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The impact of digital technologies on business competitiveness: a comparison between Latin America and Europe

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Abstract

Purpose – This study aims to examine how the adoption of digital technologies affects the business competitiveness of countries in Latin American and European countries.

Design/methodology/approach – This study used a structural model based on factors representing the pillars of the Global Competitiveness Index: financial system, adoption of information and communication technologies (ICT), skills, labor market, product market, macroeconomic stability, business dynamism and gross domestic product (GDP) purchasing power parity (PPP) as a percentage of the total world value. The authors considered 17 Latin American and 28 European countries. The model was analyzed by partial least squares-structural equation modeling.

Findings – ICT adoption in Latin American countries is a strong predictor of business dynamism (66% of the variance), skills (81% of the variance), product market (75% of the variance), labor market (42% of the variance) and financial system (49% of the variance). Similarly, ICT adoption in European countries is a strong predictor of business dynamism (35.6% of the variance), skills (72.2% of the variance), product market

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(51.6% of the variance), labor market (81.7% of the variance, but with a negative path coefficient) and financial system (38% of the variance).

Practical implications – Latin American countries should create policies to build skills to increase ICT adoption, and improve business and labor market dynamism. A theoretical implication is that the authors propose two structural models based on the GCI that best explains competitiveness in Europe and Latin America.

Originality/value – Using GCI data, the authors present empirical evidence on the predictors of competitiveness across 17 Latin American and 28 European countries with a special focus on the adoption of digital technologies.

Keywords Digital technologies, Competitiveness, ICT, Latin America, Europe

Paper type Research paper

1. Introduction

In recent decades, organizations have been forced to develop their businesses in more versatile ways to respond to different market needs, become more efficient and productive and, ultimately, be more competitive than their competitors. The implementation and application of new digital technologies is crucial in this context. They can positively affect the ability of companies to respond to market needs (Blichfeldt and Faullant, 2021). Ferrari (2012) notes that technological development has been a priority in government agendas in many countries, and considered as the engine of economic and competitive development. While companies incorporating these technological developments, such as digital transformation, may be doing so to evolve themselves, it can also cause internal resistance from employees owing to the complexity and uncertainty that it may bring. For instance, despite the changes over the past 15 years, very few economies have managed to completely advance toward the fourth industrial revolution, since a mix of both the digital and physical worlds is needed (Teigens *et al.*, 2020). Furthermore, Karim *et al.* (2022) argue that the business performance of regarding information and communication technologies (ICT) depends on the national context in which they are developed. For instance, firms in developing countries may lack access to ICTs which may be readily available to their counterparts in developed countries. Then, the former will need to learn these ICTs from the latter and introduce them into their own firms to gain a competitive advantage.

This study explores how the adoption of digital technologies influences the competitiveness of countries. For instance, ICT adoption has been slow in Latin American countries and a generalized implementation policy is missing. Furthermore, only a small fraction of the society has high broadband connectivity (Gallego and Gutierrez, 2015). Ramírez-Alujas (2011) also notes that Latin America has social problems which affect its growth and market development: an education system that does not focus on skills and innovation, economic inequality and low levels of ICT adoption and implementation, which generally remain in the hands of a few private companies.

Arredondo-Trapero *et al.* (2020) point out that cooperation is necessary to create new technologies, products and processes, especially in emerging economies where resources and capacity for innovation are relatively limited. Sukno and Pascual del Riquelme (2019) found that in some countries such as Chile, the e-commerce has been growing but it is still far from its real potential. Meanwhile, developed countries have allocated resources for ICT implementation and are seeking to move from an industrial economy to a global economy based on knowledge transfer. According to the World Economic Forum (WEF, 2016a), digitization as well as access to, and the use and development of ICT allow countries to have greater opportunities to generate citizen well-being.

Goumagias *et al.* (2022, p. 78) state that "firms reconfigure their resources when they respond to changes in their external or internal environment, often by incorporating new knowledge and resources in collaboration with external stakeholders. However, the reconfiguration process is

difficult, costly[,] and often fails." Ideally, these decisions around firm and resource reconfiguration and transformation should be made with the participation of all members of the company together with the leadership. The latter manages the relationships and integration of all the necessary components for the achievement of the desired objectives.

Moreover, digitization is becoming a way to improve the efficiency of processes and promote the development of countries, allowing greater competitiveness and facilitating important transformations in all spheres of human life (Aghimien *et al.*, 2021). This has been the case with the development of ICT. Almost all manifestations of social life are now available in digital format (Cijan *et al.*, 2019), which allows us to conceive a broader concept of the performance and impact generated. In turn, this can help us analyze strategies for the development of digital transformation and organizational innovation. Essentially, digital technologies can contribute to the organization via better production, services, performance and productivity. An interconnected world also allows firms to visualize the opportunities for offering a product or service that satisfies client needs, exploiting new strategies and opening the possibilities for implementing activities for promoting innovation. This is because the way of creating products, services and processes has transformed (Vallejo, 2018). In this context, it is important to ask how ICT adoption impacts configuration, reconfiguration and international competitiveness in Latin American and European countries. To our knowledge, this is the first study to provide information on factors that could explain competitiveness from the perspective of digital technology adoption.

The rest of this article is organized as follows. Section 2 reviews the literature on digital technologies. Section 3 develops our hypotheses and structural model of this study. Section 4 outlines the methodology and the results are presented in Section 5. This is followed by a discussion of the results in Section 6. Section 7 describes the theoretical and practical implications. Finally, Section 8 presents the conclusions of this study.

2. Evolution of digital technologies

In this section, we discuss the literature on the importance of digital technologies for companies, and the advantages and opportunities created by ICT adoption in entrepreneurial contexts. Essentially, this theoretical review identifies the extent to which digital technologies may be key to competitiveness.

Companies must have the ability to promote and lead the different changes in production models in an immediate and flexible way. This can help them survive and remain competitive. In addition, companies must be innovative to become more competitive and should not be afraid of risks when adding networks that improve the productivity of their business processes.

A particularly important aspect is investigating how digital transformation helps the empowerment of their business. Furthermore, we should examine whether it is necessary to change the organizational culture for the successful implementation of digital transformation, and the collective reorientation of business objectives and processes toward a digital future. The exchange of information is an additional element that the digital medium offers us because it collects different data that users provide. In this way, firms can evaluate what is needed to satisfy the client, what the client expects from their product or service, making the corresponding changes and, thus, be relevant, visible and competitive.

Moreover, digital transformation and innovation are positively integrated, allowing the development of new organizational and administrative processes that generate value, and improve financial and market performance (Gerasimenko and Razumova, 2020). Furthermore, digitization and innovation have been changing exponentially. Therefore, entrepreneurs have had to evaluate the new demands of the market and the product/service offerings that their firms must have to remain competitive. There are new types of opportunities, ranging from

products, digital services, platforms and, above all, customer experience, radically changing the market offering (Kagermann, 2015).

There are different ways to integrate digital transformation into organizations to improve competitiveness. Essentially, there are five fundamental principles: integrating digital platforms to make the exchange of information transparent and streamlined; standardize technological and business processes while maintaining an efficient production management and control system; adapting the organizational structure by hiring people trained in digital skills; supporting digital transformation so that both employees and partners understand the concept and how to implement it; and evaluating the efficiency before and after the digital transformation, taking frequently used digital tools and systems as evidence. By carefully evaluating these factors, firms can choose the right way to strategically proceed to improve or maintain their processes, while maintaining quality, low cost, timelines, efficiency, effectiveness and safety (Yurii *et al.*, 2021).

Companies must constantly transform because new elements may emerge that can help enhance internal processes. However, in a globalizing world, being competitive both locally and globally is challenging, while simultaneously fulfilling consumer needs, and growing and expanding into new emerging markets (Sheth, 2011). Given the variety of changes in organizations, technologies, societies, cultures and markets, firms must search for competitive advantages that lead to the development of the abilities to both produce and distribute as well as communicate. Firms must not only offer quality products and services, but they must also advertise themselves. The easiest way to do this can be participating in networks that allow the circulation of information and the added value that the company offers.

An organization's leadership is key to being able to design and define its strategies, character and resource allocation. Nylén and Holmström (2015) note that digital technologies generate potential scenarios for service and product innovation. Therefore, organizations need to develop dynamic tools that facilitate resource usage, user experience, business skill development and greater value propositions (Henfridsson *et al.*, 2014; Yoo, 2012). Under the leadership's guidance, these tools can help connect organizational research activities and applications for new business trends.

