in particular countries. First, previous research suggests that larger countries may have more diverse population (Alesina & Spolaore, 1997), which can facilitate the penetration of multiple products and services. Therefore, we control for the population of focal country. In addition, prior research posits that wealthier people can afford the risks of adopting new products early on (Dickerson & Gentry, 1983). Hence, product takeoffs are faster in wealthier countries that enjoy higher GDP per capita (Helsen, Jedidi, & DeSarbo, 1993). Accordingly, we control for GDP per capita. In an unreported regression, we control for any unobservable differences among countries by estimating all models with focal country fixed effects and obtain similar results.

Finally, we include mutually exclusive binary variables to control for the subcategory and the release date of each app.

Statistical Approach

The purpose of our study is to identify the determinants of the length of time taken by apps to penetrate a focal country. Accordingly, we follow previous research on penetration, takeoff, and diffusion (e.g. Chandrasekaran & Tellis, 2008; Van Everdingen et al., 2009) to use a hazard model with an accelerated failure time (AFT) specification. AFT models are used to express the impact of independent variables on time to an event. Hence, positive coefficients are associated with later penetrations whereas negative coefficients indicate earlier penetrations. This connects directly with our hypotheses that are constructed in terms of penetration speed. AFT models also make it possible to include right censored observations in which an app did not penetrate a focal market until the end of the observation period. The ability to use such observations is crucial because 63% observations are right censored in our sample. However, left censoring does not pose a problem as we track all apps from their respective launch dates.

We estimate the AFT model with multiple-record data and multiple events, in which the model considers that individuals (apps) experience different events (penetration into different countries) during the time span under analysis. Our observations are at the app-country-month level. Each observation is included till the time it penetrated a focal country or at December 31, 2017 if not penetrated within the timeframe of our study. We run AFT model assuming a hazard function with an exponential distribution.

Results

Table 2.2 reports the descriptive statistics and correlations between the variables, except for subcategory and home country dummies. Table 2 indicates little correlation among variables, indicating that multicollinearity may not be a problem.

Table 2.3 presents the results for the AFT model with exponential specification. Model 1 includes only control variables. In Model 2, we add our independent and moderating variables and test our H1 and H2. Models 3 and Model 4 test our hypotheses 3 and 4. Model 5 presents the full model. The model fit, as indicated by Log likelihood, shows improvement in each subsequent model.

Model 1 shows the impact of control variables on our dependent variable, time to penetration. We find statistically significant impacts of app age ($p<0.00$), multihoming ($p<0.00$), age restrictions ($p<0.00$), app ratings ($p<0.00$), publisher experience ($p<0.1$), publisher downloads ($p<0.00$), subcategory size ($p<0.05$), subcategory engagement ($p<0.05$), population ($p<0.00$) and GDP per capita ($p<0.00$).

Regarding our hypotheses, Model 2 shows that our Hypotheses 1 and 2 are supported. The coefficients for demand heterogeneity and international connectedness are statistically significant and negative, showing that establishing demand-side networks in lead markets facilitate app penetration in new countries. We also find negative and statistically significant coefficients for technological and marketing capabilities, which indicate that deployment of these capabilities may also facilitate app internationalization. Next, we follow Elfenbein & Knott (2015) to calculate the economic significance of our results. The economic significance of our estimates is also

substantial: when all other variables are held at their means, one standard deviation increase in demand heterogeneity, international connectedness, technological capabilities and marketing capabilities is associated with a reduction in time to penetration by 10% ($p<0.00$), 42% ($p<0.00$), 47% ($p<0.00$) and 41% ($p<0.00$) respectively.

We test our hypotheses 3a and 3b in Model 3. We find negative and statistically significant coefficients for the interaction between technological capabilities and demand heterogeneity ($p<0.00$) as well as the interaction between marketing capabilities and demand heterogeneity ($p<0.00$), showing that the impact of deploying technological and marketing capabilities strengthens when an app penetrates a lead market with higher demand heterogeneity.

Model 4 tests Hypotheses 4a and 4b by including the interaction terms between technological capabilities and international connectedness as well as the interaction between marketing capabilities and international connectedness. Contrary to our expectation, we do not find the interaction between technological capabilities and international connectedness to be statistically significant. However, we find the interaction term between marketing capabilities and international connectedness to be negative and significant ($p<0.00$), supporting hypothesis 4b.

We also report the full model in Model 5 that tests all hypotheses simultaneously. The model indicates that all relationships that are significant in isolation largely maintain their signs and significance in combination.

Robustness Tests

To examine the robustness of our results, we conduct a series of additional tests. First, we acknowledge that our empirical model may be susceptible for selection bias as apps supported by technological or marketing capabilities may be more likely to initially penetrate lead markets with higher demand heterogeneity or international connectedness. We run two separate first stage Hackman selection models with dependent variables, penetration into heterogeneous lead markets and penetration into connected lead markets. Both dependent variables are binary ones, taking the value of one if the demand heterogeneity or international connectedness scores of the lead market is 1 standard deviation above mean. As it is not statistically accurate to implement Heckman selection model using survival analysis techniques, we use a longitudinal Probit model. We neither find a significant lambda in first stage nor a significant inverse mills ratio in second stage, indicating that the selection bias may not be a major concern (Certo, Busenbark, Woo, & Semadeni, 2016). Hence, we test our hypotheses with AFT model. Nevertheless, our results stay consistent under a two-stage Heckman model.

In addition, as our criterion for international penetration is slightly unconventional, we fit several additional models under different measures of international penetration as we specify earlier in the manuscript. Under all these alternate specifications, the results remain robust.

We also ensure that our results are not driven by our operationalization of variables. Hence, we calculate our variable, technological capabilities, as an entropy measure of SDK diversity. Similarly, we operationalize marketing capabilities through a variety of other measures. We include advertising expenses incurred only in a focal country, only in the geographic region of the focal country, or outside focal country. Further, we calculate our measures of demand heterogeneity and international connectedness by multiplying demand heterogeneity and international connectedness scores of each country with an app's daily active users in the country in the month t-1. In addition, we employ normalized degree centrality, betweenness centrality, egocentricity and harmonic centrality to calculate country scores for international connectedness. We find our results to stay qualitatively consistent in signs and significance under these alternate specifications of our variables.

Another important limitation of our empirical model is absence of any distance measure between home countries of app developers and host countries. This is because we have home country information available for 400 developers only. In our main model, we seek to mitigate this problem by adding several developer level and host country level control variables. As a robustness test, we construct a reduced sample of only apps for which we have publisher information available. We run our model on reduced sample after controlling for the psychic distance between home countries of app developers and each host country. To control for psychic distance, we use the index developed by Dow & Karunaratna (2006), which measures psychic distance between each country pair with regards to language, education, industrial development, religion and political system. We combine five dimensions of psychic

distance into one comprehensive measure following Boellis, Mariotti, Minichilli, & Piscitello, (2016). Our results stay qualitatively consistent in the reduced sample after controlling for psychic distance.

Next, we ascertain that our results are not driven by our choice of Exponential model. We fit the other parametric regressions model with Weibull distributions as well as semiparametric Cox model. Our results stay nearly identical. Finally, we account for any unobservable differences among countries by estimating all models with focal country fixed effects and obtain similar results.

DISCUSSION

In this paper, we contribute to the recent discussion on the role of location in modern digital arena (e.g., Alcácer et al., 2016; Cantwell, 2009; Dunning, 2009) by examining the impact of some important demand-side location advantages on internationalization of digital innovations. We highlight the importance of location in modern digital economy by showing that demand-side networks across countries vary in their potential of contributing knowledge and innovation ideas and digital businesses may reap substantial location advantages by establishing demand-side networks in lead countries. Our analysis pertains that in a seemingly borderless digital world where digital businesses can freely interact and learn from users around the world, selectively cultivating demand-side networks in lead countries may still provide important strategic advantages for digital internationalization. Nevertheless, we indicate that digital businesses need to deploy adequate capabilities to benefit from lead markets, especially when several digital

businesses compete to exploit similar location advantages from lead markets. By building on the interplay between location advantages and capability deployment, our analysis sheds new light on digital internationalization strategies that the extant literature is yet to explore.

Our study offers some important contributions to current literature on digital internationalization. A fundamental question in IB research relates to the drivers of internationalization for firms and innovations, which is gaining a renewed interest with the rise of digital technologies that instantly access global markets thorough their platform affiliations. Given that the traditional entry barriers are minimal in digital world and successful digital innovations can be easily cloned (Boudreau, 2012; Coviello et al., 2017; Shaheer & Li, 2019), the question arises that how some digital innovations stand apart their competing technologies to attract users from multiple countries. Contributing to this discussion, we extend recent literature on evolutionary nature of digital technologies (e.g., Alcácer et al., 2016; Brouthers et al., 2016; Chen et al., 2019; Coviello et al., 2017; Kriz & Welch, 2018) to theorize how digital innovations evolve through the interplay between deployment of capabilities and interactions with demand-side networks across countries, which lead to important differences in app attributes and resulting internationalization trajectories. Such competitive heterogeneities may also be harder to imitate as newcomers may lack sufficient interactions with demand-side networks to adequately deploy suitable capabilities and reiterate their innovations (Adner & Zemsky, 2006; Priem, 2007). These findings also extend seminal strategy research by Kirzner (1973) and Penrose (1959) in a digital context by showing that digital innovations are not a product of only entrepreneurial imagination. Instead, engagement

with demand-side networks in lead markets may serve as an important source of innovation, which can be harnessed through deployment of appropriate capabilities. Hence, we stress that novel theoretical mechanisms can be developed to more comprehensively explain digital internationalization by building on the interdependence between location advantages and capability deployment.

We also extend research on internationalization strategies by distinguishing the location advantages offered by demand-side networks across countries based on their potential of contributing knowledge and innovation ideas to facilitate internationalization of digital innovations. As the locus of innovation in a digital contexts is shifting to demand environments and digital businesses are increasingly relying on demand-side networks at different locations for upgrading their innovations (Alcácer et al, 2016; Amit & Han, 2017; Autio et al., 2018; Cantwell, 2009; Coviello et al., 2017; Zott & Amit, 2010; Yoo et al., 2012), it is critical to extend current taxonomy of location advantages to also incorporate various demand-side advantages digital businesses can reap from across countries. We take an initial step in this direction by drawing attention to the role of lead markets, specifying how some characteristics of demand environments in lead markets can play a vital role in improving the global appeal of digital innovations. Recognizing the location advantages of lead markets also extends beyond the research emphasis on the importance of establishing larger demand-side networks, especially when Big Data analytics and artificial intelligence can enable businesses to extract value from massive user interactions (e.g. Kallinikos et al., 2013; Lee & Berente, 2012; Prandelli, Pasquini, & Verona, 2016). Building on IB research (e.g., Alcácer et al., 2016; Chen et al., 2019; Lynch & Beck, 2001), we posit that only

the size of demand-side networks may not matter as users across countries differ in their potential of improving the global appeal of digital innovations. In this sense, even a relatively smaller demand-side network in a lead market can be more advantageous than a larger network in other countries. Many digital businesses also recognize this caveat. For instance, King Digital Entertainment prefers upgrading its games through interactions with smaller, more focused markets instead of randomly building the largest possible demand-side network in early stages of a game's lifecycle (Rayport et al., 2019). Clearly, distinguishing location advantages of lead markets is critical to appreciate the different contributions of locations for digital internationalization.

Our research also provides digital businesses with an actionable set of measures, some of them may be applicable to more traditional industries as well. While many digital businesses may be tempted to pursue an organic diffusion pattern, we stress the need to carefully choose lead markets for establishing their demand-side networks. On one hand, our argument corresponds with the silicon valley wisdom of creating minimum viable digital products who possess the flexibility to evolve with user interactions. At the same time, we highlight that not all demand-side networks are equal and emphasize the need of choosing right demand-side networks which could help evolve an innovation to appeal a broader audience. Indeed, evolving digital innovations outside lead markets may lead to nationally idiosyncratic innovation designs that may constraint their internationalization potentials. In addition, digital businesses schooled in the direct effects of either internal capabilities or demand-side advantages outside organizational boundaries may expect to stand apart from competition after deploying their capabilities or establishing demand-side networks. We temper such beliefs by increasing awareness

that the positive effects of one source is contingent on the other. Hence, we assert that digital businesses can gain a strategic edge by focusing on lead markets that should also match their capabilities.

We also acknowledge some important limitations of our study, which may also open venues for future research. First, we recognize that initial penetration of an innovation in a specific country can be a function of the match between innovation attributes and market requirements, which may grant an advantageous position to domestic app developers (e.g., Kim & Jensen, 2014; Shaheer & Li, 2019). However, we lack data about home countries of app developers to adequately control for home country effects or the impact of cross-national distance. Nevertheless, this limitation may not undermine our conclusions as we mainly evaluate how a digital innovation that establishes demand-side network in a lead market subsequently penetrates across multiple countries, as opposed to the factors that enable a digital innovation to initially penetrate in a lead market. We further ascertain out findings by conducting robustness test using smaller sample of apps for which the home country data about app developers was available. Still, we expect that future research will utilize more extensive data to better incorporate home country effects in digital internationalization literature. Similarly, we propose a theoretical mechanism based on app evolution through interactions with demand-side networks. While our arguments are grounded in prior literature (e.g. Huang et al., 2017; Kriz & Welch, 2018; Yoo et al., 2012), these theoretical contentions need to be subjected to further empirical analysis if appropriate data becomes available. Indeed, we emphasize the need to better incorporate in current literature not only the role of demand-side networks but also supply-side networks, such

as networks of SDK providers, as well as the new range of digital intermediaries, such as in-app advertising platforms. Researchers may also consider new governance mechanisms orchestrated by platforms, instead of country governments, which may influence digital internationalization. Finally, our analysis mainly deals with the question of internationalization as cultivating a large user base across many countries is the first step toward creating higher value. Further research is needed to understand the financial implications of app internationalization, possibly through an analysis of the relationship between value creation in terms of internationalization and value capture in terms of revenue generation.

In conclusion, we consider our study as an initial step toward a vast research paradigm. We build on prior research highlighting several unique aspects of digital internationalization (e.g., Alcácer et al., 2016; Brouthers et al., 2016; Coviello et al., 2017) to propose a theoretical framework about internationalization trajectories digital innovations may take through their interaction with demand-side networks and deployment of internal capabilities by their developers. We do admit that the question of digital internationalization is an important area of enquiry for which multiple studies are needed. We hope our research will motivate scholars to further extend current frameworks or develop new theories to provide meaningful insights on internationalization strategies in a digital world.