Today, ICTs are indispensable parts of the daily life in a modern society. Importantly, the adoption of technologies has not only created opportunities but also risks. For instance, if ICT inclusion is not timely and inclusive in emerging economies, they will lag advanced digital economies (Hanna, 2020). The pervasive presence of ICT, the convergence of social media, the development of competing networks, broadband convergence and industry create a digital ecosystem where users are active players and governments not only face regulatory challenges but also play a key role in strengthening the ecosystem (Gallego and Gutierrez, 2015). Arredondo-Trapero *et al.* (2020) point out that a crucial challenge for countries is ensuring that their economies develop factors which make them more competitive, among which ICT adoption stands out. Countries are striving to meet domestic needs and improving the profitability of their own firms in the international market relative to other countries. This competitiveness allows them to increase productivity, which in turn translates into better income, a stronger economy and a better quality of life for citizens (Yamashita, 2018).

Furthermore, unlike many types of technology, ICT can be adopted in all areas of the economy, including both industry and social markets. Computer networks are essential for business and commercial activities. Furthermore, the internet is essential for the production and consumption of goods and services, and forms a fundamental part of the daily lives of many people. The adoption and development of ICTs can contribute to national

competitiveness by revolutionizing the financial environment as well as the goods and labor markets (Escuder, 2019).

Elia *et al.* (2020) observe that digital technologies have a very strong impact on the creation of new organizations. This is because these technologies combine the potential of collaboration and collective intelligence with design, and help implement stronger and more sustainable business initiatives. Notably, the authors highlight that there is limited discussion in the literature about the real impact of digital technologies and collaboration on the business process. Research should explore the nature and characteristics of the entrepreneurial ecosystem enabled by this new sociotechnical paradigm. Moreover, Skare and Soriano (2021) indicate that ICTs act by generating a competitive advantage, as they allow the integration of processes, products and services in an integral and efficient manner in an organization; this makes ICTs an essential element for firm survival and growth. Ahmadi *et al.* (2020) argue that ICT adoption in organizations is rapidly increasing, especially in small and medium-sized enterprise (SME). In particular, ICTs are being applied in different organizational domains, where new ways of identifying, storing, processing, analyzing, distributing and exchanging information within companies and with customers are being developed.

Besides reducing costs and improving efficiency, ICTs also help in providing better customer service (Travaglioni *et al.*, 2020). Jarmooka *et al.* (2020) state that ICTs and knowledge management have a positive impact on innovation. Hannigan (2018) and Ahmadi *et al.* (2020) found that the implementation of ICT has dramatically increased productivity gains owing to the new generation of business models that implement ICTs. Similarly, Cuevas-Vargas *et al.* (2020) also observe that ICT usage significantly affects firm performance and is critical for any type of business. Their research shows that ICTs allow Mexican SMEs to achieve an optimal relationship between supply chain management, innovation and performance.

Essentially, every time an industrial revolution occurs, elements that mark the evolution of the economic society emerge, and facilitate or even force the reinvention of traditional companies. Given the dramatic changes due to this evolution, a great variety of opportunities also emerge. Ultimately, companies must decide whether to adapt and change, or simply end their economic activity. For example, in the first industrial revolution, technological advances related to the application of the steam engine facilitated productivity advances and facilitated urbanization. In the second industrial revolution, electricity and chain manufacturing dramatically transformed firm productivity. In the third industrial revolution, robots were introduced in industry and the production system continuously improved. Indeed, a substantial portion of the global population lives in cities (Bal and Erkan, 2019).

Finally, the fourth industrial revolution introduced the internet and has given rise to technologies that have provided new opportunities in an interconnected world for both data, and the transport of goods and people. Today, companies have to compete both locally and internationally, thus, facilitating the birth of Industry 4.0 and Logistics 4.0 (Bernal *et al.*, 2019) in different fields, such as cities, the internet, e-commerce, cybersecurity, databases and smart grids (Garrell and Guilera, 2019). Notably, the implementation and development of these fields directly impact the way we live and interact, setting a higher standard than previous industrial revolutions for customer satisfaction and developing products that meet the needs of the times (Ghobakhloo, 2020).

Digital technologies have incorporated themselves into business models. Moreover, they have positioned themselves in the value chain such that they are collecting data as a relevant resource. Technological progress has made the collection, storage and processing of data an important strategy for improving the customer experience as firms can personalize their

products and services. Once the data are available, it can be analyzed and inform decisions. The stored data can give any type of information to the firm, including understanding their sector, measuring customer loyalty, examining current or past sales and when they increase or decrease, knowing the spending quotas of both the person and sector, locating their buyers, analyzing consumers' expectations of the product and assessing what other needs must be met (Fitzgerald *et al.*, 2013).

In summary, if companies do not evolve with the changing technologies and consumer needs, they may disappear. Therefore, firms need to safely and appropriately exploit all available information and resources via digital transformation. This can help them remain competitive in the market by increasing their business value, and the ease of relating to and understanding the customer. The latter can allow faster and more efficient response times, and increase consumers' satisfaction with the company.

3. Hypotheses development

ICT significantly improves the productivity of companies because the processes are carried out intelligently. Although human capital is still necessary, the constant training of human capital is key for positive outcomes and achieving impact (Schroeder *et al.*, 2019). Furthermore, digital technology can help in meeting commercial objectives by effectively controlling supply and demand through different tools, such as month-to-month management.

The essential objective of all these firm activities is to offer a user experience where the product/service is easy to use, aesthetically pleasing, has an impactful design, generates loyalty, offers a value proposition in markets where customers are segmented and that the different products/services are correctly positioned. Meanwhile, the company should exhibit sustainable and innovative behavior, whereby the organization offers the benefits of digital transformation and digital innovation promoting continuous learning in the field, and has a new structure and flexibility where processes are balanced, low costs and excellent customer experience.

Indeed, ICTs have transformed finance today. Marszk and Lechman (2021) note that exchange-traded funds (ETF) are highly innovative and fast-growing financial products which have benefited from the digital revolution. ETFs are changing the global economic landscape, laying solid foundations for unlimited and unrestricted flows of information and knowledge, eliminating information asymmetries and fostering the rapid diffusion of financial innovations. At the global level, the authors note that ICTs have positively influenced the spread of ETFs.

Ozili (2020) indicates that digital finance encompasses products, services and infrastructure that allow companies and individuals to access payment, savings and credit facilities through the internet (online) without the need to go to a bank branch or a financial service provider. Based on this discussion, we propose our first hypothesis as follows:

H1. ICT adoption positively affects the financial system.

Furthermore, the unprecedented global spread of ICTs has coincided with dynamic changes in financial systems, with the introduction and spread of innovative financial services, institutions and instruments (Lechman and Marszk, 2015) contributing to global financial diversity. These have influenced financial and economic development in several countries. Based on this, we propose our second hypothesis:

H2. The financial system positively affects competitiveness (GDP).

In the era of the fourth industrial revolution, ICT has replaced information technology (IT) as an essential resource for sound business performance (Koh *et al.*, 2019).

The use of ICT tools has become widespread throughout both developed or developing countries that it is now considered a necessity for all companies (Agarwal and Audretsch, 2001). Based on this discussion, we propose our third hypothesis as follows:

H3. ICT adoption positively affects business dynamism.

In recent decades, the digital revolution has dramatically changed societies and economies by offering new possibilities and paths that have significantly altered human life. For instance, studies suggest that digital transformation can be an important factor in achieving sustainability. It has spawned entirely new mechanisms to maintain and promote natural resources, national wealth and well-being (Akande *et al.*, 2019). Based on this discussion, we propose our fourth hypothesis as follows:

H4. Business dynamism positively affects competitiveness (GDP).

ICTs contribute to business innovation, and simultaneously, to the wealth of organizations. According to prevailing views in economics, unlike the accumulation of physical and human capital, technology is what counts most in explaining the differences in income and growth between countries. Moreover, ICT adoption has been linked to an increase in ICT skills and competencies (Lim *et al.*, 2021). When some firms adopt new ICTs, they increase the skills of the workers who are trained to use the new technologies (Behaghel *et al.*, 2012). Furthermore, these technologies are also used to improve the skills of their employees, such as online trainings. Based on this discussion, we propose our fifth hypothesis as follows:

H5. ICT adoption positively affects the labor market.

Vilaseca *et al.* (2006) indicate that ICTs are characterized by the application of awareness to generate new knowledge. Consequently, besides building a vital source of competitiveness for companies, ICTs have assumed a leading role in the process of transforming the economy. Ho *et al.* (2011) and Jorgenson and Vu (2016) also observe a relationship between GDP and ICT. Thus, ICT can affect the economic growth of countries. One important channel of this influence can be the labor market. Based on this, we propose our sixth hypothesis as follows:

H6. The labor market positively affects competitiveness (GDP).

ICTs also influence the flexibility of companies to adapt to market contingencies, allowing them to adapt their product/service offerings to market needs (Vilaseca *et al.*, 2006). Based on this, we propose our seventh hypothesis as follows:

H7. ICT adoption positively affects the product market.