Table 2.1
Description of SDK Categories and their Functions

SDK Category	Function
Ad Network	Enables apps to monetize the impressions in their apps with the ad networks ad traffic, or assit in enabling the apps ability to run user acquisition campaigns on that ad network
Analytics	Measure, track and analyze their performance across all of their apps
Attribution	Attributes performance to the source of the user to optimize UA and re-targeting campaigns
Crash Reporting	Can pinpoint and help fix issues that lead to crashes or disrupted user experiences
Dev Platform	Base for developers to build their apps from
Dev Tool	Tool developers use to create, debug, maintain, or otherwise support other programs and applications.
Game Dev	Tool Games developers use to create, debug, maintain, or otherwise support other programs and applications.
Game Dev Platform	Base for Game developers to build their apps from
Geo Location	Enables app to pinpoint a user's location
Media Player	Allows the app to play various forms of media, i.e. music, videos, etc.
Mediation	Adding. Platform that optimises ad revenue from ad networks and ad exchanges on behalf of the publisher.
Messaging	Push notifications and in app chat
Mobile Marketing	Omnichannel tools that allow developers to engage and reenagage users.
Monetization	Allows apps to monetize and execute on a variety of ad formats
Multi User	Implements the social connection for multiple user's to engage in a game together
Multiplayer Game Development	Implements the social connection for multiple user's to engage in a game together
Payment	Allows for payment processing in app and outside of the app stores (revenue is not in app purchase, paid, or advertising rev)
Photo	Add real-time video calls, interactive broadcasting and and scanning ability to your app.
Push Messaging	Allows app to send notifications to the user's device as reminders or for reengagement
Reviews	Implement the suite of measurement tools for desktop, mobile, and tablet surveys, Feedback projects, and Replay.
Security	Addresses device vulnerabilities, safety, and compliance.
Social	Social media related sdks used for sign in, gaming, etc.
Speech Recognition	Converts speech into text allowing the app to communicate to the user and understand what's being said.
Support	Allow consumers to submit issues from within the app
Support Reviews	Understand your customer experience in your app and help design a system to give them the best experience
Video Ad	Enables apps to monetize the impressions in their apps with the ad networks ad traffic, or assit in enabling the apps ability to run user acquisition campaigns on that ad network using videos

Table 2.2
Descriptive Statistics and Correlation Table

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
1.App penetration	0.032	0.175																	
2.App size	0.298	0.344	-0.01																
3.App age	8.715	5.782	-0.17	-0.02															
4.Multihoming	0.242	0.428	0.05	-0.15	0.08														
5.Age restriction	0.802	0.399	-0.07	0.11	0.02	-0.2													
6.App ratings	3.578	1.495	0.05	0.04	-0.09	0.04	-0.03												
7.Developer experience	24.494	67.965	0.03	0.04	-0.03	0.08	-0.07	0.03											
8.Developer finances	0.118	0.693	0	0.19	-0.04	-0.03	0.01	0.03	0.19										
9.Developer downloads	0.511	7.583	0.06	0.03	-0.03	0.02	-0.02	0	0.11	0.08									
10.Subcategory size	0.239	1.54	-0.01	0.01	-0.01	0	0.02	0.01	0	0	0.05								
11.Subcategory concentration	0.05	0.096	0.01	-0.02	-0.03	0	-0.1	-0.01	-0.01	-0.01	0.01	-0.06							
12.Subcategory engagement	1.713	3.147	-0.04	0.09	0.05	-0.04	0.08	0.01	0	0.02	0	0.05	-0.12						
13.Population	0.107	0.252	-0.01	-0.01	0.01	0.02	-0.01	0.01	0	-0.01	0.05	0.27	0.03	0					
14.GDP per capita	0.32	0.201	0.02	0.01	-0.01	-0.01	0.01	-0.01	0	0	0.01	-0.03	0.04	0	-0.31				
15.Technological capabilities	0.364	0.333	0.07	-0.03	0.2	-0.01	0.02	0.14	-0.08	-0.03	-0.02	0.01	-0.03	0	0.02	-0.02			
16.Marketing capabilities	0.001	0.002	0.27	0.1	-0.32	0.1	-0.13	0.21	0.14	0.11	0.06	0.01	-0.03	0.01	0.02	-0.01	-0.02		
17.Demand heterogeneity	-0.026	1.131	-0.06	0	-0.1	0.07	-0.06	0.3	0.09	0.05	0	0	-0.01	-0.02	0	0	0.01	0.18	
18.International connectedness	-0.306	0.932	0.1	-0.06	-0.08	0.03	-0.07	0.13	-0.01	-0.04	0.01	0.01	0.03	-0.04	0.04	-0.04	0.18	0.07	-0.03

n=1,243,207

Table 2.3
Examining Factors Influencing the Time to Penetration

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
App size	-0.07086	0.03805	0.04843	0.04853	0.05769
	(0.09544)	(0.10497)	(0.10489)	(0.10721)	(0.10732)
App age	0.12160***	0.14149***	0.14444***	0.13590***	0.13864***
	(0.00587)	(0.00714)	(0.00731)	(0.00683)	(0.00702)
Multihoming	-0.45304***	0.12812+	0.12582+	0.14753*	0.14381*
	(0.06795)	(0.06540)	(0.06585)	(0.06782)	(0.06815)
Age restriction	0.28248***	0.16974*	0.17881*	0.18822*	0.19410*
	(0.07569)	(0.07432)	(0.07440)	(0.07589)	(0.07577)
App ratings	-0.30160***	-0.07804***	-0.08022***	-0.09435***	-0.09545***
	(0.01782)	(0.01993)	(0.01995)	(0.01908)	(0.01916)
Developer experience	-0.00044+	-0.00052**	-0.00045**	-0.00051**	-0.00044*
	(0.00027)	(0.00016)	(0.00017)	(0.00017)	(0.00017)
Developer finances	0.00885	0.14230**	0.14275**	0.16581***	0.16416***
	(0.03706)	(0.04500)	(0.04485)	(0.04761)	(0.04734)
Developer downloads	-0.00176***	-0.00147***	-0.00147***	-0.00151***	-0.00152***
	(0.00023)	(0.00022)	(0.00022)	(0.00022)	(0.00022)
Subcategory size	-0.00856*	-0.00096	-0.00109	-0.00077	-0.00089
	(0.00374)	(0.00443)	(0.00444)	(0.00452)	(0.00452)
Subcategory concentration	-0.44487	-0.29186	-0.28970	-0.28159	-0.28473
	(0.28641)	(0.28749)	(0.29237)	(0.29542)	(0.29948)
Subcategory engagement	0.03153*	0.01884+	0.01994*	0.01764+	0.01877*
	(0.01351)	(0.00973)	(0.00995)	(0.00931)	(0.00954)
Population	0.13729***	0.20679***	0.21070***	0.21077***	0.21433***
	(0.02106)	(0.02404)	(0.02432)	(0.02459)	(0.02482)
GDP per capita	-0.41867***	-0.56977***	-0.57446***	-0.57710***	-0.58087***
	(0.02221)	(0.02557)	(0.02592)	(0.02638)	(0.02670)
Technological capabilities		-1.66671***	-1.91359***	-1.65769***	-1.89156***
		(0.08816)	(0.09918)	(0.08887)	(0.10034)
Marketing capabilities		-268.46162***	-267.56306***	-277.95448***	-277.19276***
		(12.07151)	(12.01222)	(12.98821)	(13.06257)
Demand heterogeneity		-0.09897***	0.10970*	0.04616	0.23484***
		(0.02743)	(0.04325)	(0.03290)	(0.04673)
International connectedness		-0.57887***	-0.60584***	-0.44447***	-0.48530***
		(0.02432)	(0.04497)	(0.02833)	(0.04707)
Technological capabilities*Demand heterogeneity			-0.45860***		-0.42709***
			(0.07422)		(0.07565)
Marketing capabilities*Demand heterogeneity			-32.31923**		-31.27232**
			(9.89586)		(10.16409)
Technological capabilities*International connectedness				0.06593	0.07666
				(0.07577)	(0.07947)
Marketing capabilities*International connectedness				-35.75973***	-33.18803***
				(8.74593)	(9.07671)
Control for app subcategory	Yes	Yes	Yes	Yes	Yes
Control for app release date	Yes	Yes	Yes	Yes	Yes
Constant	2.69055***	0.91642***	1.15854***	1.25354***	1.46167***
	(0.18558)	(0.18105)	(0.18546)	(0.18958)	(0.19359)
No of apps	1,910	1,910	1,910	1,910	1,910
Observations	1,243,207	1,243,207	1,243,207	1,243,207	1,243,207
Events (Penetrations)	39,180	39,180	39,180	39,180	39,180
Log likelihood	-93,004	-71,140	-70,800	-70,691	-70,404

Robust standard errors in parentheses, *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

ESSAY 3

THE CYBER NATIONS: MEASURING VIRTUAL DISTANCE AND VIRTUAL CLOUT IN A DIGITAL ARENA

Abstract: IB scholars are increasingly calling to transcend from surveys and macroeconomic data to measure cross-national differences and country characteristic based on actual behaviors of people, which could reflect variations in people's preferences across countries. Such an approach is particularly important to explain digital internationalization which is largely affected by preferences of people across countries. The recent rise of Big Data provides a timely opportunity by providing geocoded data on online behaviors. We explore this opportunity by using a Big Data archive on app adoption and usage across 54 countries to delineate some patterns of cross-national differences and country clouts in cyberspace. In particular, we offer two important indices, virtual distance that delineates how country dyads differ in their preferences, and virtual clout that employs network analysis techniques to map the patterns of intercountry similarities. We expect these indices to provide novel variables to empirical researcher and also provide practitioners with a rigorous understanding of cross-national variations in preferences of people, which is critical for formulating more targeted international strategies.

Keywords: Virtual Distance; Virtual Clout; Big Data Analytics; Network Theory; Digital Internationalization

INTRODUCTION

The advent of modern digital economy challenges the traditional wisdom about the role of cross-national distance and country characteristics in influencing international business (IB) activities. The relevance of transportation costs caused by higher geographic distance, transaction costs arising from differences in political, legal, or economic systems, and constraints imposed on businesses by institutional systems in home or host countries may decline for many digital businesses who seamlessly transmit bits and digits around the world via globally accessible digital platforms (Alcácer, Cantwell, & Piscitello, 2016; Autio, Nambisan, Thomas & Wright, 2018; Cavusgil & Knight, 2015; Coviello, Kano, & Liesch, 2017). Instead, researchers (Brouthers, Geisser, & Rothlauf, 2016; Ghemawat, 2011; 2018; Rietveld & Eggers, 2018; Shaheer & Li, 2017) indicate that internationalization of many digital businesses may largely depend on similarities and differences in user tastes, preferences, and behaviors across countries, as reflected in actual choices made by people in different countries. Empirical research (Chen, Shaheer, Yi, & Li, 2018; Shaheer & Li, 2019) also shows that quantitative indices based on actual behaviors are likely to outperform traditional measures extracted from macroeconomic indicators or survey-based data, particularly when analyzing international penetrations of digital technologies. Indeed, several scholars (e.g., Caprar, Devinney, Kirkman, & Caligiuri, 2015; Cuypers, Ertug, Heugens, Kogut, & Zou, 2018; Kirkman, Lowe, & Gibson, 2017) have started stressing the need to substantiate current measures of cross-national differences and country characteristics with new indices extracted from behaviors and preferences of people around countries.

An important impediment for developing new measures based on actual behaviors and preferences is the availability of suitable data sources tracking the choices made by a large number of people around the world. The rise of Big Data may address this issue as people leave digital traces of their online behaviors while interacting with digital technologies, which provides a wealth of information about their actual preferences. Perhaps the most important medium for online activities are smartphones. Cisco estimates the volume of global internet traffic at around 1 zettabyte, 57% of which originates from app usage in smartphones (Cisco, 2019; Telegraph, 2016). The extensive interaction of more than 2.5 billion people around the world with mobile apps is meticulously recorded and can be analyzed to provide a deeper understanding of the preferences and behaviors of people across different countries (Bail, 2013; 2014; Iqbal, 2019; Newzoo, 2018). Clearly, Big Data generated by mobile apps offers a vital opportunity to develop new quantitative indices related to cross-national differences and country characteristics.

In this paper, we analyze a Big Data archive on adoption and usage of 49,361 apps in 54 countries during the years 2016 and 2017 to contribute two novel indices, virtual distance and virtual clout, to IB research. We define virtual distance as the degree of differences in online preferences of two countries. We identify five important dimensions on which user preferences vary across countries and offer quantitative measures of virtual distance for each country dyad in our sample for each of the five dimensions. Next, we depart form the popular focus on distance to measure virtual clout of nations. We define virtual clout as the number of countries with which a focal country shares preferences for digital technologies. This is an important variable as people in

digital age connect on the basis of similarities in interests to form supranational communities, which have been found to influence the diffusion of products and technologies across countries (e.g., Chen et al., 2018; Van Alstyne & Brynjolfsson 2005; Van Everdingen, Fok, & Stremersch, 2009). Countries where users share similarities with a greater number of countries may enjoy higher virtual clout and play a more prominent role in enabling cross-national penetrations of innovations.

The major contribution of our study is to supplement current quantitative measures in IB field by offering some novel indices based on actual behaviors of people across countries. As these measures represent the choices made by a large number of people from multiple segments, they may contribute in resolving the limitations of traditional survey based measures that sample only a small subsection of population (Beugelsdijk, Kostova, & Roth, 2017; Caprar et al., 2015; Kirkman et al., 2017; Leung, Bhagat, Buchan, Erez, & Gibson, 2005). We also expect our measures to inform research conducted in the context of more traditional industries as online behaviors may transcend the digital realm to also reflect offline preferences in a country. For instance, a country with higher orientation toward using books and education related apps may also exhibit a stronger tendency to pursue knowledge. Therefore, we hope our measures will facilitate empirical researchers interested in not only digital internationalization but also in traditional industries or even public policy.

Another important contribution of our study is to acknowledge the important role of virtual clout for digital internationalization. While IB research predominately focuses on negative effects of distance, recent research (e.g., Li, Brodbeck, Shenkar, Ponzi, & Fisch, 2009; Marano, Arregle, Hitt, Spadafora, & van Essen, 2016; Stahl, Tung, Kostova,

& Zellmer-Bruhn, 2016; Van Everdingen et al., 2009) increasingly draws attention to several benefits businesses can draw from foreign markets. We extend this stream of research in a digital context by putting forward the concept of virtual clout. As digital technologies are connecting people with similar interests across geographical borders, we present virtual clout as an important strategic advantage, arguing that firms may reap substantial benefits from countries that possess a higher virtual clout. In this sense, our study provides a comprehensive set of measures covering both the negative aspect of virtual distance and positive impact of virtual clout.

Finally, we contribute to the debate on future of globalization and possible convergence or divergence of countries on the wake of modern technologies (Berry, Guillén, & Hendi, 2014; Friedman, 2005; Ghemawat, 2011; Huntington, 1993; Leung et al., 2005). We find substantial differences across countries while using a dataset exclusively capturing online behaviors. Despite people across the world can access digital technologies from anywhere in the world, we show that people from different countries still adopt and use different technologies, which partly indicates that the tower of babel effect still exists in cyberspace and availability of a larger number of innovations may deepen such differences in tastes and preferences. Clearly, IB research should continue delineating the new dimensions of differences across nations and evaluating the impact of such differences on individuals, businesses, governments and multilateral entities.

LITERATURE REVIEW

The realization that countries possess different characteristics and that differences in characteristics of two countries, also called cross-national distance, importantly influence IB activities is considered the raison d'être for the field of IB (Hymer, 1976; Rugman, 2012; Zaheer, 1995). Indeed, some scholars (e.g., Zaheer, Schomaker, & Nachum, 2012) conceptualize international management as management of cross-national distance. Far from the manifestation of a flat world (Friedman, 2005; Huntington, 1993), the fault lines of political, economic, cultural, and geographic boundaries still act as major impediments for global trade and foreign direct investments (FDI) (Berry, Guillén, & Zhou, 2010; Beugelsdijk, Maseland, & Van Hoorn, 2015; Brouthers & Brouthers, 2000; Ghemawat, 2001; Ronen & Shenkar, 2013). Firms choose their exports and FDI destinations that are similar to home countries for avoiding cross-national distance (Beugelsdijk, Kostova, Kunst, Spadafora, & van Essen, 2018; Johanson & Vahlne, 2009; O'grady & Lane 1996; Roth & Kostova, 2003). Accordingly, a large portion of IB research deals with conceptualizing and measuring differences and similarities across nations, which may impact corporate decisions about entering foreign markets.

Initial research on cross-national differences largely focused on geographic distance and gravity models to explain trade flows between country dyads (Anderson & van Wincoop, 2003; Bergstrand, 1985; Feenstra, Markusen, & Rose, 2001). Scholars (e.g. Rugman, 2001; 2005) divided countries based on their geographical positions, emphasizing the importance of transportation costs and regional treaties for IB activities. Beckerman (1956) extended the meaning of distance beyond its geographic dimension by stressing the role of managerial perception of cross-national distance, which may emanate

from national level differences in languages, religions, industrial development, education and political systems. The concept was termed as psychic distance that later received empirical support in several studies (Dow & Karunaratna, 2006; Guiso, Sapienza & Zingales, 2009; Hakanson, 2014; Hakanson, Ambos, Schuster, & Leicht-Deobald, 2016; Yu, Beugelsdijk & de Haan, 2015) and laid the foundation of the Uppsala Model to explain firm location choice and internationalization process (e.g., Johanson & Vahlne, 1977; Johanson & Wiedersheim-Paul, 1975; Vahlne & Wiedersheim-Paul, 1973). Later, the focus of IB research further shifted to cultural characteristics of countries, which determine business practices within a country and create friction in cross-border trade, knowledge exchanges, and working relationships (e.g., Beugelsdijk et al., 2017; Beugelsdijk et al., 2018; Hofstede, 1984; Kogut & Singh, 1988; Roth, Kostova, & Dakhli, 2011; Schwartz, 1999; Shenkar, 2012). Researchers (e.g., Beugelsdijk et al., 2015) also realized that despite absolute changes in cultural values, cultural differences between country dyads remain relatively stable across years. While these studies inspired IB research for a long time, scholars gradually realized the need to broaden the measures of cross-national distance. Ghemawat (2001) offered a four dimensional approach to include cultural, administrative, geographic and economic distance. A more extensive index of cross-national distance was proposed by Berry et al. (2010), which measured cross-national distance on nine dimensions. Some scholars also (e.g. Shenkar, 2012; Stahl et al. 2016) note the need to move beyond the negative impact of distance and also look at the positive aspects, such as cultural diversity, for IB activities.

In addition to acknowledging the importance of cross-national distance, several scholars (e.g., Kwok & Tadesse, 2006; Marano et al., 2016; Stahl et al., 2016; Van Essen,

Heugens, Otten, & van Oosterhout, 2012; Van Everdingen et al., 2009) indicated that certain country characteristics can also influence corporate practices and IB activities. Most prominently, the seminal work of Dunning (1988) showed how resource endowment in certain countries can offer several strategic advantages to multinational enterprises. With the emergence of multinationals from emerging markets, scholars (e.g. Cuervo-Cazurra & Ramamurti, 2014; Luo & Tung, 2007) noticed how multinationals from emerging economies benefit from economic, legal, and knowledge systems that characterize developed economies. Similarly, Li et al. (2017) coined the term cultural attractiveness, as opposed to cultural distance, to show how the desirability of some cultures in foreign countries contributes in bringing cultures together, as opposed to keeping them apart, and facilitates trade and FDI flows.

The rise of modern digital technologies may raise some important questions about the validity of traditional measures that are largely developed to assess firm decisions of entering foreign markets. However, such measures may have lower impact in preventing or facilitating digital businesses from entering foreign markets given no cost of transmitting digital technologies across borders and fewer legal or political restrictions on digital technologies (Amit & Zott, 2001; Cavusgil & Knight, 2015; Coviello et al., 2017; Singh & Kundu, 2002). Instead, Internationalization in the digital age is largely driven by the adoption decisions by users dispersed across national borders, which requires a deeper understanding of user preferences (Brothers et al., 2016; Chen et al., 2018; Shaheer & Li, 2019). Hence, we propose, consistent with Brouthers et al. (2016), that the extensive research stream on diffusion of innovations (Rogers, 2003) may provide the most relevant lens to understand the patterns of digital internationalization.

Similar to the initial focus of IB research on geographic distance, diffusion of innovation literature also emphasized the importance of social contagion, arguing that people located closer to each other are more likely to adopt similar innovations as they observe the usage of innovations by each other (Burt, 2009; Mahajan & Peterson, 1985). The research further shifted attention to the impact of homophily as scholars realized that people, regardless of their physical proximity, can be similar to each other in their individual characteristics such as race, gender, education, profession, and so on and as a result, may feel the need for similar products, services, technologies, and innovations (Borgatti & Halgin, 2003; McPherson, Smith-Lovin & Cook, 2001). Recently, research on diffusion of innovation is shifting toward social homogeneity as scholars seek similarities in interests and preferences of people to analyze diffusion of innovations across networks of people who are likely to make similar choices (Borgatti & Halgin, 2011; Liu-Thompkins, 2012; Van Everdingen et al., 2009).

The recent IB research also emphasizes the need to develop new measures of country characteristics and cross-national distance based on actual behaviors of people, which may be particularly useful in explaining diffusion of digital technologies (Caprar et al., 2015; Chen et al., 2018; Shaheer & Li, 2019). For instance, in the context of measuring culture, Kirkman et al. (2017) suggest researchers to go beyond values and also consider the actual ways in which people in a country behave as values may not always drive practices in a society. Similarly, Caprar et al. (2015) advocate moving beyond the latent aspects of country characteristics and cross-country differences to examine what people actually do. Same can be applied to other parameters of distance as socioeconomic, legal, political, and other institutional parameters may not always lead to

sizable differences in people's interests, preferences, and behaviors (Leung et al., 2005). Such trends may be more prominent in a digital arena where people can make choices independent of institutional constraints imposed in offline realms. However, the challenge of data availability is an important impediment for advancing research in this direction as it is difficult to observe and record actual behaviors of a large number of people across multiple countries. This can be an important reason that IB field largely relies on government supplied dataset or surveys to understand differences across nations.

Big Data and Cross-national Research

The increasing availability of Big Data offers an important opportunity to develop novel indices of country characteristics and cross-national distance as digitization of global economy is generating a sheer volume of structured and unstructured data about people's activities in cyberspace, including financial transactions, social media participation, downloads and usage of mobile apps, website visits, and video content. Given its scale, the data generated from online activities of people is often termed as "Big Data," characterized by high volume, velocity (real time data collection), and variety (plurality of data sources) (Chintagunta, Hanssens, & Hauser, 2016; McAfee & Brynjolfsson, 2012).

Scholars in several disciplines, particularly in economics and social sciences, are employing Big Data to address novel question in their fields. For instance, Big Data has helped in understanding and predicting sales of books and movies (Gruhl, Guha, Kumar, Novak, & Tomkins, 2005; Mishne & Glance 2006), public opinion and election results

(O'Connor, Balasubramanyan, Routledge, & Smith, 2010; Tumasjan, Sprenger, Sandner, & Welpe, 2010), spread of diseases (Paul & Dredze, 2011), and even outcomes of NFL games (Sinha, Dyer, Gimpel, & Smith, 2013). A notable study by Liu, Singh, & Srinivasan (2016) leverage cloud computing to analyze nearly two billion Tweets, 400 billion Wikipedia pages, 100 million google searches, 4000 IMDB reviews, and 5.5 million news articles to accurately predict the demand of TV shows. Some scholars are also exploring the opportunity of advancing the current understanding of individuals, nations, and societies as Big Data brings unparalleled information on people's opinions and actual activities (Boyd & Crawford, 2012; Chintagunta, Hanssens, & Hauser, 2016; Foster, Ghani, Jarmin, Kreuter, & Lane, 2017). For instance, Grimmer & King (2011) analyze thousands of political texts about US presidents in order to classify the ideological positions of presidents on a range of substantive issues. On a macro level as well, Michel et al., (2011) use Big Data to analyze 200 years of national and cultural evolution in terms of languages, human values, technological landscapes, politics, and epidemics.

The potential of Big Data has also started attracting international business (IB) and management scholars and leading business journals are stressing the need for research articles based on big data analytics (Caprar et al., 2015; George, Haas, & pentland, 2014; George, Osinga, Lavie, & Scott, 2016; Kirkman et al., 2017). The availability of cross-national and geocoded Big data tracking millions of individuals, which may also include exact locations and demographics, may shed important light on similarities and differences among nations (Bail, 2014). In fact, a recent editorial in the journal of international business studies specifically emphasizes the need to utilize Big

Data about actual behavior of people to better understand national cultures (Caprar et al., 2015). These editorial comments well resonate with Big Data scientists and sociologists, who stress the need to go beyond surveys and preprocessed secondary data to analyze nations and cultures by observing people's practices and activities, a methodology that has been successful in predicting country level voting behaviors, crime rates, and educational attainment (Boyd & Crawford, 2012; Foster et al., 2017; Bail, 2013).

As a theory driven discipline, however, the field of IB aims at using Big Data in a way to inform and extend current theoretical frameworks (Buckley, Doh, & Benischke, 2017; Cuypers et al., 2018; Meyer, Van Witteloostuijn, & Beugelsdijk, 2017; Verbeke, Coeurderoy, & Matt, 2018). This goal may go beyond predictions and forecasts to deepen scholarly knowledge about IB activities. We take an initial step in this direction by drawing attention to an important feature of Big Data, the opportunity of profiling individual users based on their interests and preferences which, according to McKinsey & Company, is one of the most promising opportunities to unlock the potential of Big Data. Indeed, some scholars (e.g. Grimmer & King, 2011; Trusov, Ma, & Jamal, 2016) have already developed individual user profiles from online surfing data which, from an IB perspective, can be aggregated on national levels to analyze similarities and differences across countries. Extending these recent attempts, our paper aims at collecting country level data on actual behaviors of people to delineate national preferences, which could be turned into quantitative indices to inform research on country characteristics and cross-national distances. Below, we first discuss our research context, mobile apps. Subsequently, we discuss our samples, empirical procedures, and results for two indices we have developed, virtual distance and virtual clout.

RESEARCH CONTEXT

We use online data about mobile apps to construct our indices of virtual distance and virtual clout. Mobile apps can be defined as software that enable users to perform various functions on smartphones (Ghose & Han, 2014). Mobile apps provide a particularly suitable context for developing our indices as they represent 57% of global internet traffic generated by more than 2.5 billion people around the word (Cisco, 2019; Iqbal, 2019; Newzoo, 2018; Telegraph, 2016), which offers an adequate ground for generalization. Given that mobile apps are now integral parts of the daily lives of people, aggregating their usage patterns on country levels may provide important information about the collective ways people live in a country. The context of mobile apps has also been previously employed in several studies (e.g. Boudreau, 2012; Boudreau & Jeppesen, 2015; Chen et al., 2018; Claussen, Kretschmer, & Mayrhofer, 2013; Eckhardt, 2016) on digital innovations, online entrepreneurship, and platform governance.

Mobile apps are extensively used worldwide to perform a variety of tasks from playing games to reading books to improving work productivity. On average, a smartphone user downloads 40 apps, uses 15 of them actively, and spends approximately 82% of mobile time using apps (Gupta, 2013). According to International Data Corporation (2016), worldwide annual downloads of mobile apps are likely to hit the mark of 210 billion and earn annual revenues of $57 billion by 2020. This number is especially striking given that total revenues earned by app developers during the first five years of apps industry generated just $15 billion (Forbes, 2015).

Mobile apps are available to users through a variety of app stores. App stores are multi-sided platforms that connect developers of mobile apps, (i.e., app publishers or app developers), with app users around the world who can download mobile apps for free or at a fee (Boudreau, 2012; Eckhardt, 2016; Rietveld, 2018). The app store model came into prominence in 2008 when Apple launched Apple's app store to open the space for independent, third party developers. Beginning with only 500 apps at its launch, Apple's app store surpassed a staggering number of 300,000 apps by 2010 (Lardinois, 2010). While several smartphone platforms such as Google Android and RIM (Blackberry) followed after the success of app store model, Apple's app store maintains its position as the world's largest app store in terms of revenues and the second largest in terms of downloads. According to the announcement by Apple Inc. during 2016 worldwide developers conference (WWDC), Apple's app store hosts more than 2 million apps which generate 130 billion downloads and earn more than $50 billion in revenues.

In our study, we limit our attention to mobile apps available in Apple's app store. Focusing on a specific app store offers us several important advantages. Mainly, previous research confirms that various systematic differences across app stores exist (Ghose & Han, 2014). Restricting our sample to only one app store may mitigate the influence of such unwanted heterogeneity. Nonetheless, as Apple's app store is one of the world's most prominent platforms, our sample grants us adequate grounds to generalize our results.

Sample

To construct our sample for virtual distance and virtual clout indices, we acquire a proprietary dataset on mobile apps for the years 2016 and 2017. The dataset includes all apps that have been active in Apple's app store during 2016 and 2017. This rich dataset provides detailed information on daily performance of mobile apps across 54 countries, including country wise rankings, downloads, revenues, daily active users, ratings, and profiles of app developers. As only a few apps claim an overwhelming majority of users (Garg & Telang, 2013; Ghose & Han, 2014), we follow the approach similar to Kapoor & Agarwal (2017) to construct a more manageable but also comprehensive sample that could include most apps that are widely adopted and actively used. First, we generate a list of top 1500 apps in each of the 54 countries for the period January 2016 to December 2017. We use app ranking on 15th of every month and only include those apps that appear in rankings at least three times. Following these criteria, we construct a sample of 49,361 apps that account for more than 90% of downloads, ratings, daily active users, and revenues at Apple's app store across 54 countries during our study period.

VIRTUAL DISTANCE

Our measure of virtual distance calculates differences in aggregate preferences of people between country dyads based on the usage of different types of mobile apps. As mentioned by Caprar et al. (2015), aggregating online data about actual choices and behaviors of people can help in better understanding national characteristics and cross-national differences. Accordingly, we argue that an important way to delineate the

patterns of behaviors and preferences is to compare online activities across countries, such as differences in the usage of different types of apps across country dyads.

Methodology

To develop our measure of virtual distance, we draw on the extensive categorization scheme Apple's app store follows. Apple's app store categorizes mobile apps into 28 categories such as games, books, health & fitness, and social networking etc. An app can register into only one main category. Allowing apps to register in categories improves app discoverability as there is a large variety of apps in Apple's app store and categorization enable people to find apps that match their interests and preferences. While imperfections exist in these categorization schemes, prior research (e.g. Eckhardt, 2016; Shaheer & Li, 2019) suggests that in several ways, these categories compare favorably to schemes that are commonly used to group related products and innovations in management and entrepreneurship research, such as industry and patent classes. In the context of our study, these categories reflect the interest of people in different types of apps.

We separately construct our measures of virtual distance for the years 2016 and 2017 in order to provide a longitudinal set of variables to future researchers and also to compare changes in virtual distances between country dyads across two years. We focus on daily active users in each category, defined as the total number of users using apps in each category. We cumulate daily active users for each category on annual basis for each of the years 2016 and 2017 to calculate our main variable, annual active users. The resulting variable, annual active users, offers a comprehensive measure reflecting not

only the total number of users but also the number of different apps they use in each category. Next, we convert annual active users into percentages to reflect the share of each category in the annual active users by each country. This measure reflects the relative importance of a category in a country and also avoids confounding the number of annual active users with the size of population. This is a critical transformation of the variable without which our results may be heavily driven by the size of population or general propensity of using multiple apps in a country.

We treat country as our unit of analysis and annual active users in each category as our main variables, resulting into a dataset comprising 54 countries and 23 variables (i.e. annual active users in 23 categories). To offer a more fine grained measure of virtual distance and also make results more interpretable, we follow prior research (e.g., Conway & Huffcutt, 2003; Lenartowicz & Roth, 1999) to use exploratory factor analysis (EFA) technique to combine 23 variables into fewer but comprehensive factors. First, we use principal factor analysis to extract factors with minimum eigenvalue of 1. We had to drop one category, catalogues, as its uniqueness was higher than the cutoff value of 0.5. We obtain 5 factors extracted from 22 category level variables. These five factors reflect five groupings of preferences on which basis, we can cluster countries and calculate virtual distance scores between each country dyad. Next, we rotate factors using the oblique oblimin rotation method. Oblique rotation method is suitable in our context as we seek more interpretable factors at the cost of moderate correlation across extracted factors. As we find similar results for the years 2016 and 2017, we provide our extracted factors and corresponding loadings in Figures 3.1 to 3.5 for the year 2016 only and discuss them in detail in our results section. Results of 2017 are available on request.

Next, we use the five factor solution from EFA to cluster countries based on their similarities. Given that we extract multiple factors, cluster analysis provides perhaps the best method to investigate the dimensions of nations, which are so complex, undifferentiated, and composed of several interrelated factors (Georgas & Berry, 1995; Lenartowicz & Roth, 1999; Ronen & Shenkar, 2013). Our cluster analysis extends the framework by Rugman (2001; 2005) based on geographic triads and Ronen & Shenkar (2013) clusters based on attitudes by providing an alternative regional division based on empirically drawn boundaries. Hence, we provide a map of countries that allows for finer discrimination among countries and may also capture the challenges involved in reaching across a region better than traditional distance measures (Ghemawat, 2001, 2003; Ronen & Shenkar, 2013).

To empirically draw the clusters of 54 countries in our sample based on the five extracted factors from EFA, we first use Ward's Linkage to conduct a hierarchical cluster analysis. As the Dendrogram in Figure 3.6 indicates the presence of 5 clusters, we run non-hierarchical clustering based on 5 cluster solutions with K-mean clustering method. We find exactly same clustering for the years 2016 and 2017. Hence, we provide the Dendrogram in Figure 3.6 and detailed characteristics of all clusters in Table 3.1 for the year 2016 only. The results for year 2017 are available on request.

Finally, we use five extracted factors that group the preferences of countries to calculate five different measures of virtual distance. As each factor comprises of multiple variables, we use Mahalanobis distance formula, similar to Berry et al. (2010), to calculate differences between country dyads in their preferences. As we find the results of

2016 and 2017 largely similar with a correlation of 99%, we present the results for only 2016 in Tables 3.2 to 3.6. The results for 2017 are available on request.

Results

In this section, we discuss the results for EFA, cluster analysis, and virtual distance matrices. First, our EFA solution offers a five factor solution by combining 22 original variables into 5 broader constructs. As shows in Figures 3.1 to 3.5, all 22 factors are loaded above the cutoff of 0.4. Only 1 factor, Food & Drink, was loaded at a level of 0.35 but we decide to keep the factor as its inclusion improves the Cronbach's Alpha. In addition, the uniqueness of all 22 variables is far below the cutoff of 0.5. We name the constructs based on our subjective assessment of the types of categorirs in each factor.