ICTs positively affect productivity both directly and indirectly depending on the sector (Gretton *et al.*, 2004). ICT investments contribute to productivity growth at the firm level through direct capital deepening effects as well as through the overall effect on the factor contributing to productivity. Based on this, we propose our eighth hypothesis as follows:

H8. The product market positively affects competitiveness (GDP).

As noted, ICTs can influence the economy via the labor market by affecting workers skills. Based on this, we propose our ninth hypothesis as follows:

H9. ICT adoption positively affects skills.

Furthermore, skills are crucial labor productivity, and, thus, a country's economic performance and competitiveness. Based on this, we propose our tenth hypothesis as follows:

H10. Skills positively affect competitiveness (GDP).

Rasiah (2006) found a strong and significant positive effect of ICT indicators on GDP per capita for the period 1995–2000; consequently, the author calls for more investment in ICT to increase the development of countries. Furthermore, Welfens and Perret (2014) find that ICT investment has been underestimated in some official statistics; that is, the influence of ICT investment on GDP may be higher than reported. Indeed, a large and growing body of literature connects ICT adoption and some ICT proxies with GDP and economic development in some countries and regions (Njoh, 2018; Hossein and Yazdan, 2012; Dehghan and Shahnazi, 2019), including small island states (Qureshi and Najjar, 2016). Based on this, we propose our eleventh hypothesis as follows:

H11. Institutions positively affect competitiveness (GDP).

ICTs have profoundly transformed the global landscape, radically altered the structure of economies and created new types of organizational and social networks (Marszk and Lechman, 2019). Thus, we propose our twelfth hypothesis as follows:

H12. ICT adoption positively affects institutions.

Figures 1 and 2 show the structural models for Latin America and Europe, respectively.

4. Methodology

The objective of this study is to identify how the adoption of digital technologies influences the competitiveness of Latin American countries and compare these results with those of European countries. To our knowledge, this is the first study to provide information on factors that could explain competitiveness from the perspective of digital technology adoption. To validate the hypothetical structural model (presented in Figures 1 and 2), we used data from the World Economic Forum's Global Competitiveness Index (GCI) on the following GCI pillars: financial system, ICT adoption, skills, labor market, product market, macroeconomic stability, business dynamism and GDP (PPP) as a percentage of total world value.

The following Latin American countries were considered: Bolivia, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, Honduras, Haiti, Mexico, Nicaragua, Panama, Peru, Paraguay, El Salvador, Uruguay and Venezuela. Next, the following European countries were considered: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom. To evaluate the structural models, partial least squares-structural equation modeling (PLS-SEM) was applied using SmartPLS software package (Ringle *et al.*, 2015). PLS-SEM is useful when a complex research model includes multiple variables, which can be difficult to manage with first-generation techniques such as linear regression or ANOVA (Deng *et al.*, 2018; Gefen *et al.*, 2000). Studies in the field of competitiveness have also applied this technique to evaluate complex models (Mohammad and Pourghanbary, 2023; Padilla-Lozano and Collazzo, 2021).

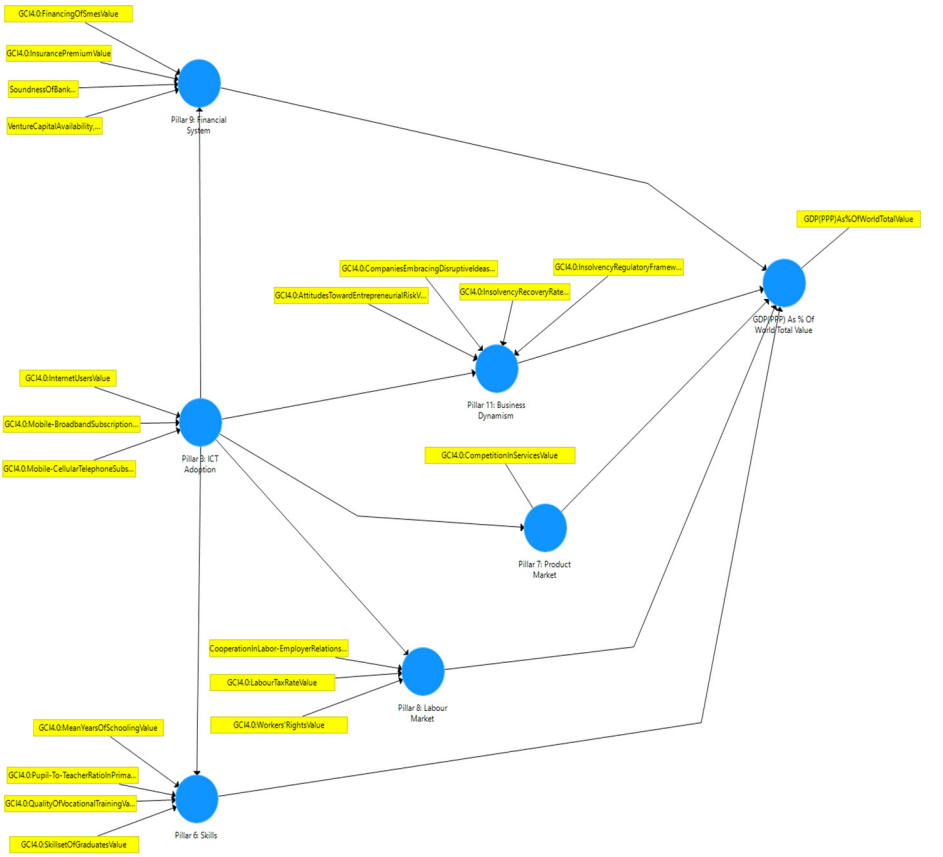


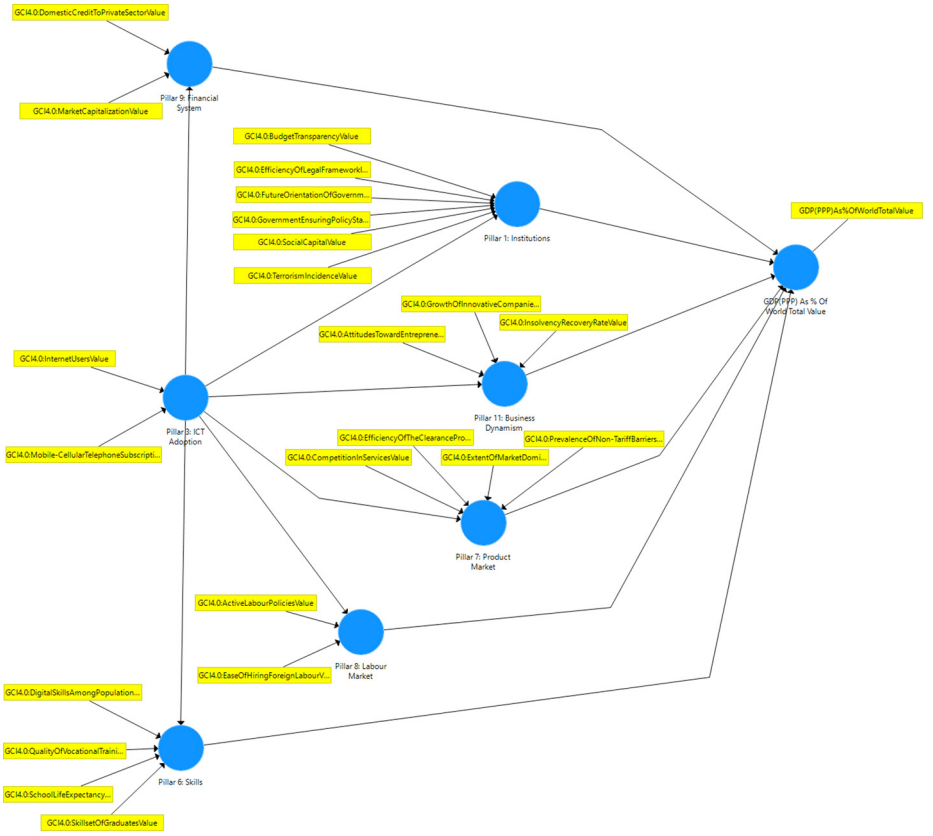
Figure 1.
Structural model for Latin America

Source: Figure by authors

Note that we developed two theoretical models: one for Latin America and the other for Europe. Each region differs from the other, and consequently, some predictors may be more important than others in explaining the variables of interest. Furthermore, most European countries are first-order economies, while most Latin American countries are emerging economies. Consequently, the degree of influence of each factor may differ. A unique model for both regions may also be misleading because some GCI pillars predict the competitiveness of each region in different ways. Thus, the conclusions obtained from the model may not be generalized.