Our first construct, what we name workaholic, shows the preference of using apps that improve work productivity and knowledge. The variables loaded on this factor, book, business, education, productivity, and references, all correspond to this construct. The only factor that appears slightly irrelevant is health & fitness but it can be argued that people highly active in work also require a fair amount of fitness activities. Our second construct, what we term as up-to-date, reflects the propensity of people to stay abreast with current affairs, as reflected on variables like news, sports, and weather. People with such preferences also show a higher tendency to use Finance and Medical apps, which is possibly because people in this group are highly rich, old in terms of age, or involve in financial markets and high speed trading. The third construct shows the tendency of people to engage in activities related to outing and recreation. Interestingly, we find a

substitution effect showing that people in this category show a higher tendency to either engage in food and travel or in shopping and utilities. Hence, countries with positive scores in this construct are likely to be outgoing whereas low in this construct may show a preference to stay at home, as reflected in their tendency of relying more on online facilities for shopping, bill payments, and other necessary activities. Our fourth construct shows the tendency of some countries to engage in fun oriented activities. We again find a substitution effect, showing that people in countries with higher scores in this construct may be more likely to engage in fun activities alone, as reflected in positive scores of entertainment, music, and lifestyle. On the other hand, people in countries that score low in this construct may engage more with other people through online channels like social networking. Our last category is mainly about gaming, showing countries where people engage more in gaming. Interestingly, the categories of navigation and photos & Videos also heavily load on this category, which may reflect a busy urban lifestyle.

Next, our cluster analysis indicates the groupings of countries based on their scores on five constructs extracted from EFA. Cluster 1 is mainly comprised of North American and other highly developed economies. This cluster is distinguished by its tendency of engaging more in fun oriented activities and less in gaming. Cluster 2 is dominated by developed economies from Asia and Europe with a few developing countries. This cluster shows a higher propensity of being workaholic, staying up-to-date, and playing games. Cluster 3 largely comprises of developing economies with some exceptions like New Zealand. These countries appear to be less workaholic, up to date, or outgoing but very high in using social networking. Cluster 4 contains mostly developed countries and emerging markets. This cluster shows a higher tendency of playing games.

Cluster 5 is also dominated by developed economies and shows a higher tendency of being up-to-date and outgoing.

Finally, the results of virtual distance reflect differences in country pairs. Table 3.7 shows the correlations between 5 measures of virtual distance as well as the correlation between each virtual distance variable and each cross-national distance variable developed by Berry et al (2010). We find lower correlation between each pair of virtual distance measures, which indicates that all indicators of virtual distance are capturing a different aspect of distance. We also find a lower correlation between our measures of virtual distance and Berry et al. (2010)'s distance measures, showing that virtual distance measures distinct differences compared with previously constructed measures.

Validity Test for Virtual Distance

We assess the validity of our virtual distance indices by running a regression analysis predicting international penetrations of 127 newly launched mobile apps in health and fitness category of iOS app store. We replicate the dataset and methodology employed by Shaheer & Li (2019) as their study used traditional distance measures developed by Berry et al (2010) to test for the impact of distance on app penetration. We replicate the research of Shaheer & Li (2019) to offer a better comparison of virtual distance and traditional distance measures. For the purpose of this regression, we use Mahalonobis distance method to combine all 5 measures of distance into one comprehensive measure of virtual distance that indicates the extent to which people from any two countries

download apps from different app categories and delineates some patterns about differences in preferences of people across country dyads.

We show our results in Table 3.8 using accelerated failure time model in Survival analysis. All distances are measured from the home country of app developer to each foreign country in which an app was available. In Model 1, we put four traditional distance measures, cultural, administrative, geographic, and economic distances as provided by Berry et al. (2010). The model shows that traditional measures of distance, cultural, geographic, and economic distances, delay app penetration in a foreign market, even in cyberspace. However, when we insert virtual distance in Model 2, cultural, geographic, and economic distances no more remain significant while virtual distance appears as a significant variable delaying app penetration in foreign market. These results reflect the potential of measures like virtual distance to more accurately capture the dynamics of a digital world.

VIRTUAL CLOUT

Our measure of virtual clout extends social network analysis in a digital context to evaluate the influence of countries on each other with regards to the diffusion of innovations. We draw from social network theory (e.g. Goldenberg, Han, Lehmann, & Hong, 2009) to argue that countries hold different positions in a global web in which countries share ties with each other based on similarities of preferences. Central countries that occupy boundary spanning positions due to their similarities with multiple countries play a crucial role in accelerating the diffusion of innovations to other countries. Our argument is consistent with the recent report by McKinsey & Company (2016) on digital

globalization, which ranks countries based on cross-country flows of goods, services, finance, people, and data/information. While countries perform better in some respects than others, the general picture is that cross-country flows together define a country's clout, a notion similar to a network node's centrality.

As noticed by several scholars (Alstyne & Brynjolfsson, 2005; Ter Hofstede, Wedel, & Steenkamp, 2002), users in cyberspace tend to form special interest communities that often surpass geographic boundaries. In this web of cross-national networks, a country may enjoy a more central position if its users make choices similar to other users around multiple countries. An important indicator of such similarity is the number of apps adopted by people in a country, which are also adopted in other countries. Following prior literature on network analysis (e.g. Aral & Walker, 2012; Hidalgo, Klinger, Barabási, & Hausmann, 2007), we conceptualize such similarities in app adoption as ties between country pairs, whereas the strength of each tie is determined by the number of apps common in each country pair. The higher the number of ties, the more central is a country in the virtual network of nations and hereby, enjoys a higher virtual clout. We follow this logic to empirically construct our measure of virtual clout.

Methodology and Results

To construct our measure of virtual clout, we follow recent research on the measurement of similarities across categories, countries, and user segments, broadly referred as social homogeneity literature based on choice model (Aral & Walker, 2011; Borgatti & Halgin, 2011; Hidalgo et al., 2007; Liu-Thompkins, 2012). Consistent with this important research stream on measuring similarities, we argue that countries who adopt similar apps

like other countries can be conceptualized as having ties with each other. The greater the number of ties, the more similar the country is with other nations in terms of preference overlaps. According to recent research (Liu-Thompkins, 2012; McPherson, Lovin, & Cook, 2001; Phillips, Northcraft, & Neale, 2006; Watts, 2004), such an approach is more accurate to assess similarities compared to traditionally employed approaches based on demographic and socioeconomic variables. Especially in a virtual world, such demographic variables become less relevant as users in cyberspace connect with other users based on similar interests and such online interactions have important impact on driving user choices (Chen et al., 2019; Reuber & Fischer, 1997; Shaheer & Li, 2019; Van Alstyne & Brynjolfsson, 2005).

To calculate virtual clout scores for each country in our sample, we rely on app rankings in each country, which reflect an adequate level of app adoption in a focal country (Chen et al, 2018; Shaheer & Li, 2019). We find that country pairs, on average, have 12,548 apps in 2016 and 13,431 apps in 2017 that were ranked in both countries. Using this information, we consider a focal country to have a tie, or preference overlap, with another country if the number of common apps between focal country and another country exceeds by at least 1 standard deviation from the mean. This approach is similar to prior research (e.g., Chen et al., 2018; Kali & Reyes, 2007), which recommends considering two countries to have a tie only when the magnitude of relationships is above a threshold. Using this criterion, we generate a network of intercountry ties and calculate the most important measures of clout for each country, i.e. degree centrality, weighted degree centrality, closeness centrality, harmonic centrality, betweenness centrality, eigen centrality and page ranks (Freeman, 1978). Higher a country score in any of these

centrality dimensions, the greater is the virtual clout of the country and higher the capacity of a country to transmit influence to other countries. We present all degree centralities for years 2016 and 2017 in Table 3.9.

To better interpret the patterns for virtual clout, we divide countries into networked communities, a concept akin to country clusters, using the modularity scores of countries. Similar to cluster analysis results, we find 5 main communities of countries which maintain higher number of ties with each other. At the same time, we find a number of unique countries that do not belong to any community and exhibit largely unique preferences. We present these communities of countries in Figure 3.7.

DISCUSSION

In this paper, we leverage the opportunity offered by the recent rise of Big Data to analyze actual choices made by people across multiple countries. Based on the cross-country patterns of adoption and usage of mobile apps, we develop two novel indices to facilitate future empirical research. First, we analyze differences in preferences of people across countries to develop a measure of virtual distance, which shows how country dyads differ in the type of apps they use. We also demonstrate that our measure exhibit lower resemblance with traditional measures of distance and can also outperform traditional measures in explaining international penetrations of mobile apps. We also construct a novel of measure of virtual clout, which acknowledges that countries offer strategic advantages through their positions in the web of cross-national networks. Both

indices provide a variety of variables, which can be useful in investigating several research questions.

The major contribution of our study is to transcend from survey based and macroeconomic indicators to focus on behaviors and preferences of people across countries, as revealed by actual choices made by people in cyberspace. This is an important step as several researchers advocate employing the revealed preferences and choices of people to advance current knowledge of country characteristics and cross-national differences (Caprar et al., 2015; Kirkman et al., 2017). Even though Hofstede and GLOBE surveys also ask for preferences and behaviors in their questionnaires, Scholars (Ben-Akiva et al., 2002; Beugelsdijk et al., 2017; Taras, Kirkman, & Steel, 2010; Train, 1986, 2009) notice that survey responses are more likely to represent stated preferences, which may be different from actual behaviors. We seek to overcome this limitation by using Big Data archives for constructing new measures based on actual behaviors. We also demonstrate that indices developed through analyses of actual behaviors indeed reveal some new dimensions of country characteristics and cross-national distance and also outperform traditional measures, particularly when conducting research in digital contexts. Hence, we expect our indices to substantiate traditional measures in facilitating empirical research.

We also take an initial step in utilizing Big Data in IB research to advance current understanding of country characteristics and cross-national differences. Despite its promise, the availability of Big Data is considered an important barrier for academic research. Some scholars (e.g., Boyd & Crawford, 2012) even employ the terminologies like “Big Data rich” and “Big Data poor”, referring to disparities within scholarly

communities with regards to the access to Big Data. However, we show that a large portion of Big Data is becoming accessible through application programming interface (API), which can be captured and cleaned into usable formats without sophisticated machine learning and artificial intelligence algorithms. Nevertheless, we concur with the observations of scholars about the barriers of technical sophistication to gather and clean large amounts of Big Data in usable formats (Bail, 2013; 2014). While employing such sophisticated techniques may greatly contribute in advancing IB research, we show that Big Data can be managed in a way to apply traditional techniques such as EFA, clustering or network analysis. We hope our study will pave the way for employing novel Big Data archives to advance IB research.

We also acknowledge some limitations of our study, which may provide important venues for future research. As one of the first studies to utilize preferences and behaviors across countries, we take an initial, indicative step to identify some important patterns. While we demonstrate the validity and possible applications of our indices, we expect future researchers to deploy more sophisticated data and analytical techniques. In particular, we mainly take an exploratory approach for calculating our indices but we shed limited light on the rationale behind the observed patterns. We also do not engage in a longitudinal trend analysis to look for convergence or divergence in preferences around the world. Another important opportunity for future researchers is to go beyond quantitative variables to also evaluate qualitative Big Data sets which are becoming increasingly available. For instance, the US Library of Congress now archives every single Twitter message ever made, leading to a Big Data archive of 170 billion tweets. Google has also released its entire dataset in "ngram" format, which is ready for analysis

by researchers. Even conventional media outlets such as the New York Times now offer APIs to bulk download articles as well as reader comments. Similarly, Facebook and Google provide API to enable direct interface with their massive archives of web content, which, under certain restrictions, also include geographic locations and demographics of users (Bail 2013; 2014).

We also advocate the need to employ more sophisticated analytical techniques in future research. Fortunately, new and easy to learn techniques are increasingly surfacing. API and web spiders have long been used by researchers to gather data from web sources (Gaby & Caren 2012; Livne, Simmons, Adar, & Adamic, 2011). Perhaps the most powerful innovation for researchers interested in national cultures has been screen scraping, which automatically extracts large text data from not only websites but also scanned images (Bail, 2014). In future, technologies for graphical analysis may particularly advance IB studies because a large portion of behaviors is manifested not only in speech or texts but also in bodily interactions, which may be uncovered by images and videos (e.g., Eliasoph & Lichterman, 2003; Lan, Raptis, Sigal, & Mori, 2013). Some researchers (e.g. Lu, Xiao, & Ding, 2016) have recently started incorporating video analytic techniques.

Finally, the drive for Big Data needs to maintain and promote the appetite for theory. While Big Data provides interesting patterns, scholars (e.g. Bail, 2014; Boyd & Crawford, 2012; Liu et al., 2016) increasingly emphasize to integrate theories with empirical findings. A theory driven discipline like IB can certainly help in explaining the interesting mechanism behind empirical discoveries of Big Data.

In conclusion, we have taken a small, indicative step toward a large research paradigm. We expect future researcher to evaluate our indices while exploring their research questions, which may provide perhaps the most accurate feedback about the applicability of our indices as well as the need for developing new measures for exploring novel IB questions. We hope our research will inspire development and testing of new measures for further advancing IB research.