5. Results

According to Hair *et al.* (2017), to evaluate a structural model under the PLS-SEM method, the following steps must be followed first: evaluation of the formative measurement model (see Section 5.1), evaluation of the structural model (see Section 5.2) and evaluation of the predictive relevance of the model (see Section 5.3).



Source: Figure by authors

Figure 2.
Structural model for Europe

5.1 Evaluation of the formative measurement model

The following exogenous variables and their corresponding indicators defined the formative measurement model: financial system, ICT adoption, skills, labor market, product market, macroeconomic stability and business dynamism. Redundancy analysis was applied to evaluate the convergent validity of the measurement model. In addition, collinearity analysis [variance inflation factor (VIF)] and external load analysis (Hair *et al.*, 2017) were considered to evaluate the formative measurement model. The results for the 17 Latin American and 28 European countries are shown in Tables 1 and 2, respectively. Regarding convergent validity, the results show that the formative constructs are clearly above the recommended threshold of 0.7.

5.2 Evaluation of the structural model

A bootstrapping method was applied in SmartPLS to evaluate the structural model following Hair *et al.* (2017). Table 3 (Table 4) shows the results of R^2 and R^2 (adjusted) for each endogenous latent construct (i.e. dependent variable) as well as the total and indirect effects for each of the corresponding exogenous constructs (i.e. independent variables) for Latin America (Europe).

Table 1.
Outer loadings, convergent validity, composite reliability and average variance extracted (AVE) for the formative measurement model for Latin America

Formative constructs	Construct indicators	External loads (> 0.5)	Convergent validity - redundancy analysis (> 0.7)	Collinearity (VIF < 5)	Composite reliability (> 0.7)	AVE (> 0.5)
Financial system			0.964		0.935	0.879
	GCI4.0: domestic credit to private sector value	0.827		2.35		
	GCI4.0: value of market capitalization	0.993		2.35		
ICT adoption			0.713		0.928	0.865
	GCI4.0: value of internet users	0.999		2.17		
	GCI4.0: mobile-cellular telephony subscription value	0.701		2.17		
Institutions			1.000		0.848	*0.496***
	GCI4.0: value of budget transparency	0.512		1.32		
	GCI4.0: effectiveness of the legal master in value adjustment regulation	*0.400**		9.65***		
	GCI4.0: future government value orientation	0.608				
	GCI4.0: stability government policy value	0.655		15.44***		
	GCI4.0: value of social capital	0.971				
	GCI4.0: impact value of terrorism	0.788		7.23***		
Business dynamism			0.749		0.903	0.755
	GCI4.0: attitudes toward the value of business risk	0.746		3.17		
	GCI4.0: Growth of innovative companies value	0.687		3.41		
	GCI4.0: value of the insolvency recovery rate	0.955		1.50		
Product market					0.852	0.537
	GCI4.0: competence in services value	0.657		1.82		
	GCI4.0: complexity of tariffs value	0.755		1.59		
	GCI4.0: efficiency of value dispatch process	0.756		2.66		

(*continued*)

Table 1.

Formative constructs	Construct indicators	External loads (> 0.5)	Convergent validity - redundancy analysis (> 0.7)	Collinearity (VIF < 5)	Composite reliability (> 0.7)	AVE (> 0.5)
	GCI4.0: degree of market value dominance	0.745		2.72		
	GCI4.0: prevalence of nontariff barriers value	*0.500**		1.44		
Labor market			1.000		0.988	0.977
	GCI4.0: value of active labor market policies	0.674		10.98***		
	GCI4.0: ease of foreign labor recruitment value	0.865		10.98***		
Skills			0.982		0.864	0.613
	GCI4.0: digital skills at people's value	*0.500**		2.70		
	GCI4.0: quality of professional training value	0.552		6.27		
	GCI4.0: value of school life expectancy	0.952		1.11		
	GCI4.0: graduate skill set value	0.514		6.67		

Notes: *Subthreshold external loads that were withheld to maintain model relevance; **the AVE of institutions was slightly below the threshold, but the construct was retained due to its relevance to the model; ***indicators with VIF above the thresholds that were maintained due to their importance in the model
Source: Table by authors

Table 2.
Outer loadings, convergent validity, composite reliability and average variance extracted (AVE) for the formative measurement model for Europe

Formative constructs	Construct indicators	External loads (> 0.5)	Convergent validity – redundancy analysis (>0.7)	Collinearity (VIF < 5)	Composite reliability (> 0.7)	AVE (> 0.5)
Financial system			0.999		0.939	0.795
	GCI4.0: finance from tables value	0.947		*7.043**		
	GCI4.0: insurance premium value	0.949		4.776		
	Bank soundness.1–7 (best) value	0.625		2.795		
	Availability of risk capital.1–7 (better) Index 1–7 (better)	0.581		3.809		
ICT adoption			0.986		0.886	0.724
	GCI4.0: value of internet users	0.807		2.952		
	GCI4.0: value of mobile broadband subscriptions	0.953		*6.044**		
	GCI4.0: value of mobile subscriptions	0.775		3.180		
Business dynamism			0.999		0.821	0.551
	GCI4.0: attitudes toward the value of business risk	0.983		*6.043**		
	GCI4.0: companies employ disruptive ideas value	0.500		1.369		
	GCI4.0: value of the insolvency recovery rate	0.500		2.225		
	GCI4.0: insolvency regulatory framework value	0.692		5.010		
Product market			0.999		0.999	0.999
	GCI4.0: competence in services value	0.999		1.000		
Labor market			0.923		0.741	0.510
	Cooperation in labor relations with employers.1–7 (best) score	0.916		1.129		
	GCI4.0: value of labor taxation	0.728		1.211		
	GCI4.0: value of workers' rights	0.579		1.107		

(*continued*)

Table 2.

Formative constructs	Construct indicators	External loads (> 0.5)	Convergent validity – redundancy analysis (>0.7)	Collinearity (VIF < 5)	Composite reliability (> 0.7)	AVE (> 0.5)
Skills			0.999		0.861	0.611
	GCI4.0: mean value of years of schooling	0.995		1.739		
	GCI4.0: pupil-teacher relationships in primary education	0.504		1.324		
	GCI4.0: quality of professional training value	0.500		3.368		
	GCI4.0: graduate skill set value	0.500		3.703		

Note: *Three indicators with high VIF levels were retained because of their importance in model prediction
Source: Table by authors

Dependent variable	Independent variable	R^2 (R^2 adjusted)	Total effects	Indirect effect
GDP (PPP) as a percentage of total world value		0.664 (0.511)		
	Business dynamism		1.319	
	ICT adoption		0.541	0.541
	Skills		−0.125	
	Product market		−0.020	
	Labor market		0.140	
	Financial system		−0.498	
Business dynamism		0.669 (0.647)		
	ICT adoption		0.818	
Skills		0.813 (0.801)		
	ICT adoption		0.902	
Product market		0.754 (0.738)		
	ICT adoption		−0.869	
Labor market		0.422 (0.384)		
	ICT adoption		−0.650	
Financial system		0.498 (0.464)		
	ICT adoption		0.705	

Source: Table by authors

Table 3. Results of R^2, adjusted R^2, total effects and indirect effects of the structural model for Latin America

Dependent variable	Independent variable	R^2 (R^2 adjusted)	Total effects	Indirect effect
GDP (PPP) as a percentage of total world value		0.497 (0.353)		
	Business dynamism		0.112	
	Institutions		1.082	
	ICT adoption		0.114	0.114
	Skills		−0.302	
	Product market		0.747	
	Labor market		1.161	
	Financial system		−0.270	
Business dynamism		0.356 (0.331)		
	ICT adoption		0.580	
Skills		0.722 (0.712)		
	ICT adoption		0.853	
Product market		0.516 (0.497)		
	ICT adoption		0.916	
Labor market		0.817 (0.810)		
	ICT adoption		−0.921	
Financial system		0.380 (0.356)		
	ICT adoption		0.589	

Source: Table by authors

Table 4. Results of R^2, adjusted R^2, total effects and indirect effects of the structural model for Europe

For Latin America, the model explains 66% of the variance in the GDP (competitiveness). The constructs that positively affect GDP (competitiveness) are ICT adoption (0.541), business dynamism (1.319) and labor market (0.140). Meanwhile, GDP (competitiveness) is negatively influenced by skills (−0.125), product market (−0.020) and financial system (−0.498). Next, ICT adoption in Latin America is a strong predictor of other pillars of

competitiveness, such as business dynamism (predicts 66% of the variance), skills (predicts 81% of the variance), product market (predicts 75% of the variance), labor market (predicts 42% of the variance) and financial system (predicts 49% of the variance).

For Europe, the model explains 49.7% of the variance in GDP (competitiveness). The constructs that positively affect GDP (competitiveness) are business dynamism (0.112), institutions (1.082), ICT adoption (0.114), product market (0.747) and labor market (1.161). Meanwhile, GDP (competitiveness) is negatively influenced by skills (−0.302) and financial system (−0.270). Next, ICT adoption is a strong predictor of other pillars of competitiveness, such as business dynamism (predicts 35.6% of the variance), skills (predicts 72.2% of the variance), product market (predicts 51.6% of the variance), labor market (predicts 81.7% of the variance, but with a negative path indicating a negative influence) and financial system (predicts 38% of the variance).

Tables 5 and 6 show the hypothesis testing results for Latin America and Europe, respectively.

5.3 Predictive importance of the structural model

As recommended by Hair *et al.* (2017), the Stone–Geisser Q^2 was used to assess the predictive relevance of the structural model. This measure provides information about the degree to which the model can predict new values (from another data set). To obtain the Stone–Geisser Q^2 in SmartPLS, the Blindfolding method was applied with an omission distance of 7 and using the cross-validated redundancy approach. Tables 7 and 8 show the results for Latin America and Europe, respectively. For Latin America, the results show that all endogenous variables exhibit high predictive power, except for GDP (competitiveness) which has low predictive power. Meanwhile, for Europe, two endogenous constructs show low predictive power: institutions and GDP (competitiveness). This may because the predictive power of these constructs may depend on other factors.

Hypothesis	Route	Path coefficient	Effect size (f^2)	*t*-Value	*p*-Value	Supported
H1	ICT adoption→ financial system	0.705	0.990	4.908	<0.001	Yes
H2	Financial system→ GDP (competitiveness)	−0.498	0.201	0.820	0.413	No
H3	ICT uptake→ business dynamism	0.818	2.018	12.490	<0.001	Yes
H4	Business dynamism→ GDP (competitiveness)	1.319	1.243	2.204	0.028	Yes
H5	ICT adoption → labor market	−0.650	0.731	5.198	<0.001	Yes
H6	Labor market→ GDP (competitiveness)	0.140	0.018	0.355	0.722	No
H7	ICT adoption→ product market	−0.869	3.071	20.222	<0.001	Yes
H8	Product market→ GDP (competitiveness)	−0.020	0.000	0.030	0.976	No
H9	ICT adoption→ skills	0.902	4.355	14.729	<0.001	Yes
H10	Skills→ GDP (competitiveness)	−0.125	0.007	0.220	0.826	No

Source: Table by authors

Table 5. Hypothesis testing results for Latin America

Hypothesis	Route	Path coefficient	Effect size (f^2)	*t*-Value	*p*-Value	Supported
H1	ICT adoption→ financial system	0.616	0.61	5.64	<0.001	Yes
H2	Financial system→ GDP (competitiveness)	−0.270	0.05	0.757	0.44	No
H3	ICT adoption → business dynamism	0.597	0.55	3.67	<0.001	Yes
H4	Business dynamism→ GDP (competitiveness)	0.112	0.00	0.26	0.79	No
H5	ICT uptake→ labor market	−0.904	4.47	1.10	0.27	No
H6	Labor market→ GDP (competitiveness)	1.161	0.25	1.27	0.20	No
H7	ICT adoption→ product market	0.718	1.06	6.75	<0.001	Yes
H8	Product market→ GDP (competitiveness)	0.747	0.25	1.58	0.11	No
H9	ICT adoption→ skills	0.850	2.60	8.94	<0.001	Yes
H10	Skills→ GDP (competitiveness)	−0.302	0.01	0.46	0.64	No
H11	Institutions→ GDP (competitiveness)	1.082	0.12	1.43	0.15	No
H12	ICT adoption→ institutions	0.909	4.74	5.45	<0.001	Yes

Table 6.
Hypothesis testing results for Europe

Source: Table by authors

Endogenous variables	Stone–Geisser's Q^2
GDP (competitiveness)	0.037
Business dynamism	0.196
Skills	0.326
Product market	0.722
Labor market	0.156
Financial system	0.341

Table 7.
Stone–Geisser Q^2 for the predictive relevance of the structural model for Latin America

Source: Table by authors

Endogenous variables	Stone–Geisser's Q^2
GDP (competitiveness)	0.067
Business dynamism	0.225
Skills	0.240
Product market	0.268
Labor market	−0.617
Financial system	0.303
Institutions	0.066

Table 8.
Stone–Geisser's Q^2 for the predictive relevance of the structural model for Europe

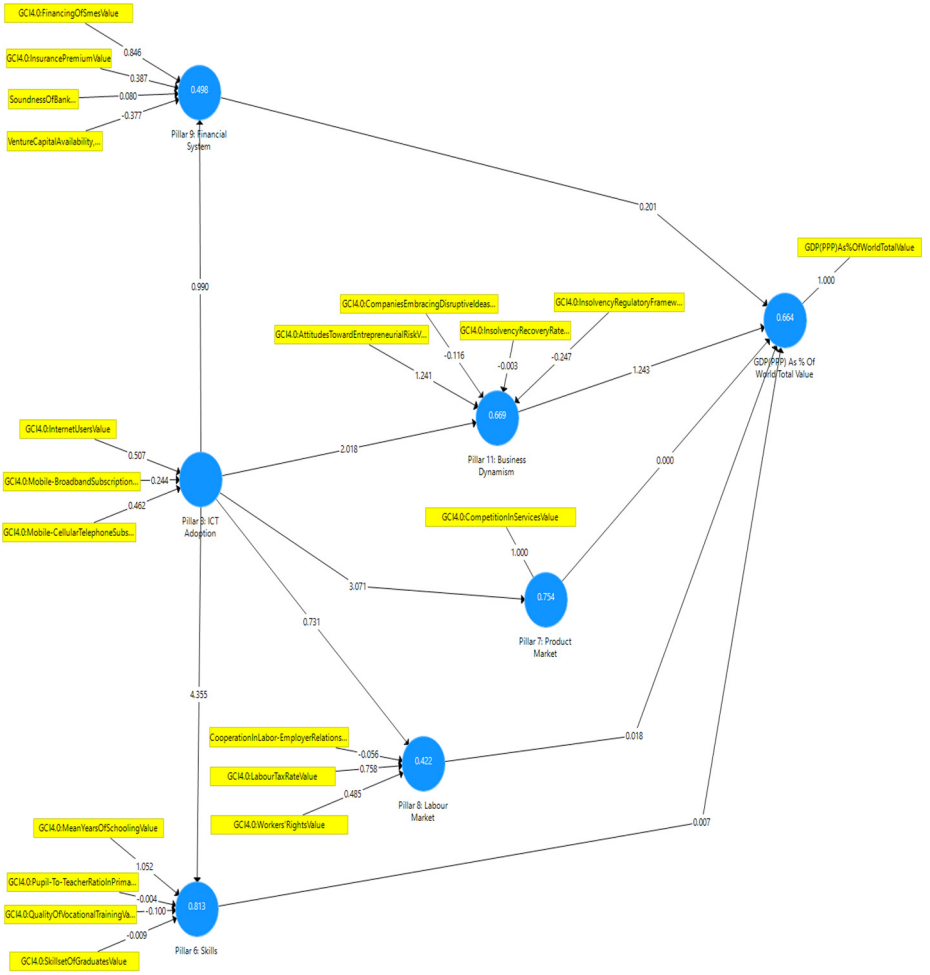
Source: Table by authors

Figures 3 and 4 show the validated structural models for Latin America and Europe, respectively.

6. Discussion

Table 9 summarizes the hypotheses or paths that were supported by the two models. Notably, some hypotheses were supported for both the Latin American and European models, while two were only supported for the Latin American model. Here, we discuss these paths with respect to the literature.

First, ICT adoption affects the financial system, in line with the literature on the importance of ICT in the financial sector. For instance, Hernández-Nieves *et al.* (2020) indicate that ICT advancements have allowed financial institutions to improve the provision of services, such as digital finance.