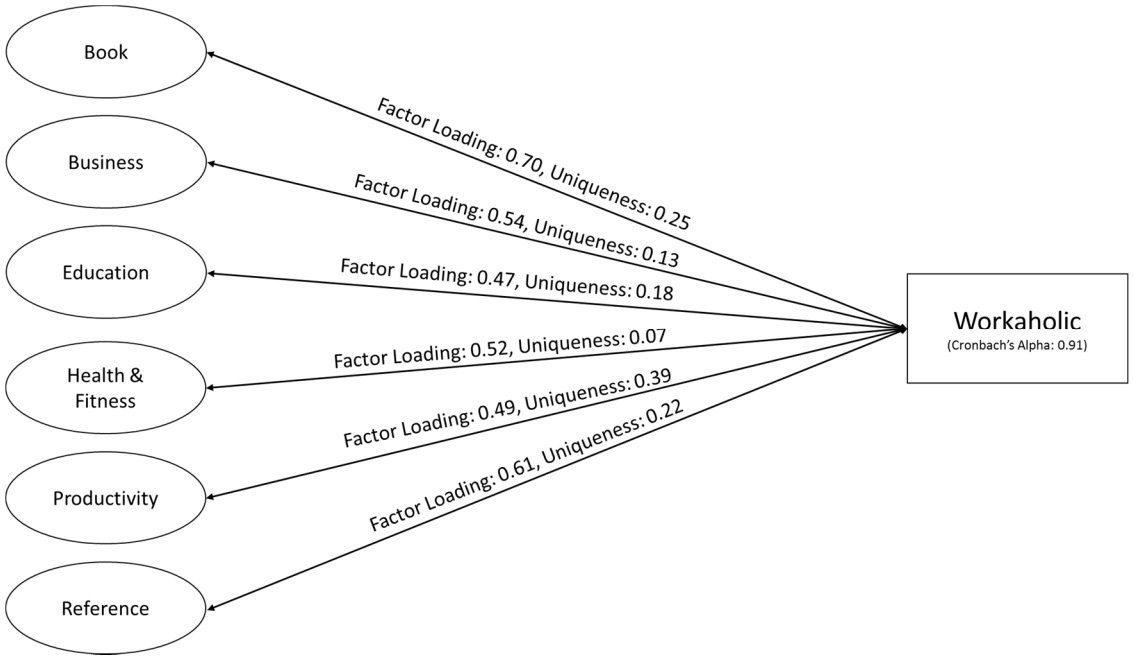

Figure 3.1
Factor 1 extracted from exploratory factor analysis

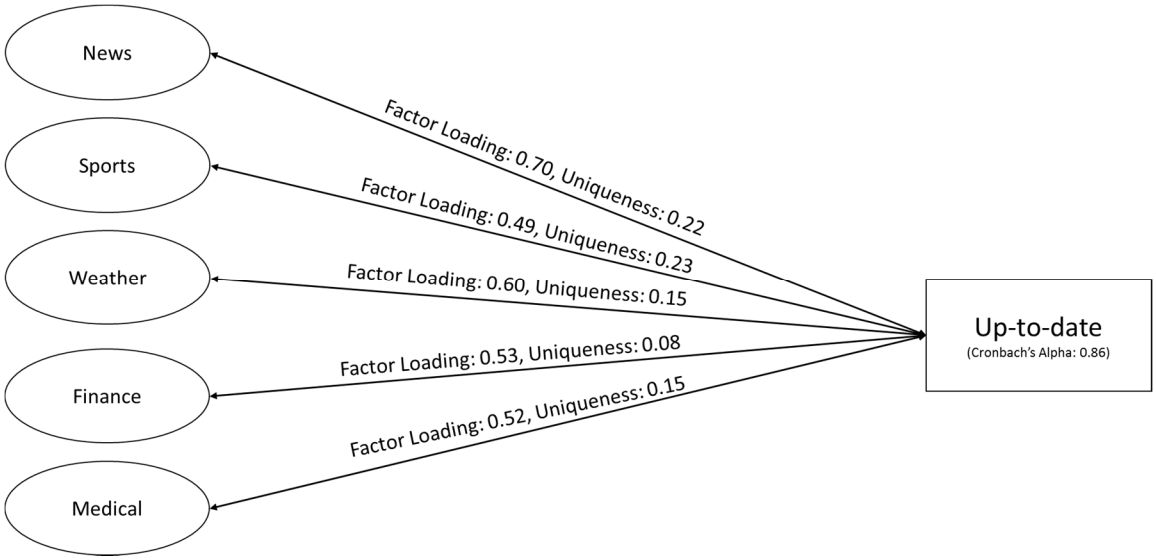

Figure 3.2
Factor 2 extracted from exploratory factor analysis

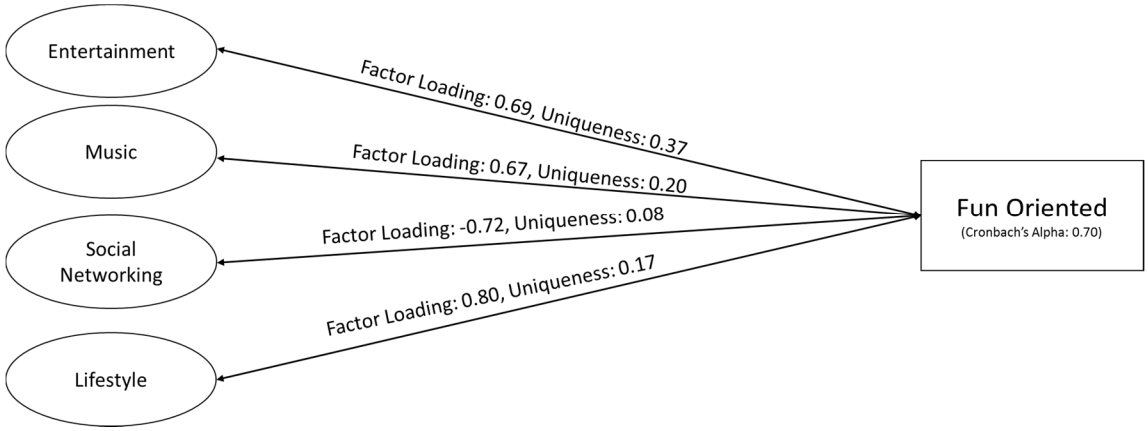

Figure 3.3
Factor 3 extracted from exploratory factor analysis

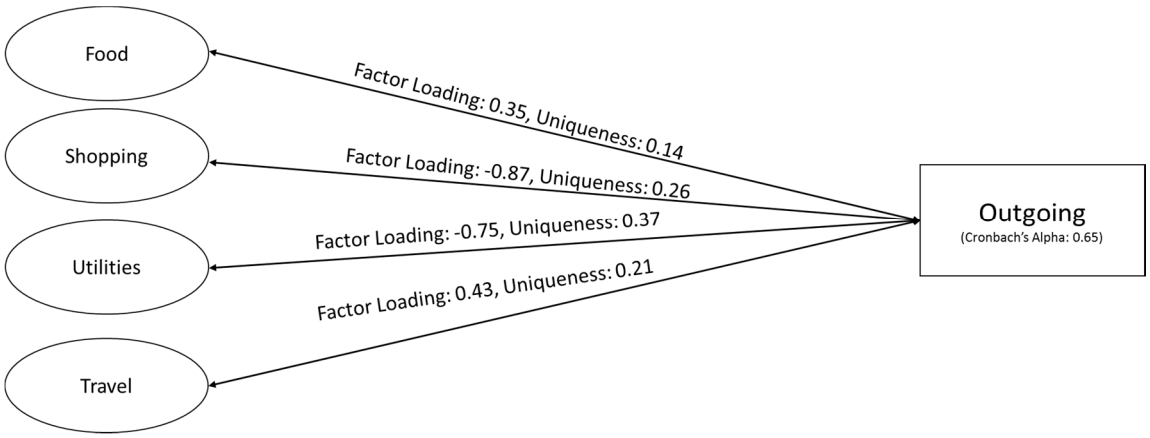

Figure 3.4
Factor 4 extracted from exploratory factor analysis

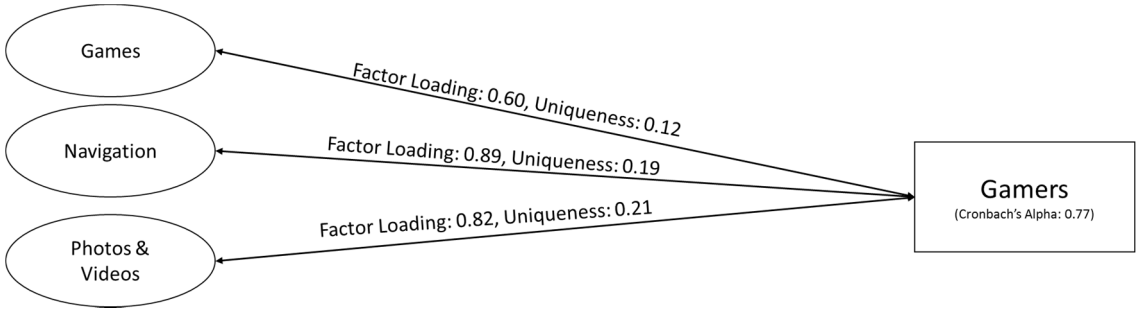

Figure 3.5
Factor 5 extracted from exploratory factor analysis

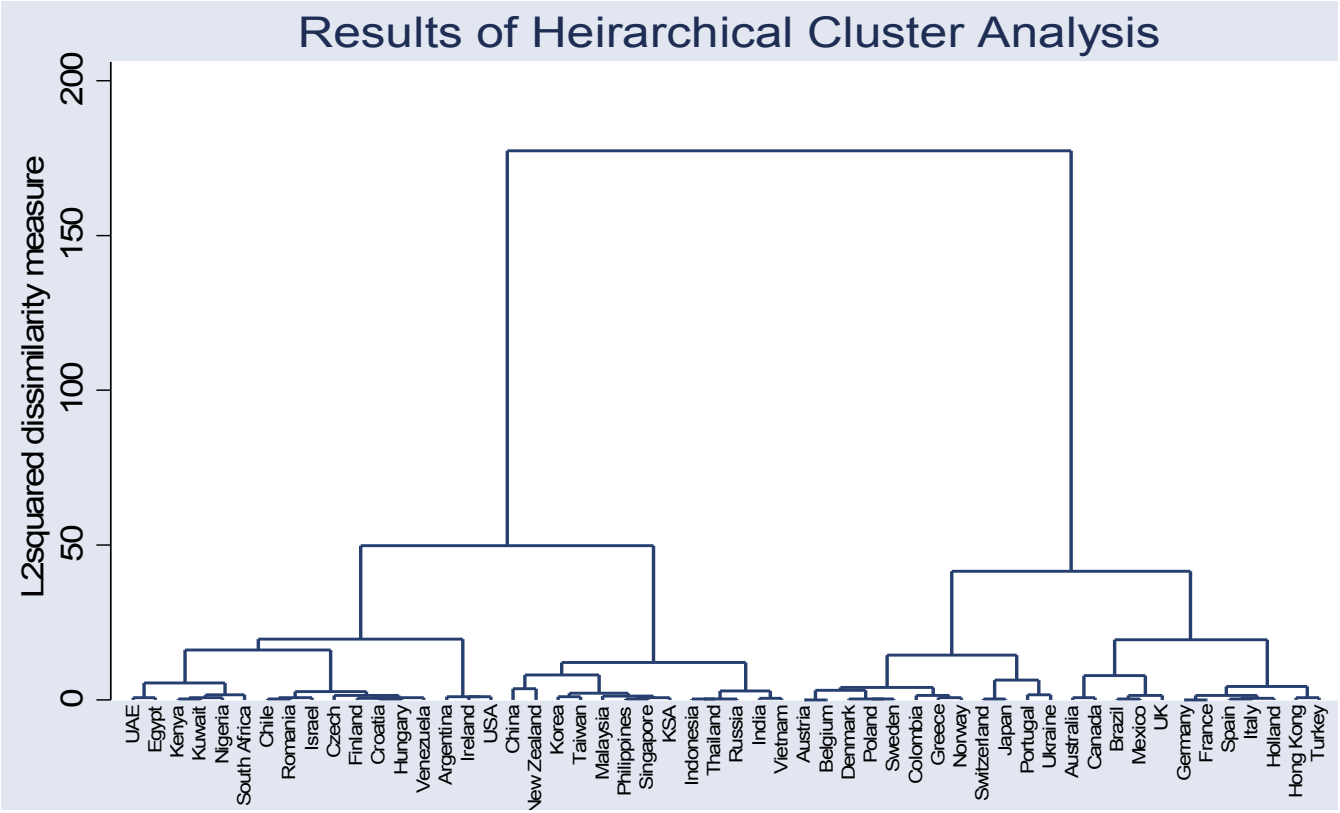

Figure 3.6
Dendrogram for Cluster Analysis

Table 3.1
Results of Cluster Analysis

Cluster	Country	Mean of Workaholic	Mean of Up-to-date	Mean of Outgoing	Mean of Fun Oriented	Mean of Gamers
Cluster 1	USA Canada Ireland Australia	-0.29	0.15	0.64	1.4	-0.8
Cluster 2	Japan Ukraine Colombia Greece Switzerland Austria Portugal Belgium	1.4	0.99	0.69	0.2	0.96
Cluster 3	Kenya Singapore India Nigeria Egypt Russia New Zealand Taiwan Vietnam Indonesia South Africa KSA Philippines Thailand China Kuwait	-0.97	-1.02	-0.84	.-56	-0.57
Cluster 4	Israel Korea Chile Denmark Malaysia Czech UAE Croatia Finland Norway Romania Argentina Venezuela Hungary Poland Sweden	-0.07	-0.2	-0.22	-0.17	0.75
Cluster 5	UK Brazil Germany Spain Hong Kong Holland Turkey France Mexico Italy	0.64	1.08	0.91	0.22	-0.71

Table 3.2
Virtual Distance- Workaholic

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1.UAE																										
2.Argentina	13																									
3.Austria	13	3																								
4.Australia	6	10	17																							
5.Belgium	11	2	1	13																						
6.Brazil	19	14	17	15	18																					
7.Canada	6	7	14	1	10	17																				
8.Switzerland	17	24	20	29	21	18	24																			
9.Chile	17	1	5	15	5	13	12	22																		
10.China	35	17	31	22	27	29	17	43	15																	
11.Colombia	20	10	16	14	16	3	14	19	8	15																
12.Czech	10	1	5	7	3	17	5	26	5	21	15															
13.Germany	15	4	7	9	6	8	7	21	7	24	10	4														
14.Denmark	8	7	14	1	10	13	1	25	10	14	10	6	7													
15.Egypt	2	13	17	5	16	18	7	21	16	29	17	11	17	7												
16.Spain	12	3	9	6	7	6	5	18	4	14	4	5	2	4	12											
17.Finland	14	1	3	11	3	12	10	27	2	22	10	3	4	9	15	5										
18.France	12	8	10	14	9	11	9	7	8	22	10	9	6	11	14	5	11									
19.UK	5	19	22	4	17	23	4	25	24	30	23	15	17	5	8	14	20	18								
20.Greece	15	5	3	19	3	23	15	23	5	22	16	8	13	13	18	11	6	12	21							
21.HongKong	14	11	18	11	16	14	10	23	10	9	6	15	17	6	10	7	13	14	14	12						
22.Croatia	10	2	3	11	2	22	8	25	5	22	18	1	8	8	12	8	3	10	16	3	14					
23.Hungary	13	1	5	9	2	18	6	26	3	15	13	2	5	6	15	4	3	9	15	4	11	1				
24.Indonesia	8	8	11	13	10	22	8	14	9	22	18	7	12	11	9	10	13	4	17	11	14	7	8			
25.Ireland	10	2	6	8	3	22	6	30	7	24	19	0	6	7	12	8	4	12	15	8	17	1	2	8		
26.Israel	7	7	14	1	10	14	1	28	12	22	14	4	6	2	7	5	8	11	7	17	13	8	7	11	5	
27.India	13	9	15	9	12	22	5	24	15	29	23	5	7	10	15	9	14	8	16	21	24	10	9	7	7	6
28.Italy	12	5	8	11	7	7	7	11	6	21	7	6	2	8	14	2	7	1	17	12	13	9	7	7	10	8
29.Japan	49	45	46	45	37	59	35	42	51	47	54	45	40	37	60	39	52	34	34	41	46	42	35	44	46	45
30.Kenya	9	6	14	6	11	17	3	20	8	11	11	6	9	4	7	5	11	6	11	13	7	7	6	4	7	5
31.Korea	7	3	8	3	5	17	2	25	6	17	14	1	6	3	7	5	5	9	10	9	10	2	2	6	1	2
32.Kuwait	4	8	14	6	12	18	5	18	11	23	15	6	12	6	2	9	12	8	10	15	11	8	10	3	7	5
33.Mexico	13	9	10	13	11	2	12	9	9	28	4	12	5	11	13	4	9	4	19	16	12	15	13	12	16	11
34.Malaysia	6	17	16	18	15	30	14	12	18	33	25	16	24	16	7	19	22	11	15	13	16	12	17	5	17	18
35.Nigeria	20	8	16	14	14	23	9	28	11	22	21	6	7	13	20	9	13	8	25	21	24	11	9	7	9	10
36.Holland	13	1	2	12	1	15	8	20	2	18	11	2	4	8	15	4	2	6	18	3	12	2	1	7	4	9
37.Norway	5	4	8	3	6	14	2	22	7	17	11	3	7	1	5	4	5	9	6	7	6	4	3	8	4	3
38.New Zealand	9	3	6	8	4	21	6	27	6	25	19	1	6	8	10	8	5	10	16	9	18	2	3	5	1	5
39.Philippines	11	7	14	6	10	17	2	19	9	13	13	6	7	4	12	4	11	5	11	14	10	8	5	5	7	5
40.Poland	14	1	4	10	2	19	7	28	4	18	15	1	5	7	16	5	2	10	17	5	14	1	0	10	2	7
41.Portugal	14	9	10	9	7	17	9	30	12	22	14	10	10	6	17	8	7	17	10	9	10	9	6	21	10	9
42.Romania	6	2	4	6	3	16	4	18	4	19	13	1	5	5	7	4	4	5	11	5	10	1	2	3	2	5
43.Russia	16	8	15	9	13	16	7	29	13	28	18	5	4	10	17	7	10	10	20	23	24	11	9	11	7	5
44.Saudia Arabia	3	7	12	2	10	14	3	21	10	21	12	5	9	3	2	6	9	10	7	14	8	7	8	7	6	2
45.Sweden	12	6	13	5	12	6	5	24	6	13	3	7	6	3	9	2	6	10	13	14	5	11	7	13	9	5
46.Singapore	6	6	9	10	8	22	7	19	7	19	16	6	14	8	5	10	9	9	13	7	9	4	6	3	6	9
47.Thailand	19	6	15	13	12	19	8	22	8	15	15	6	7	11	18	6	12	5	23	17	17	10	7	5	9	10
48.Turkey	9	8	3	20	5	18	16	9	8	36	18	9	11	17	14	12	10	6	22	7	19	7	10	6	10	16
49.Taiwan	19	9	15	18	14	21	14	24	5	7	10	13	18	12	15	10	12	12	24	8	4	11	9	10	15	18
50.Ukraine	15	13	12	11	10	13	14	35	17	38	16	13	10	10	19	11	8	23	14	16	19	15	13	29	13	11
51.USA	17	11	17	15	14	32	11	36	11	9	20	12	22	10	15	14	14	21	17	8	7	9	8	14	12	16
52.Venezuela	11	5	6	16	7	18	12	16	3	18	12	7	13	12	10	9	7	8	20	3	8	5	6	5	9	14
53.Vietnam	21	8	19	13	18	14	9	24	7	8	8	10	10	9	16	5	13	8	24	19	10	14	10	9	14	11
54.South Africa	10	4	11	6	8	21	3	26	7	15	17	2	8	5	9	6	8	8	13	11	12	4	3	4	3	4