Source: Figure by authors

Figure 3.
Validated structural model for Latin America

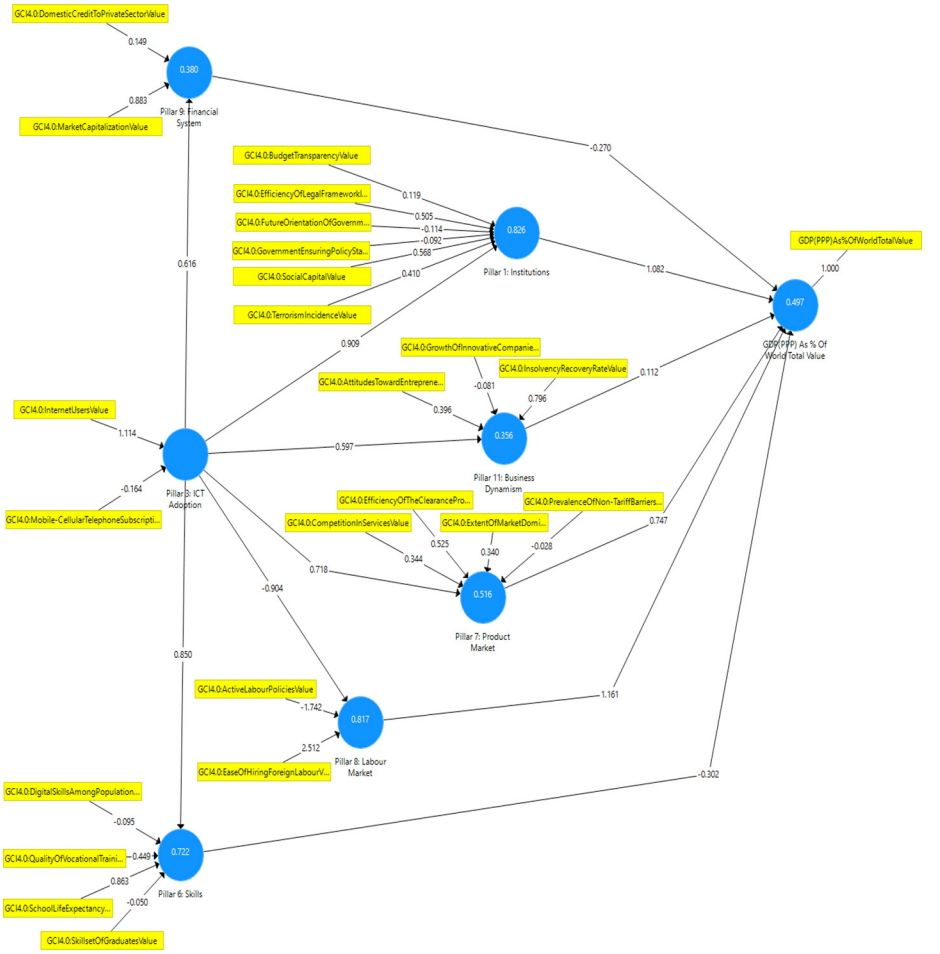


Figure 4.
Validated structural model for Europe

Source: Figure by authors

Hypothesis	Path	Model
H1	ICT adoption→ financial system	Europe and Latin America
H3	ICT adoption → business dynamism	Europe and Latin America
H4	Business dynamism→ GDP (competitiveness)	Latin America
H5	ICT adoption→ labor market	Latin America
H7	ICT adoption→ product market	Europe and Latin America
H9	ICT adoption→ skills	Europe and Latin America

Table 9.
Summary of supported hypotheses

Source: Table by authors

Second, ICT adoption positively and significantly affects business dynamism. This result is consistent with Karim *et al.* (2022), who find that both enabling and general-purpose technologies significantly influence business performance. Yunis *et al.* (2018) also find improvements in productivity and business performance in companies that have adopted ICT.

Third, business dynamism positively affects competitiveness in Latin America. This may be because the region has many informal micro-companies in a highly competitive market (Lopes *et al.*, 2021). To address this, Latin American countries should develop policies to improve business dynamism, and thereby, improve their competitiveness.

Fourth, ICT adoption positively affects the labor market in Latin America. This may be because ICT can be useful for improving the skills of workers in this region. Some researchers note that ICT adoption and the labor market may be related (Díaz-Chao *et al.*, 2009). Our result is also in line with research which indicates that companies that adopt ICTs can increase the skills of workers (Behaghel *et al.*, 2012). In general, ICT adoption has been linked to an increase in skills and competencies (Lim *et al.*, 2021). Thus, to improve the labor market, Latin America countries should pursue policies to improve ICT adoption in companies.

Fifth, ICT adoption positively influences the product market. This may be via e-commerce platforms, which can expand the product market. The COVID-19 pandemic showed that to survive, companies required a digital presence or mechanisms that take advantage of technology. Some small businesses were unable to adapt or move to a digital presence during the pandemic, and simply disappeared.

Sixth, ICT adoption positively affects skills. Research also shows that ICT adoption positively affects the marketing capabilities in small- and medium-sized enterprises (Setiowati *et al.*, 2015). Others show that innovation environments have a positive relationship with management and workforce development (Kipper *et al.*, 2021). Our result demonstrates that ICT adoption can help increase the skills which job market candidates must possess for both current and future jobs.

The debate on the effect of ICT, as one of the main dimensions in the processes of competitiveness and innovation of organizations, has increased notably in recent decades, particularly owing to the effect of the internet. According to Castro and Rajadel (2015), technology and innovation support direct and stimulate local development, favoring business productivity and competitiveness, and the social, economic and intellectual development of countries. Similarly, Arrieta (2019) observes that ICTs have become a necessary factor for economic development. Indeed, the European Union indicates that the development of ICT is vital for Europe's competitiveness in today's increasingly digitalized world economy. This process of digitalization has been accelerated by COVID-19, such as remote work. Our results support these assertions and provide empirical evidence demonstrating the importance of ICT adoption for the competitiveness of Latin American and European countries.

7. Theoretical and practical implications

Theoretically, our findings show that skills, product market and financial system negatively influence GDP. Future research should examine the causal factors and underlying mechanisms in these relationships. Next, we propose a structural model that explains competitiveness in Europe and Latin America using the GCI pillars. This model can be used to explore new avenues for research on competitiveness in other regions. Future research should also examine why certain factors do not influence competitiveness at all.

Practically, the model highlights the factors that Europe and Latin America can focus on to strengthen the competitive advantages of their firms via ICT adoption. In particular, Latin American countries should develop policies to build skills, and improve business and labor market dynamism. Finally, the models suggested here can be used by business

administration instructors to train students on the different strategies that can improve firm competitiveness. Moreover, students can be challenged to analyze how each factor positively influences a firm's competitiveness.

8. Conclusions

In this paper, we examine how ICT adoption affects the competitiveness of Latin American and European countries using a model based on GCI pillars. Digital technologies have significantly affected the creation or transformation of companies. They can help create more solid and sustainable companies which are competitive globally, and offer world-class products. Importantly, ICTs can help firms achieve these objectives efficiently and productively. Furthermore, organizations should have a hybrid approach and can achieve better results by leveraging the different perspectives within the company. These perspectives can highlight the diverse opportunities and which capabilities should be built to take advantage of these opportunities. However, these decisions are made through leaders, who must be trained for everything the world brings that enables the improvement of their business. Crucially, leaders must have the ability to transform and manage uncertainty, while motivating and empowering their work teams. Simultaneously, companies must stay competitive by updating and transforming technologies, as digitalization revolutionizes product and service systems, as well as tools and processes. Coupling these with good decision-making, digitalization can drive productivity, innovation and competitive advantage for the company. However, the education system must also train human capital with values, principles and skills in ICT. Our findings are summarized below.

First, for 17 Latin American countries, ICT adoption is a strong predictor of business dynamism (predicts 66% of the variance), skills (predicts 81% of the variance), product market (predicts 75% of the variance), labor market (predicts 42% of the variance) and financial system (predicts 49% of the variance). Thus, ICT adoption positively affects a Latin American country's competitiveness. Furthermore, our model explains 66% of the variance in GDP (competitiveness), with ICT adoption, business dynamism and labor market positively affecting GDP. This suggests that Latin American countries should create policies to build skills to increase ICT adoption, and improve business and labor market dynamism. Meanwhile, skills, product market and financial system negatively influence GDP. Future research should examine why and how these pillars negatively influence GDP.

Second, for 28 European countries as well, ICT adoption is a strong predictor of business dynamism (predicts 35.6% of the variance), skills (predicts 72.2% of the variance), product market (predicts 51.6% of the variance), labor market (predicts 81.7% of the variance but with a negative path, indicating a negative influence) and financial system (predicts 38% of the variance). This demonstrates the importance of digital technologies for fostering the competitiveness of European countries, in line with Zoroja (2015) and Zoroja and Pejić (2016). Furthermore, our model explains 49.7% of the variance in GDP (competitiveness), with business dynamism, institutions, ICT adoption, product market and labor market positively affecting GDP, and skills and financial system negatively affecting GDP. Future research can explore why skills and the financial system negatively influence the GDP of European countries.

References

Agarwal, R. and Audretsch, D.B. (2001), "Does entry size matter? The impact of the life cycle and technology on firm survival", *Journal of Industrial Economics*, Vol. 49 No. 1, pp. 21-43.