Table 3.2 (Continued)
Virtual Distance- Workaholic

	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
27.India																											
28.Italy	7																										
29.Japan	39	36																									
30.Kenya	7	6	40																								
31.Korea	6	7	43	3																							
32.Kuwait	8	9	53	3	4																						
33.Mexico	15	2	48	11	12	11																					
34.Malaysia	19	16	47	11	13	6	18																				
35.Nigeria	2	7	46	6	7	10	16	23																			
36.Holland	10	4	37	7	4	10	9	15	9																		
37.Norway	10	7	41	4	1	4	10	11	13	5																	
38.New Zealand	5	8	49	6	2	5	14	14	6	4	4																
39.Philippines	4	5	29	1	4	6	11	14	5	6	5	7															
40.Poland	9	7	37	8	3	11	14	19	9	1	4	3	7														
41.Portugal	21	13	32	14	8	18	15	24	25	8	5	13	13	6													
42.Romania	6	5	39	3	1	4	9	9	8	2	2	2	4	2	9												
43.Russia	2	6	51	9	7	10	12	27	3	10	11	6	7	9	21	8											
44.Saudia Arabia	9	8	51	4	2	1	10	10	12	9	2	5	6	9	11	3	9										
45.Sweden	13	6	51	5	5	8	6	21	13	8	4	10	7	8	9	6	10	4									
46.Singapore	12	11	49	4	4	3	14	4	13	6	4	5	7	8	14	2	16	4	10								
47.Thailand	4	5	41	4	7	9	12	19	1	6	11	7	3	8	22	6	5	11	10	11							
48.Turkey	15	8	47	13	11	10	9	8	17	6	11	8	14	10	18	5	18	12	17	7	15						
49.Taiwan	23	13	50	7	10	11	16	14	18	9	9	14	11	12	17	9	24	12	10	6	12	15					
50.Ukraine	24	16	50	22	13	22	14	32	31	14	9	17	21	12	4	14	21	13	11	22	30	21	29				
51.USA	24	21	45	9	8	14	26	16	23	11	7	13	12	10	12	9	28	12	13	6	18	21	5	25			
52.Venezuela	17	9	50	7	7	7	11	7	16	4	6	8	10	8	14	4	19	8	10	2	12	5	3	22	8		
53.Vietnam	11	7	50	3	8	9	11	21	6	10	11	12	5	12	22	9	10	10	6	11	3	19	7	30	16	11	
54.South Africa	4	8	41	2	1	4	15	13	4	5	4	2	2	4	13	2	6	4	8	4	4	12	10	20	9	8	7

Table 3.3

Virtual Distance- Up-to-date

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1.UAE																										
2.Argentina	2																									
3.Austria	12	7																								
4.Australia	2	3	10																							
5.Belgium	5	3	3	2																						
6.Brazil	15	17	32	12	18																					
7.Canada	3	1	9	3	3	12																				
8.Switzerland	16	11	3	10	4	30	10																			
9.Chile	5	1	5	6	4	26	3	10																		
10.China	3	3	15	6	10	16	6	24	6																	
11.Colombia	13	11	20	13	12	19	6	16	11	20																
12.Czech	5	1	6	6	5	21	4	14	2	3	16															
13.Germany	12	10	3	8	4	27	12	6	11	15	28	9														
14.Denmark	4	5	11	2	5	13	7	15	10	5	24	6	6													
15.Egypt	1	2	12	3	6	17	4	18	4	1	16	3	11	3												
16.Spain	4	3	10	2	4	7	2	11	7	5	13	4	8	3	4											
17.Finland	1	1	9	2	3	16	2	12	2	3	10	3	11	4	1	3										
18.France	6	5	7	3	3	14	6	9	9	7	21	6	3	1	5	2	5									
19.UK	10	13	17	5	7	11	10	12	18	19	19	19	12	7	14	7	11	6								
20.Greece	3	3	9	2	4	12	4	13	6	3	19	3	6	1	2	1	3	1	8							
21.HongKong	1	1	9	1	3	12	3	13	5	2	14	3	8	2	1	2	1	3	9	1						
22.Croatia	3	1	4	4	3	22	2	9	0	5	12	1	8	7	3	5	1	6	15	4	3					
23.Hungary	4	1	6	5	3	18	1	10	1	4	10	1	10	7	3	4	2	6	15	4	3	0				
24.Indonesia	2	4	14	5	7	15	4	19	6	3	12	5	14	6	2	6	2	8	15	4	2	4	5			
25.Ireland	0	2	11	1	4	16	4	13	4	5	13	5	11	4	1	5	1	5	9	3	2	3	4	3		
26.Israel	1	2	14	3	6	10	3	18	6	1	14	4	12	3	1	2	2	5	11	2	1	4	4	2	3	
27.India	2	1	11	5	6	20	3	17	2	2	12	2	14	7	1	6	1	9	18	5	2	2	2	2	3	2
28.Italy	5	5	6	2	1	18	6	6	8	11	19	8	3	3	6	4	5	1	4	3	4	6	7	9	4	7
29.Japan	41	32	38	37	37	25	30	47	39	28	50	27	34	30	36	22	38	27	45	26	30	34	29	38	44	28
30.Kenya	17	24	29	21	21	28	23	33	28	21	31	24	23	19	18	21	20	19	25	18	16	23	25	10	21	17
31.Korea	5	1	8	7	7	26	4	15	1	4	14	1	13	10	4	7	3	10	22	6	5	1	1	6	5	5
32.Kuwait	1	4	16	4	8	16	7	22	8	2	21	5	13	3	1	5	3	6	13	2	1	6	7	2	2	1
33.Mexico	15	17	31	13	17	9	10	23	22	23	5	25	34	22	20	13	15	22	13	20	16	20	17	16	15	15
34.Malaysia	1	1	11	2	4	14	1	13	3	4	7	4	14	6	2	4	0	7	11	4	2	2	2	2	1	2
35.Nigeria	22	29	33	28	26	37	28	39	32	27	34	29	29	27	23	29	25	27	35	25	22	27	29	14	26	23
36.Holland	7	4	1	4	1	25	5	3	4	12	16	5	3	7	8	6	5	4	11	5	6	3	4	10	6	9
37.Norway	4	3	11	4	5	15	1	10	4	9	3	7	16	11	6	5	3	10	11	8	5	4	3	6	4	5
38.New Zealand	2	1	8	3	4	20	4	14	2	2	17	1	8	4	1	4	1	5	15	2	1	1	2	4	2	2
39.Philippines	7	5	22	9	14	9	4	26	10	4	12	7	24	11	6	5	6	13	20	8	6	8	6	6	9	3
40.Poland	7	3	10	6	6	12	1	12	5	7	6	5	14	11	7	3	5	9	15	7	5	4	2	7	8	5
41.Portugal	8	10	14	5	7	12	11	17	16	9	29	11	6	1	8	4	9	1	6	2	5	12	12	11	8	6
42.Romania	2	2	12	3	6	13	4	18	5	0	17	2	11	3	1	2	2	4	14	1	1	3	3	3	3	0
43.Russia	3	2	13	6	8	13	3	19	5	2	11	3	15	8	2	4	2	8	17	4	2	3	2	2	5	1
44.Saudia Arabia	1	2	14	2	7	16	5	19	5	2	17	4	13	4	0	5	1	6	13	3	1	4	5	3	1	1
45.Sweden	2	3	11	0	3	9	2	11	6	6	10	7	10	3	4	2	2	4	4	3	2	5	4	4	2	2
46.Singapore	1	1	12	3	6	14	2	17	3	2	10	3	14	6	1	4	0	7	14	3	1	2	2	2	2	1
47.Thailand	4	2	11	6	8	26	5	18	1	4	14	2	15	10	3	8	2	11	22	7	5	2	2	6	4	5
48.Turkey	6	4	13	6	6	12	1	11	6	11	2	9	18	13	9	5	4	11	12	9	6	6	4	7	7	6
49.Taiwan	5	2	8	7	6	21	3	14	2	4	11	1	12	9	4	6	3	9	20	6	3	1	1	3	6	4
50.Ukraine	20	16	13	20	12	30	12	14	15	23	12	16	18	25	21	16	17	20	27	19	17	13	12	14	22	19
51.USA	7	13	28	7	15	21	15	27	18	15	25	20	25	11	11	14	10	15	10	13	11	17	19	15	6	11
52.Venezuela	1	1	7	2	3	21	3	11	2	5	13	3	9	5	2	6	1	6	12	4	2	1	3	3	1	4
53.Vietnam	3	2	13	6	9	21	6	22	4	1	18	2	14	6	1	6	2	8	20	4	3	3	3	3	4	2
54.South Africa	1	2	12	5	7	18	4	18	3	2	13	2	14	6	1	6	1	8	17	4	2	2	3	1	2	2

Table 3.3 (Continued)

Virtual Distance- Up-to-date

	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
27.India																											
28.Italy	9																										
29.Japan	38	39																									
30.Kenya	19	23	55																								
31.Korea	2	10	35	29																							
32.Kuwait	3	7	37	16	7																						
33.Mexico	19	20	50	34	25	22																					
34.Malaysia	2	6	39	21	4	4	10																				
35.Nigeria	23	30	65	1	32	22	40	26																			
36.Holland	8	2	39	27	6	11	24	7	33																		
37.Norway	4	8	40	26	6	10	7	1	30	7																	
38.New Zealand	1	5	34	22	2	2	23	3	27	5	7																
39.Philippines	6	16	23	27	8	8	14	5	33	17	7	8															
40.Poland	5	10	24	26	5	11	11	4	31	8	2	7	4														
41.Portugal	13	4	28	19	16	6	24	11	28	10	16	8	15	14													
42.Romania	2	7	26	19	4	1	20	3	25	8	7	1	4	5	6												
43.Russia	1	11	27	17	4	4	16	2	21	11	5	3	2	3	12	2											
44.Saudia Arabia	2	6	39	21	5	1	19	2	27	9	6	1	6	8	8	1	4										
45.Sweden	5	3	36	20	8	5	9	1	27	6	3	4	7	5	6	4	5	3									
46.Singapore	1	8	35	20	3	3	14	1	25	8	3	2	3	4	11	1	1	1	3								
47.Thailand	1	11	41	29	1	6	24	3	33	8	6	2	8	7	17	4	4	3	7	2							
48.Turkey	6	10	37	26	8	12	5	3	31	9	0	9	7	2	17	8	5	9	4	4	9						
49.Taiwan	1	10	31	19	2	7	20	3	22	7	5	3	6	3	15	3	2	5	7	3	3	6					
50.Ukraine	16	21	41	18	17	25	24	16	18	15	13	20	22	10	27	20	13	24	18	18	21	12	9				
51.USA	15	11	66	35	20	10	19	10	44	18	14	13	20	22	14	14	19	8	8	11	15	17	23	46			
52.Venezuela	2	4	44	21	3	3	19	1	26	4	4	1	10	7	10	3	5	2	3	2	2	7	4	18	10		
53.Vietnam	1	10	33	23	2	2	25	4	28	10	8	1	5	8	12	1	2	1	7	2	2	11	3	23	15	3	
54.South Africa	0	9	37	17	3	2	19	2	20	9	5	1	5	6	11	2	1	1	5	1	2	7	2	16	14	2	1

Table 3.4
Virtual Distance- Outgoing

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1.UAE																										
2.Argentina	7																									
3.Austria	14	2																								
4.Australia	8	1	2																							
5.Belgium	15	5	2	4																						
6.Brazil	13	3	1	1	3																					
7.Canada	11	9	8	6	4	8																				
8.Switzerland	17	8	3	4	3	2	5																			
9.Chile	8	0	3	2	7	4	12	10																		
10.China	20	10	8	12	3	12	7	13	12																	
11.Colombia	7	0	1	1	4	2	8	6	1	10																
12.Czech	16	3	2	4	5	4	14	9	2	9	2															
13.Germany	13	4	2	3	0	3	3	2	6	4	3	5														
14.Denmark	15	3	1	4	2	3	9	7	3	5	2	1	2													
15.Egypt	47	38	31	39	34	32	47	37	35	41	32	32	36	28												
16.Spain	14	2	1	2	5	1	13	6	2	13	1	1	5	2	33											
17.Finland	17	3	3	5	8	5	18	13	2	13	3	1	8	3	33	1										
18.France	13	3	0	1	2	0	6	2	4	9	2	3	1	2	36	2	5									
19.UK	15	7	6	4	12	3	14	5	9	26	6	11	10	12	44	5	11	5								
20.Greece	17	4	2	5	6	3	16	8	4	14	3	2	7	2	21	2	2	4	9							
21.HongKong	8	1	1	1	2	1	5	3	2	7	1	3	1	2	34	2	5	1	7	4						
22.Croatia	17	3	4	6	7	6	17	13	2	10	3	0	8	2	35	2	0	6	14	3	5					
23.Hungary	17	3	4	5	9	5	19	13	2	15	3	1	9	4	37	1	0	5	10	3	5	1				
24.Indonesia	18	4	6	8	10	8	21	17	3	12	4	1	10	4	39	3	1	8	16	5	7	0	1			
25.Ireland	14	2	2	4	4	5	12	10	2	7	2	0	5	1	36	2	1	4	12	4	3	0	2	1		
26.Israel	13	5	4	6	7	5	16	11	3	13	3	3	8	3	17	4	4	6	13	1	5	4	5	6	4	
27.India	7	16	25	19	32	23	31	32	15	41	16	26	30	27	40	23	24	27	22	22	21	26	24	27	26	16
28.Italy	12	1	0	1	2	1	8	4	2	9	1	1	2	1	32	1	3	1	6	2	1	3	3	5	2	4
29.Japan	37	24	23	20	35	18	41	22	25	58	24	27	32	32	63	19	26	22	7	23	26	30	22	32	31	30
30.Kenya	13	8	9	11	13	10	21	17	6	19	6	8	13	7	14	8	8	12	16	4	9	9	9	10	9	1
31.Korea	18	3	3	5	7	4	18	11	2	13	3	0	8	3	34	1	0	4	10	2	5	0	0	1	1	4
32.Kuwait	3	7	11	8	12	11	12	15	7	17	6	13	11	11	28	12	14	12	16	11	7	14	15	16	12	6
33.Mexico	11	3	1	2	1	1	3	2	5	7	2	5	0	3	35	4	8	1	7	5	1	8	8	10	5	7
34.Malaysia	7	0	2	2	4	3	8	8	1	8	0	2	4	2	36	2	3	3	9	4	1	2	3	3	1	4
35.Nigeria	8	2	6	5	9	8	15	16	1	12	3	4	9	5	41	4	3	8	14	7	5	2	3	2	2	6
36.Holland	12	1	0	1	2	1	8	5	2	7	1	1	2	1	35	1	3	1	7	3	1	3	3	4	1	5
37.Norway	15	2	1	3	4	2	13	8	2	10	1	0	4	1	31	0	1	2	8	1	2	1	1	2	1	3
38.New Zealand	5	1	6	3	9	7	13	14	1	14	2	5	9	6	44	5	4	7	11	8	4	4	4	5	4	7
39.Philippines	11	1	3	3	5	5	12	11	1	8	1	1	5	2	39	2	1	4	11	4	2	1	2	1	0	5
40.Poland	14	2	0	2	2	1	8	5	2	7	1	1	2	1	33	1	3	1	8	2	1	3	3	4	1	4
41.Portugal	17	6	3	4	8	2	15	5	6	19	4	5	7	5	24	2	5	3	4	1	5	7	6	10	7	4
42.Romania	19	5	3	7	7	6	18	12	3	11	4	1	8	2	23	3	1	6	14	1	5	1	2	2	2	2
43.Russia	20	6	8	9	15	10	27	20	4	20	6	3	15	7	43	4	1	10	15	6	10	2	1	1	4	8
44.Saudia Arabia	2	4	11	6	12	11	10	16	5	14	5	12	10	12	55	11	12	10	15	16	6	11	12	12	9	13
45.Sweden	15	2	1	3	5	1	13	6	2	12	2	1	5	2	28	0	1	2	6	1	2	2	2	4	2	3
46.Singapore	6	0	4	2	8	4	12	11	0	13	1	3	7	5	39	2	3	5	8	5	3	3	3	4	3	5
47.Thailand	20	5	8	9	14	10	25	20	3	18	6	3	14	7	43	4	1	10	16	6	9	1	1	1	3	8
48.Turkey	15	3	2	3	6	1	15	6	3	16	2	2	6	3	29	0	2	3	5	1	3	3	2	5	3	3
49.Taiwan	16	3	2	4	2	4	9	8	3	4	3	1	3	1	36	3	3	3	13	4	2	2	4	3	1	6
50.Ukraine	10	1	2	2	5	2	11	7	1	11	1	2	5	2	25	1	2	3	8	1	2	3	3	4	2	1
51.USA	12	3	4	2	11	3	16	8	3	22	3	6	9	8	43	2	5	4	2	6	5	7	4	8	7	8
52.Venezuela	8	1	4	3	7	5	13	11	0	11	1	2	7	3	32	2	2	5	10	4	3	2	2	3	2	3
53.Vietnam	12	2	6	6	9	8	17	16	1	11	3	2	9	4	40	4	1	7	15	6	5	1	2	1	1	5
54.South Africa	7	1	5	4	7	6	13	13	0	10	1	3	7	4	38	3	3	6	12	6	3	2	3	2	2	4