Aghimien, D., Aigbavboa, C., Oke, A., Edwards, D., Thwala, W.D. and Roberts, C.J. (2021), "Dynamic capabilities for digitalisation in the AECO sector-a scientometric review", *Engineering, Construction and Architectural Management*, doi: 10.1108/ECAM-12-2020-1012.

Ahmadi, M., Osman, M. and Aghdam, M. (2020), "Integrated exploratory factor analysis and data envelopment analysis to evaluate balanced ambidexterity fostering innovation in manufacturing SMEs", *Asia Pacific Management Review*, Vol. 25 No. 3, pp. 142-155.

Akande, A., Cabral, P., Gomes, P. and Casteleyn, S. (2019), "The Lisbon classification for sustainable smart cities in Europe", *Sustainable Cities and Society*, Vol. 44, pp. 475-487.

Arredondo-Trapero, F.G., Vázquez-Parra, J.C. and Guerra-Leal, E.M. (2020), "Information and communication technologies and their impact on competitiveness in Latin America", *Journal of Technology Management and Innovation*, Vol. 15 No. 4, pp. 43-53.

Arrieta, F.J. (2019), "Digital cooperatives as channels for digital work in a collaborative economy context", *International Cooperative Law Association Newsletter*, No. 54, pp. 75-96, doi: 10.18543/baidc-54-2019pp75-96.

Bal, H.Ç. and Erkan, Ç. (2019), "Industry 4.0 and competitiveness", *Procedia Computer Science*, Vol. 158, pp. 625-631, doi: 10.1016/j.procs.2019.09.096.

Behaghel, L., Caroli, E. and Walkowiak, E. (2012), "Information and communication technologies and skills upgrading: the role of internal vs external labour markets", *Oxford Economic Papers*, Vol. 64 No. 3, pp. 490-517, doi: 10.1093/oep/gpr045.

Bernal, J., Bacca, J. and Daza, J. (2019), "Una aplicación móvil de realidad aumentada para la enseñanza de la gestión de almacenes en logística", in Serna, E. (Ed.), *Investigación Formativa en Ingeniería (Cuarta Edi). Editorial Instituto Antioqueño de Investigación*, pp. 85-95, doi: 10.5281/zenodo.3387691.

Blichfeldt, H. and Faullant, R. (2021), "Performance effects of digital technology adoption and product and service innovation – a process-industry perspective", *Technovation*, Vol. 105, p. 102275, doi: 10.1016/j.technovation.2021.102275.

Castro, N. and Rajadel, O. (2015), "Local development, governance and innovation systems", *Revista Universidad y Sociedad*, Vol. 7 No. 1, pp. 63-72.

Cijan, A., Jenič, L., Lamovšek, A. and Stemberger, J. (2019), "How digitalization changes the workplace", *Dynamic Relationships Management Journal*, Vol. 8 No. 1, pp. 3-12, doi: 10.17708/DRMJ.2019.v08n01a01.

Cuevas-Vargas, H., Parga-Montoya, N. and Estrada, S. (2020), "The impact of marketing innovation on firm performance: an application based on structural equation modeling", *Estudios Gerenciales*, Vol. 36 No. 154, pp. 66-79.

Dehghan, Z. and Shahnazi, R. (2019), "Energy consumption, carbon dioxide emissions, information and communications technology, and gross domestic product in Iranian economic sectors: a panel causality analysis", *Energy*, Vol. 169, pp. 1064-1078, doi: 10.1016/j.energy.2018.11.062.

Deng, L., Yang, M. and Marcoulides, K. (2018), "Structural equation modeling with many variables: a systematic review of issues and developments", *Frontiers in Psychology*, Vol. 9, doi: 10.3389/fpsyg.2018.00580.

Díaz-Chao, A., Montes, J. and Torrent-Sellens, J. (2009), "Modeling the relationship between industrial employment and the information and communication technologies", *Proceedings of the 23rd European Conference on Modelling and Simulation*, 500-504, doi: 10.7148/2009-0500-0504.

Elia, G., Margherita, A. and Passiante, G. (2020), "Digital entrepreneurship ecosystem: how digital technologies and collective intelligence are reshaping the entrepreneurial process", *Technological Forecasting and Social Change*, Vol. 150, p. 119791, doi: www.doi.org/10.1016/j.techfore.2019.119791.

Escuder, S. (2019), "Regionalising the digital divide. ICT infrastructure development in Latin America and Uruguay", *PAAKAT. Journal of Technology and Society*, Vol. 9 No. 17, pp. 0-0.

Ferrari, A. (2012), "Digital competence in practice: an analysis of frameworks", *Seville: JRC IPTS*, Vol. 10, p. 82116, available at: www.ftp.jrc.es/EURdoc/JRC68116.pdf

Fitzgerald, M., Kruschwitz, N., Bonnet, D. and Welch, M. (2013), "Embracing digital technology: a new strategic imperative (MIT Sloan management review)", MIT Sloan Management Review, available at: www.sloanreview.mit.edu/projects/embracing-digital-technology/

Gallego, J. and Gutierrez, L. (2015), "ICTs in Latin American and the Caribbean firms: stylized facts, programs and policies", pp. 1-43, available at: www.publications.iadb.org/en/icts-latin-american-and-caribbean-firms-stylized-facts-programs-and-policies-knowledge-sharing

Garrell, A. and Guilera, L. (2019), "La industria 4.0 en la sociedad digital", Marge Books, available at: www.margebooks.com/libro/la-industria-4-0-en-la-sociedad-digital/

Gefen, D., Straub, D. and Boudreau, M.-C. (2000), "Structural equation modeling and regression: guidelines for research practice", *Communications of the Association for Information Systems*, Vol. 4 No. 1, doi: 10.17705/1CAIS.00407.

Gerasimenko, V.V. and Razumova, T.O. (2020), "Digital competencies in management: a path to superior competitiveness and resilience to change", *Serbian Journal of Management*, Vol. 15 No. 1, pp. 115-126, available at: www.scindeks-clanci.ceon.rs/data/pdf/1452-4864/2020/1452-48642001115G.pdf

Ghobakhloo, M. (2020), "Industry 4.0, digitization and opportunities for sustainability", *Journal of Cleaner Production*, Vol. 252, p. 119869, doi: 10.1016/j.jclepro.2019.119869.

Goumagias, N., Fernandes, K.J., Nucciarelli, A. and Li, F. (2022), "How to overcome path dependency through resource reconfiguration", *Journal of Business Research*, Vol. 145, pp. 78-91, doi: www.doi.org/10.1016/j.jbusres.2022.02.040.

Gretton, P., Gali, J. and Parham, D. (2004), "The effects of ICT and complementary innovations on Australian productivity growth", *The Economic Impact of ICT: Measurement, Evidence and Implications*, pp. 105-130.

Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M. and Thiele, K.O. (2017), "Mirror, mirror on the wall: a comparative evaluation of composite-based structural equation modeling methods", *Journal of the Academy of Marketing Science*, Vol. 45 No. 5, pp. 616-632, doi: 10.1007/s11747-017-0517-x.

Hanna, N. (2020), "Assessing the digital economy: aims, frameworks, pilots, results, and lessons", *Journal of Innovation and Entrepreneurship*, Vol. 9 No. 1, pp. 1-16, doi: 10.1186/s13731-020-00129-1.

Hannigan, B. (2018), *The Law of Corporations*, Oxford University Press, United States.

Henfridsson, O., Mathiassen, L. and Svahn, F. (2014), "Managing technological change in the digital age: the role of architectural frameworks", *Journal of Information Technology*, Vol. 29 No. 1, pp. 27-43, doi: 10.1057/jit.2013.30.

Hernández-Nieves, E., Hernández, G., Gil-González, A.B., Rodríguez-González, S. and Corchado, J.M. (2020), "Fog computing architecture for personalized banking product recommendation", *Expert Systems with Applications*, Vol. 140, p. 112900.

Ho, S.C., Kauffman, R.J. and Liang, T.P. (2011), "Internet-based selling technology and e-commerce growth: a hybrid growth theory approach with cross-model inference", *Information Technology and Management*, Vol. 12 No. 4, pp. 409-429.

Hossein, S. and Yazdan, G. (2012), "Forecasting the impact of information and communication technologies on Iran's gross domestic product", *Journal of Economics and Sustainable Development*, Vol. 3 No. 8, pp. 140-155.

Jarmooka, Q., Fulford, R., Morris, R. and Barratt-Pugh, L. (2020), "The mapping of information and communication technologies, and knowledge management processes, with company innovation", *Journal of Knowledge Management*, Vol. 25 No. 2, pp. 313-335, doi: 10.1108/JKM-01-2020-0061.

Jorgenson, D.W. and Vu, K.M. (2016), "The ICT revolution, global economic growth and policy issues", *Telecommunications Policy*, Vol. 40 No. 5, pp. 383-397.