Table 3.4 (Continued)
Virtual Distance- Outgoing

	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
27.India																											
28.Italy	23																										
29.Japan	37	22																									
30.Kenya	12	8	34																								
31.Korea	26	2	24	9																							
32.Kuwait	6	10	39	5	15																						
33.Mexico	26	1	27	12	7	10																					
34.Malaysia	17	2	29	7	3	7	3																				
35.Nigeria	16	5	33	9	4	9	9	1																			
36.Holland	25	0	25	10	2	11	1	1	4																		
37.Norway	24	1	24	7	1	12	4	2	4	1																	
38.New Zealand	13	5	28	9	5	7	7	1	1	4	5																
39.Philippines	22	2	30	9	2	10	5	1	1	1	1	2															
40.Poland	26	0	26	9	2	11	1	2	5	0	1	5	2														
41.Portugal	22	3	14	7	5	13	5	6	11	4	3	10	8	4													
42.Romania	25	3	31	5	2	12	7	4	5	3	1	7	3	3	5												
43.Russia	26	7	26	12	2	19	14	6	4	7	4	5	3	7	10	5											
44.Saudia Arabia	14	9	37	16	13	7	9	4	4	8	11	2	6	10	17	15	14										
45.Sweden	22	1	20	6	1	11	4	3	5	1	0	5	2	1	2	2	5	12									
46.Singapore	14	3	24	7	3	7	6	1	1	3	3	0	1	3	7	5	4	4	3								
47.Thailand	26	6	29	12	1	19	13	5	3	6	3	5	3	6	11	4	0	13	5	4							
48.Turkey	22	1	16	7	1	12	5	4	6	2	1	6	3	2	1	3	5	13	0	3	5						
49.Taiwan	30	2	34	11	3	13	3	2	4	1	1	6	1	1	8	3	7	10	3	4	6	4					
50.Ukraine	16	1	24	3	2	6	3	1	3	2	1	4	2	2	3	2	6	9	1	2	6	1	3				
51.USA	18	4	10	12	4	14	7	5	7	4	4	5	5	5	4	9	6	10	3	3	7	2	9	4			
52.Venezuela	14	3	28	5	2	6	6	1	1	3	2	1	1	3	6	3	4	5	2	1	4	3	3	1	5		
53.Vietnam	20	4	33	9	2	11	9	2	0	4	3	2	1	4	10	4	2	7	4	2	2	5	3	3	7	1	
54.South Africa	15	3	31	7	3	7	6	1	0	3	3	1	1	4	9	4	4	4	4	1	4	5	3	2	6	0	1

Table 3.5
Virtual Distance- Fun Oriented

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1.UAE																										
2.Argentina	8																									
3.Austria	0	9																								
4.Australia	13	4	14																							
5.Belgium	0	9	0	13																						
6.Brazil	16	24	16	16	16																					
7.Canada	6	8	6	4	6	8																				
8.Switzerland	1	10	2	13	2	10	6																			
9.Chile	1	4	2	7	2	15	5	2																		
10.China	10	10	11	4	10	14	3	12	7																	
11.Colombia	2	3	3	8	3	15	6	2	1	11																
12.Czech	0	10	0	13	0	17	6	2	1	9	4															
13.Germany	7	19	8	15	8	3	6	4	7	10	9	7														
14.Denmark	0	9	0	12	0	15	5	2	1	8	3	0	6													
15.Egypt	0	9	0	14	0	17	7	1	1	12	2	1	8	0												
16.Spain	4	3	5	3	5	15	3	5	1	3	3	5	9	4	5											
17.Finland	0	8	1	12	0	15	6	1	1	10	2	1	7	0	0	4										
18.France	6	17	6	13	6	4	4	4	6	7	9	6	0	5	7	7	6									
19.UK	20	26	20	16	20	0	9	13	18	15	18	20	5	18	21	16	19	6								
20.Greece	0	9	1	15	1	17	8	1	2	14	2	1	9	1	0	6	0	8	21							
21.HongKong	1	8	2	9	2	14	4	3	1	5	4	1	6	1	2	2	1	4	17	3						
22.Croatia	0	9	0	15	0	17	8	1	2	13	2	1	9	1	0	6	0	8	21	0	3					
23.Hungary	0	10	0	14	0	18	6	2	2	10	4	0	8	0	0	6	1	7	21	1	2	1				
24.Indonesia	4	13	5	13	4	18	7	7	4	5	9	2	8	2	5	5	4	5	21	7	1	6	4			
25.Ireland	18	3	19	6	19	38	14	22	13	15	12	19	33	19	19	9	18	29	38	19	16	19	19	22		
26.Israel	1	11	1	15	1	20	7	4	3	10	6	0	10	1	1	6	2	8	24	2	2	2	0	3	19	
27.India	2	11	3	12	3	19	7	5	2	6	7	1	8	1	3	4	3	6	22	5	1	4	2	0	19	2
28.Italy	5	15	5	13	5	6	4	3	5	6	8	4	1	3	5	6	4	0	8	7	3	6	5	4	28	6
29.Japan	3	10	5	12	4	8	8	1	3	12	3	4	3	3	3	5	2	4	12	3	4	4	5	7	23	7
30.Kenya	2	8	3	16	3	18	11	2	3	18	1	4	10	4	2	7	2	10	22	1	6	2	4	11	20	6
31.Korea	2	12	2	12	2	16	5	4	2	6	6	1	6	1	2	4	2	4	19	4	1	3	1	1	20	1
32.Kuwait	0	9	0	13	0	17	6	2	1	10	3	0	8	0	0	4	0	6	21	1	1	1	0	3	18	1
33.Mexico	10	5	11	3	11	8	4	8	6	7	5	12	8	10	11	4	9	8	8	11	8	12	13	14	13	15
34.Malaysia	2	8	3	9	3	16	4	4	1	4	5	1	7	1	3	2	2	5	18	4	0	4	2	1	16	2
35.Nigeria	1	8	1	16	1	20	9	2	2	15	2	2	11	2	0	7	1	10	24	0	4	0	1	8	18	2
36.Holland	2	11	2	11	2	12	4	3	2	5	5	1	4	1	2	4	2	3	15	3	0	3	2	1	21	2
37.Norway	0	9	1	12	1	12	6	0	1	10	2	1	5	1	0	4	0	4	16	1	2	1	1	5	20	2
38.New Zealand	11	2	11	3	11	27	7	14	6	7	7	11	22	11	11	3	11	18	28	12	8	12	12	12	2	11
39.Philippines	4	11	5	9	5	16	5	7	3	3	8	3	7	3	5	3	5	5	18	7	1	7	4	0	19	4
40.Poland	1	11	1	12	1	14	5	2	2	7	4	0	5	0	1	4	1	4	17	2	1	2	1	2	20	1
41.Portugal	1	8	1	15	1	15	8	1	2	15	2	2	8	2	1	6	1	7	19	0	4	0	2	8	20	4
42.Romania	0	10	0	14	0	18	6	2	2	10	4	0	8	0	0	5	1	7	22	1	1	1	0	3	19	0
43.Russia	4	9	5	9	4	18	6	6	2	4	7	3	8	2	4	3	4	6	21	6	1	6	4	0	17	4
44.Saudia Arabia	3	13	4	12	4	18	7	6	3	5	8	2	8	2	4	5	4	6	22	6	1	6	3	0	21	2
45.Sweden	1	11	2	11	2	10	4	1	2	7	4	1	3	1	2	4	1	2	13	3	1	3	2	2	22	3
46.Singapore	2	9	3	9	2	16	4	5	2	4	6	1	7	1	3	3	3	5	19	5	0	4	2	1	17	2
47.Thailand	9	20	10	17	10	24	11	14	9	6	16	7	13	7	11	9	10	9	27	14	5	13	9	1	28	7
48.Turkey	2	13	3	12	3	11	5	3	3	5	6	1	4	1	3	4	3	2	14	5	1	4	2	1	23	3
49.Taiwan	3	10	4	10	3	16	5	5	2	4	6	2	7	2	4	3	3	5	19	6	0	5	3	0	18	3
50.Ukraine	6	12	7	19	7	16	15	3	6	23	3	8	10	8	5	11	5	11	20	4	10	5	8	16	26	11
51.USA	46	57	38	54	40	54	35	47	50	49	52	43	52	44	45	54	48	49	54	45	49	43	40	53	57	39
52.Venezuela	1	8	2	14	2	14	9	1	1	13	2	2	7	2	1	5	1	6	18	1	3	1	3	7	20	4
53.Vietnam	9	20	9	17	9	23	10	13	8	6	16	6	12	6	10	9	10	9	26	13	4	12	8	1	27	6
54.South Africa	0	8	0	12	0	17	6	2	1	9	3	0	8	0	0	4	0	6	21	1	1	1	0	3	17	1

Table 3.5 (Continued)
Virtual Distance- Fun Oriented

	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
27.India																											
28.Italy	4																										
29.Japan	6	3																									
30.Kenya	8	9	3																								
31.Korea	0	3	6	8																							
32.Kuwait	2	5	4	3	1																						
33.Mexico	12	8	6	10	12	11																					
34.Malaysia	0	3	5	7	0	2	9																				
35.Nigeria	5	8	5	1	5	1	13	5																			
36.Holland	1	1	4	7	0	1	9	1	4																		
37.Norway	3	3	1	2	3	1	8	3	1	2																	
38.New Zealand	10	17	15	14	11	11	8	8	12	12	12																
39.Philippines	1	3	7	11	1	4	10	0	8	1	5	10															
40.Poland	1	2	4	5	0	0	10	1	2	0	1	12	2														
41.Portugal	6	6	2	0	5	2	9	5	1	4	1	13	9	3													
42.Romania	2	5	5	4	1	0	12	2	1	1	1	11	4	0	2												
43.Russia	0	4	6	9	1	3	10	0	7	2	4	9	0	2	8	3											
44.Saudia Arabia	0	4	8	10	0	3	13	1	7	1	4	12	0	2	8	2	1										
45.Sweden	2	1	2	5	1	1	8	1	4	0	1	13	2	1	3	2	2	2									
46.Singapore	0	3	6	8	0	2	10	0	5	1	3	9	0	1	6	2	1	0	1								
47.Thailand	2	7	14	19	3	8	20	3	14	5	11	16	2	6	16	8	2	1	7	3							
48.Turkey	1	1	4	8	1	2	10	1	6	0	2	13	1	1	5	2	1	1	0	1	4						
49.Taiwan	0	3	6	9	0	2	10	0	6	1	3	10	0	1	7	2	0	0	2	0	2	1					
50.Ukraine	13	11	3	1	13	7	11	12	5	10	4	20	16	9	2	9	14	16	7	13	26	11	13				
51.USA	52	49	60	56	45	46	57	49	44	45	47	51	53	43	47	41	56	50	48	46	59	49	52	66			
52.Venezuela	5	5	1	1	4	1	9	4	2	3	1	13	7	2	1	3	5	6	2	5	13	4	5	2	56		
53.Vietnam	2	7	14	19	3	7	20	3	14	4	10	16	2	5	15	7	2	1	6	3	0	3	2	25	55	13	
54.South Africa	2	5	4	3	1	0	10	1	1	1	1	10	3	0	2	0	3	3	1	2	8	2	2	7	45	2	7

Table 3.6
Virtual Distance- Gamers

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1.UAE																										
2.Argentina	0																									
3.Austria	3	4																								
4.Australia	5	6	7																							
5.Belgium	3	4	0	7																						
6.Brazil	2	3	4	2	5																					
7.Canada	4	5	7	1	6	2																				
8.Switzerland	1	1	2	6	1	3	4																			
9.Chile	2	1	4	7	3	5	4	0																		
10.China	8	9	14	2	13	5	1	10	9																	
11.Colombia	2	2	8	12	8	5	10	4	5	14																
12.Czech	6	4	8	12	6	11	8	3	1	14	9															
13.Germany	1	2	4	2	4	0	1	2	3	4	5	8														
14.Denmark	2	1	5	8	4	6	5	1	0	9	4	1	3													
15.Egypt	2	1	9	10	9	6	8	3	3	10	1	6	4	2												
16.Spain	2	3	2	2	2	0	2	2	3	6	6	9	0	4	6											
17.Finland	2	2	2	11	2	6	9	1	2	16	4	4	5	2	4	5										
18.France	1	1	6	3	6	1	2	3	3	4	3	9	0	3	3	1	6									
19.UK	4	5	7	0	7	1	1	6	6	2	10	13	1	7	8	1	10	2								
20.Greece	3	4	1	13	2	7	12	3	4	20	5	9	6	5	7	5	1	7	12							
21.HongKong	2	2	4	2	3	1	1	2	2	4	6	6	0	2	5	1	5	1	1	7						
22.Croatia	5	4	10	19	9	13	15	4	3	21	4	3	10	3	3	12	3	9	17	6	10					
23.Hungary	2	1	7	12	6	8	9	2	1	15	2	3	6	1	1	7	1	5	11	4	5	1				
24.Indonesia	2	2	5	2	4	1	1	2	2	3	6	6	0	2	4	1	6	1	1	8	0	10	5			
25.Ireland	2	1	5	3	4	3	2	1	1	5	6	3	1	1	4	2	4	2	3	7	1	7	3	1		
26.Israel	2	1	9	10	9	5	8	4	4	11	1	7	4	3	0	6	4	2	8	7	5	4	2	4	4	
27.India	6	6	9	1	8	4	0	5	5	1	13	8	3	6	10	3	11	4	2	14	2	16	11	1	2	10
28.Italy	1	1	6	4	6	1	3	3	3	5	3	8	1	3	2	2	5	0	2	7	1	9	4	1	2	2
29.Japan	2	3	3	9	4	3	10	4	6	15	3	12	4	6	5	3	3	4	8	2	5	9	6	6	7	5
30.Kenya	6	4	8	7	6	9	4	3	2	8	12	1	6	2	7	6	7	7	8	11	4	8	5	4	1	9
31.Korea	4	3	13	11	11	9	8	5	3	10	4	4	6	2	1	9	6	5	10	11	6	4	2	5	3	2
32.Kuwait	2	1	6	6	5	5	3	1	1	7	6	2	3	0	3	4	4	3	6	8	2	5	2	2	0	4
33.Mexico	1	3	4	2	4	0	2	3	4	5	5	11	0	5	5	0	6	1	1	6	1	12	7	1	3	5
34.Malaysia	1	2	3	2	3	1	1	1	2	5	6	7	0	3	5	0	4	1	1	5	0	10	5	0	1	5
35.Nigeria	9	7	13	11	10	13	6	6	4	10	15	2	9	4	9	10	10	10	12	16	6	9	7	6	3	11
36.Holland	2	3	2	3	1	2	2	1	2	7	8	5	1	3	7	1	4	3	3	5	1	10	6	1	1	7
37.Norway	5	3	11	15	9	12	11	4	2	16	5	2	8	2	2	10	4	8	14	9	7	1	1	7	4	3
38.New Zealand	3	2	6	2	5	3	1	2	2	3	7	5	1	2	4	2	6	1	2	9	0	10	5	0	0	5
39.Philippines	1	1	7	4	7	2	2	3	2	4	4	6	1	2	2	3	6	1	3	9	1	8	4	1	1	2
40.Poland	4	3	4	6	2	6	4	1	1	10	10	2	4	2	7	4	3	6	7	6	3	7	4	3	1	8
41.Portugal	3	4	1	11	2	5	11	3	5	19	5	10	6	6	8	4	2	6	10	0	6	8	5	7	7	7
42.Romania	2	1	5	10	4	6	7	1	0	12	3	2	4	0	2	5	1	4	9	4	3	2	0	4	2	2
43.Russia	7	6	20	15	19	11	12	11	9	11	5	12	9	8	3	13	13	6	12	18	10	9	7	8	9	3
44.Saudia Arabia	2	2	5	1	4	1	1	2	2	3	6	7	0	3	4	1	6	1	1	8	0	10	6	0	1	5
45.Sweden	2	1	5	5	4	5	3	1	0	7	5	2	2	0	3	3	3	3	5	6	1	5	2	1	0	4
46.Singapore	3	2	7	3	5	4	1	2	2	4	8	3	2	2	5	3	6	3	3	10	1	9	5	1	0	5
47.Thailand	3	3	11	6	11	4	4	5	5	4	4	9	3	4	2	5	9	1	4	12	3	9	6	2	3	2
48.Turkey	1	1	3	3	4	0	2	2	3	5	3	8	0	3	3	1	4	0	2	5	1	9	5	1	2	3
49.Taiwan	3	3	5	2	4	3	1	2	2	3	8	4	1	2	5	2	6	2	2	9	0	10	6	0	0	6
50.Ukraine	8	10	5	17	8	8	18	10	13	25	8	22	10	14	13	8	7	11	15	4	12	16	13	14	15	12
51.USA	11	8	13	10	10	14	6	7	5	11	17	2	10	5	11	11	11	11	12	16	7	11	9	7	4	13
52.Venezuela	6	4	12	17	10	13	13	5	3	18	5	3	10	2	3	12	4	9	16	9	9	1	1	8	6	4
53.Vietnam	18	19	37	27	38	21	25	27	26	21	13	33	20	24	12	26	29	15	22	34	23	25	22	21	24	11
54.South Africa	4	2	6	9	4	8	6	1	0	12	7	0	5	0	4	6	3	6	9	6	4	3	2	4	2	6