Kagermann, H. (2015), "Change through digitization—value creation in the age of industry 4.0", in Albach, En H., Meffert, H., Pinkwart, A. and Reichwald, R. (Eds), *Management of Permanent Change*, pp. 23-45. Springer Fachmedien, doi: 10.1007/978-3-658-05014-6_2.

Karim, M.S., Nahar, S. and Demirbag, M. (2022), "Resource-based perspective on ICT use and firm performance: a meta-analysis investigating the moderating role of cross-country ICT development status", *Technological Forecasting and Social Change*, Vol. 179, p. 121626.

Kipper, L., Iepsen, S., Dal Forno, A., Frozza, R., Furstenau, L., Agnes, J. and Cossul, D. (2021), "Scientific mapping to identify the competencies required by industry 4.0", *Technology in Society*, Vol. 64, p. 101454, doi: 10.1016/j.techsoc.2020.101454.

Koh, L., Orzes, G. and Jia, F.J. (2019), "The fourth industrial revolution (industry 4.0): disrupting technologies in operations and supply chain management", *International Journal of Operations and Production Management*, Vol. 39 Nos 6/7/8.

Lechman, E. and Marszk, A. (2015), "ICT technologies and financial innovations: the case of exchange-traded funds in Brazil, Japan, Mexico, South Korea and the United States", *Technological Forecasting and Social Change*, Vol. 99, pp. 355-376.

Lim, W., Lau, B., Chua, C. and Islam, F. (2021), "Do information and communication technologies influence skills, competencies, health and well-being of teenagers? Current evidence", *EAI Endorsed Transactions on Pervasive Health and Technology*, Vol. 7 No. 27, pp. 1-15, doi: 10.4108/eai.6-4-2021.169174.

Lopes, J., Oliveira, M., Silveira, P., Farinha, L. and Oliveira, J. (2021), "Business dynamism and innovation capacity, an entrepreneurship worldwide perspective", *Journal of Open Innovation: Technology, Market, and Complexity*, Art. 1, Vol. 7 No. 1, doi: 10.3390/joitmc7010094.

Marszk, A. and Lechman, E. (2019), "New technologies and the diffusion of innovative financial products: evidence on exchange-traded funds in selected emerging and developed economies", *Journal of Macroeconomics*, Vol. 62, p. 103064.

Marszk, A. and Lechman, E. (2021), "Reshaping financial systems: the role of ICT in the diffusion of financial innovations-recent evidence from European countries", *Technological Forecasting and Social Change*, Vol. 167, p. 120683.

Mohammad, M. and Pourghanbary, F. (2023), "Developing a scale for export competitiveness: a mixed method approach in the minerals industry in Iran", *Competitiveness Review*, doi: 10.1108/CR-08-2022-0111.

Njoh, A.J. (2018), "The relationship between modern information and communication technologies (ICTs) and development in Africa", *Utilities Policy*, Vol. 50, pp. 83-90, doi: 10.1016/j.jup.2017.10.005.

Nylén, D. and Holmström, J. (2015), "Digital innovation strategy: a framework for diagnosing and improving digital product and service innovation", *Business Horizons*, Vol. 58 No. 1, pp. 57-67, doi: 10.1016/j.bushor.2014.09.001.

Ozili, P.K. (2020), "Covid-19 pandemic and economic crisis: the Nigerian experience and its structural causes", *Journal of Economic and Administrative Sciences*.

Padilla-Lozano, C.P. and Collazzo, P. (2021), "Corporate social responsibility, green innovation and competitiveness – causality in manufacturing", *Competitiveness Review: An International Business Journal*, Vol. 32 No. 7, pp. 21-39, doi: 10.1108/CR-12-2020-0160.

Qureshi, S. and Najjar, L. (2016), "Emerging technology use in very small island states: a tenuous relationship between average information and communication technology (ICT) use and gross domestic product (GDP) per capita growth", *2016 49th HI International Conference on System Sciences (HICSS)*, 4655-4664, doi: 10.1109/HICSS.2016.578.

Ramírez-Alujas, Á.V. (2011), "Open government and modernisation of public management. Tendencias actuales y el (inevitable) Camino que Viene-Reflexiones seminales: Tendencias actuales y el (inevitable) camino que Viene-Reflexiones seminales)", *Journal Enfoques: political Science and Public Administration*, Vol. 9 No. 15, pp. 99-125.

Rasiah, R. (2006), "Information and communication technology and GDP per capita", *International Journal of Internet and Enterprise Management*, Vol. 4 No. 3, pp. 202-214, doi: 10.1504/IJIEM.2006.010914.

Ringle, C.M., Wende, S. and Becker, J.M. (2015), "SmartPLS 3. SmartPLS GmbH, boenningstedt", *Journal of Service Science and Management*, Vol. 10 No. 3, pp. 32-49.

Schroeder, A., Ziaee Bigdeli, A., Galera Zarcos, C. and Baines, T. (2019), "Capturing the benefits of industry 4.0: an enterprise network perspective", *Production, Plannning and Control*, pp. 1-17, doi: 10.1080/09537287.2019.1612111.

Setiowati, R., Hartoyo, Daryanto, H. and Arifin, B. (2015), "The effects of ICT adoption on marketing capabilities and business performance of Indonesian SMEs in the fashion industry", *The Business and Management Review*, Vol. 6 No. 4, pp. 297-311.

Sheth, J. (2011), "Impact of emerging markets on marketing: rethinking existing perspectives and practices", *Journal of Marketing*, Vol. 75 No. 4, pp. 166-182, doi: 10.1509/jmkg.75.4.166.

Skare, M. and Soriano, D.R. (2021), "How globalization is changing digital technology adoption: an international perspective", *Journal of Innovation and Knowledge*, Vol. 6 No. 4, pp. 222-233.

Sukno, R. and Pascual del Riquelme, I. (2019), "C2C e-commerce in Chile: incorporating reputation and trust in the TAM", *Journal of Technology Management and Innovation*, Vol. 14 No. 3, pp. 72-81.

Teigens, V., Skalfist, P. and Mikelsten, D. (2020), *Inteligencia Artificial: La Cuarta Revolución Industrial*, Cambridge Stanford Books.

Travaglioni, M., Ferazzoli, A., Petrillo, A., Cioffi, R., De Felice, F. and Piscitelli, G. (2020), "Digital manufacturing challenges through open innovation perspective", *Procedia Manufacturing*, Vol. 42, pp. 165-172.

Vallejo, G. (2018), "Re-evolución en el servicio: La transformación del servicio al cliente en el siglo XXI", Penguin Random House Grupo Editorial Colombia, available at: www.books.google.com.co/books?id=xFhUDwAAQBAJ

Vilaseca, J., Torrent, J., Lladós, J. and Garay, L. (2006), "The impact of ICT on the tourism enterprise: the case of Catalonia", Online working paper, UOC.

WEF (2016a), "The future of jobs, report by the world economic forum, davos. January 2016", available at: www.weforum.org/reports/the-future-of-jobs/

Welfens, P. and Perret, J. (2014), "Information and communication technology and real GDP: economic analysis and findings for selected countries", *International Economics and Economic Policy*, Vol. 11 Nos 1/2, pp. 5-27, doi: 10.1007/s10368-013-0261-8.

Yamashita, H. (2018), *Competitiveness and Entrepreneurial Culture*, Routledge.

Yoo, Y. (2012), "The tables have turned: How can the field of information systems contribute to research on technology and innovation management?", *Journal of the Association for Information Systems*, Vol. 14 No. 5, p. 4, doi: 10.17705/1jais.00334.

Yunis, M., Tarhini, A. and Kassar, A. (2018), "The role of ICT and innovation in improving organizational performance: the catalytic effect of corporate entrepreneurship", *Journal of Business Research*, Vol. 88, pp. 344-356.

Yurii, D., Nataliia, T., Olena, S., Yelyzaveta, S. and Ganna, B. (2021), "Standardization of business processes in the transportation sector", *Open Journal of Business and Management*, Art. 5, Vol. 9 No. 5, doi: 10.4236/ojbm.2021.95125.

Zoroja, J. (2015), "ICT as a supporting factor for innovation activities", *ENTRENOVA – ENTerprise REsearch InNOVAtion*, Vol. 1 No. 1, pp. 1-8.

Zoroja, J. and Pejić, M. (2016), "Editorial: impact of information and communication technology to the competitiveness of European Countries – Cluster analysis approach", *Journal of Theoretical and Applied Electronic Commerce Research*, Art. 5, Vol. 11 No. 1, doi: 10.4067/S0718-18762016000100001.

Further reading

Psychoyios, D. and Dotsis, G. (2018), "The competitiveness of the European food industry".

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