Table 3.6 (Continued)
Virtual Distance- Gamers

	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
27.India																											
28.Italy	4																										
29.Japan	12	4																									
30.Kenya	4	7	13																								
31.Korea	9	4	11	5																							
32.Kuwait	4	3	8	1	2																						
33.Mexico	4	1	3	8	8	5																					
34.Malaysia	2	1	4	5	6	2	1																				
35.Nigeria	6	10	18	1	5	2	12	8																			
36.Holland	3	3	5	3	8	2	2	1	6																		
37.Norway	12	7	10	4	1	2	11	8	5	8																	
38.New Zealand	1	2	8	2	4	1	2	1	4	2	7																
39.Philippines	3	0	6	5	2	2	2	2	7	3	5	1															
40.Poland	5	6	9	1	7	2	6	3	3	1	5	3	5														
41.Portugal	14	7	1	12	12	8	5	5	17	5	10	9	8	7													
42.Romania	8	4	5	4	3	1	5	3	6	3	1	4	3	2	4												
43.Russia	13	5	14	12	2	7	11	11	13	15	6	8	4	15	18	8											
44.Saudia Arabia	1	1	6	4	5	2	1	0	7	1	8	0	1	3	7	4	9										
45.Sweden	4	3	7	1	3	0	4	2	3	2	3	1	2	1	7	1	8	2									
46.Singapore	1	3	9	1	4	1	4	2	3	2	5	0	2	2	10	3	8	1	1								
47.Thailand	5	1	8	7	2	3	4	4	9	7	6	2	0	9	12	5	2	2	4	3							
48.Turkey	4	0	3	6	6	3	0	0	10	2	8	2	1	5	4	3	8	1	2	3	3						
49.Taiwan	1	3	8	2	5	1	3	1	4	1	7	0	2	2	9	4	10	0	1	0	4	2					
50.Ukraine	22	11	2	24	21	17	8	10	31	11	20	17	15	16	2	12	25	14	15	19	18	8	17				
51.USA	6	11	20	1	7	3	13	8	0	6	7	5	8	3	18	7	16	7	4	3	11	11	4	32			
52.Venezuela	14	8	11	6	2	3	12	9	6	10	0	8	6	7	11	2	6	9	4	7	7	9	8	20	8		
53.Vietnam	28	14	24	33	15	23	20	24	34	31	22	22	14	36	32	24	6	21	24	24	10	19	26	34	39	22	
54.South Africa	7	6	9	1	3	1	7	4	2	3	2	3	4	1	7	1	11	4	1	2	7	5	3	17	3	3	30

Table 3.7
Correlation Table- Virtual Distance and Traditional Distance Measures

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1.Virtual Distance- Workaholic	12	9.1													
2.Virtual Distance- Up-to-date	10	9.42	0.57												
3.Virtual Distance- Outgoing	8	8.89	0.43	0.23											
4.Virtual Distance- Fun Oriented	8	10.08	0.15	0.25	0										
5.Virtual Distance- Gamers	6	5.66	0.21	0.18	0.04	0.24									
6.Admiistrative Distance	19.59	24.91	-0.05	-0.05	-0.09	-0.08	0.05								
7.Cultural Distance	17.01	22.41	0.02	-0.04	0	-0.01	-0.01	-0.04							
8.Demographic Distance	11.98	15.01	0.24	0.2	0.26	-0.09	-0.02	0.02	-0.08						
9.Economic Distance	10.12	13.65	0.05	-0.03	-0.04	-0.02	-0.04	0.03	0.03	0.13					
10.Financial Distance	6.21	10	0.05	-0.04	-0.04	-0.05	-0.09	-0.09	0.11	0.07	0.67				
11.Geographic Distance	7526.94	4871.31	0.07	0.1	-0.02	0.22	0.05	0.04	0.01	0.06	0.11	0.09			
12.Global connectedness Distance	2.65	2.69	-0.05	0.18	0.12	0.01	0.12	0.14	-0.03	0.05	0.18	0.01	0.12		
13.Knowledge Distance	7.53	9.8	0.49	0.44	0.3	0.12	0.06	0.13	0.13	0.28	0.12	0	0.1	0.21	
14.Political Distance	3215.86	2937.07	0.31	0.31	0.15	0.13	0.05	0.08	0.05	-0.01	-0.1	-0.13	0.35	0.06	0.4

Table 3.8
Validity Testing for Virtual Distance Measure

VARIABLES	Model 1 Traditional measures of distance	Model 2 Virtual distance
App price	-0.02	-0.02
	(0.02)	(0.02)
Trial promotion	-1.58*	-1.59*
	(0.76)	(0.76)
No. of SDKs	-0.13+	-0.13+
	(0.08)	(0.08)
Media exposure	1.25	1.25
	(0.96)	(0.96)
In app advertising	0.00	0.00
	(0.00)	(0.00)
Featured app	-0.05	-0.14
	(0.23)	(0.23)
Language	-0.97***	-0.85***
	(0.08)	(0.08)
Multihoming	0.28	0.26
	(0.38)	(0.38)
Social media followers	-0.00***	-0.00***
	(0.00)	(0.00)
Specialized app	1.63	1.65
	(1.07)	(1.07)
Developer experience	-0.11	-0.11
	(0.10)	(0.10)
Market size	0.05*	0.01
	(0.03)	(0.03)
Category concentration	0.16	0.31
	(1.43)	(1.42)
Virtual distance		0.02***
		(0.00)
Cultural distance	0.63**	0.29
	(0.22)	(0.23)
Administrative distance	-0.27	-0.34*
	(0.17)	(0.17)
Geographic distance	0.19*	0.06
	(0.08)	(0.08)
Economic distance	1.02**	0.56
	(0.35)	(0.35)
Constant	3.43+	2.82
	(1.82)	(1.82)
Control for app apps home country	Yes	Yes
Control for app subcategory	Yes	Yes
Observations	5,757	5,757
Number of apps	127	127
Log likelihood	5,746	5,731
$\chi 2$	325	355

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 3.9
Virtual Clout of Each Country in the Sample

Country	Degree Centrality		Wtd. Degree Centrality		Closness Centrality		Harmonic Centrality		Betweeness Centrality		Eigen Centrality		Page Ranks	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Argentina	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Australia	38	38	710,466	621,084	1.00	1.00	1.00	1.00	0.06	0.07	1.00	1.00	0.05	0.05
Austria	20	20	356,115	311,187	0.68	0.68	0.76	0.76	0.00	0.00	0.72	0.72	0.03	0.03
Belgium	24	25	434,966	396,188	0.73	0.75	0.82	0.83	0.00	0.00	0.80	0.83	0.03	0.03
Brazil	7	7	117,695	102,576	0.55	0.55	0.59	0.59	0.00	0.00	0.29	0.29	0.01	0.01
Canada	38	38	702,278	614,136	1.00	1.00	1.00	1.00	0.06	0.07	1.00	1.00	0.05	0.05
Chile	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
China	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colombia	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Croatia	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Czech	6	6	100,382	87,578	0.54	0.54	0.58	0.58	0.00	0.00	0.25	0.25	0.01	0.01
Denmark	21	20	375,218	314,465	0.69	0.68	0.78	0.76	0.00	0.00	0.75	0.72	0.03	0.03
Egypt	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Finland	14	14	241,573	210,953	0.61	0.61	0.68	0.68	0.00	0.00	0.54	0.55	0.02	0.02
France	30	30	547,111	478,496	0.83	0.83	0.89	0.89	0.01	0.01	0.93	0.94	0.04	0.04
Germany	33	32	604,367	514,667	0.88	0.86	0.93	0.92	0.02	0.02	0.97	0.96	0.04	0.04
Greece	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Holland	33	32	600,602	511,435	0.88	0.86	0.93	0.92	0.02	0.02	0.96	0.96	0.04	0.04
Hong Kong	17	16	297,036	243,007	0.64	0.63	0.72	0.71	0.00	0.00	0.60	0.58	0.02	0.02
Hungary	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
India	13	14	223,108	210,605	0.60	0.61	0.67	0.68	0.00	0.00	0.52	0.55	0.02	0.02
Indonesia	9	7	153,647	104,412	0.57	0.55	0.62	0.59	0.00	0.00	0.34	0.25	0.01	0.01
Ireland	17	17	304,052	266,121	0.64	0.64	0.72	0.72	0.00	0.00	0.65	0.65	0.02	0.02
Israel	3	3	50,375	43,937	0.52	0.52	0.54	0.54	0.00	0.00	0.13	0.13	0.01	0.01
Italy	30	30	543,392	475,944	0.83	0.83	0.89	0.89	0.01	0.01	0.93	0.94	0.04	0.04
Japan	2	2	33,438	29,195	0.51	0.51	0.53	0.53	0.00	0.00	0.09	0.09	0.01	0.01
Kenya	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Korea	2	2	34,806	30,406	0.51	0.51	0.53	0.53	0.00	0.00	0.09	0.09	0.01	0.01
KSA	11	13	187,702	193,762	0.58	0.60	0.64	0.67	0.00	0.00	0.45	0.53	0.01	0.02
Kuwait	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Malaysia	18	19	315,776	288,474	0.66	0.67	0.74	0.75	0.00	0.00	0.61	0.63	0.02	0.03
Mexico	11	9	187,699	134,145	0.58	0.57	0.64	0.62	0.00	0.00	0.45	0.38	0.01	0.01
New Zealand	28	27	499,356	419,909	0.79	0.78	0.87	0.86	0.01	0.01	0.88	0.87	0.03	0.03
Nigeria	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Norway	19	20	336,031	308,122	0.67	0.68	0.75	0.76	0.00	0.00	0.69	0.72	0.02	0.03
Philippines	11	10	187,797	148,851	0.58	0.58	0.64	0.63	0.00	0.00	0.40	0.37	0.02	0.01
Poland	14	14	240,739	210,821	0.61	0.61	0.68	0.68	0.00	0.00	0.54	0.55	0.02	0.02
Portugal	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Romania	9	10	150,849	146,002	0.57	0.58	0.62	0.63	0.00	0.00	0.37	0.41	0.01	0.01
Russia	16	17	281,917	261,315	0.63	0.64	0.71	0.72	0.00	0.00	0.62	0.65	0.02	0.02
Singapore	19	18	332,108	273,989	0.67	0.66	0.75	0.74	0.00	0.00	0.62	0.61	0.02	0.02
South Africa	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spain	28	30	504,143	470,690	0.79	0.83	0.87	0.89	0.01	0.01	0.89	0.94	0.03	0.04
Sweden	30	29	543,379	460,247	0.83	0.81	0.89	0.88	0.01	0.01	0.93	0.92	0.04	0.04
Switzerland	28	29	506,661	456,685	0.79	0.81	0.87	0.88	0.01	0.01	0.90	0.92	0.03	0.04
Taiwan	7	6	119,728	88,989	0.55	0.54	0.59	0.58	0.00	0.00	0.24	0.19	0.01	0.01
Thailand	21	19	367,887	289,931	0.69	0.67	0.78	0.75	0.01	0.00	0.69	0.64	0.03	0.03
Turkey	18	18	312,963	274,554	0.66	0.66	0.74	0.74	0.00	0.00	0.67	0.68	0.02	0.02
UAE	24	25	427,925	390,423	0.73	0.75	0.82	0.83	0.00	0.00	0.82	0.85	0.03	0.03
UK	34	33	625,616	535,733	0.90	0.88	0.95	0.93	0.02	0.02	0.98	0.97	0.04	0.04
Ukraine	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
USA	10	13	175,129	198,002	0.58	0.60	0.63	0.67	0.00	0.00	0.41	0.53	0.01	0.02
Venezuela	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vietnam	5	2	85,170	30,110	0.54	0.51	0.57	0.53	0.00	0.00	0.19	0.09	0.01	0.01

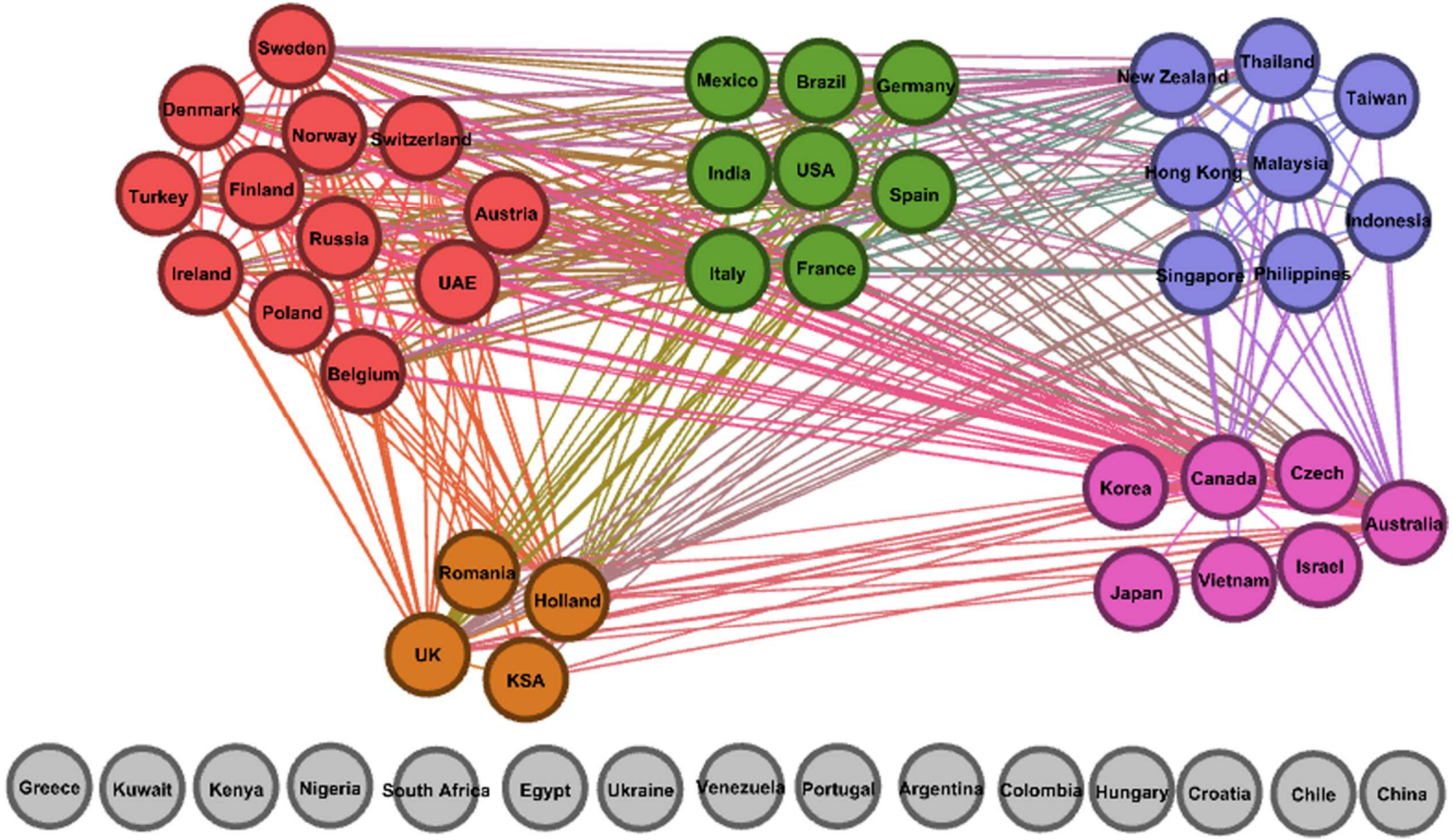

Figure 3.7
Communities of Countries in Virtual Clout Network

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