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Examining the Drivers of E-Commerce Adoption by Moroccan Firms: A Multi-Model Analysis

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Abstract: In the context of an increasingly digitized global marketplace, this study seeks to shed light on its adoption in developing countries, focusing on Morocco. Applying logit, probit, and conditional mixed-process probit models to a sample of 807 Moroccan firms, we identify key factors that influence e-commerce adoption. The results show that younger, innovation-driven firms and those with a highly educated workforce tend to adopt e-commerce more readily. However, digital skills required in hiring do not significantly affect adoption, suggesting a complex relationship between digital skills and e-commerce use. The results also show that firms that are active on digital platforms and engage in innovative practices are more likely to adopt e-commerce. Therefore, this study argues for the need to improve digital skills training and for firms to establish a presence on digital platforms and promote innovation. On the policy front, the study suggests the promotion of supportive policies such as financial assistance, improved Internet infrastructure, and robust regulatory frameworks. As an important starting point for future research, these findings underscore the complexities of e-commerce adoption in Morocco and can guide further research, particularly in the context of similar emerging economies.

Keywords: technology adoption; e-commerce; facilitating conditions; qualitative; Moroccan firms; logit; probit; conditional mixed process-probit model

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1. Introduction

This paper examines the adoption of e-commerce by Moroccan firms, a topic that has received little attention in the existing literature despite the high potential of e-commerce. The adoption of e-commerce by Moroccan firms remains remarkably slow, and academic research focusing specifically on the Middle East and North Africa (MENA) region, and Morocco in particular, is surprisingly sparse. The main reason for this paucity of research is the lack of surveys that specifically ask about the determinants of the adoption of e-commerce activities. This study attempts to fill this knowledge gap by using data from the recent Enterprises' Digitization Survey (ENT/SED) conducted by the Economic Research Forum (ERF). The survey provides an in-depth and comprehensive source of information on e-commerce adoption, thereby enhancing our understanding of this phenomenon in Morocco.

The diffusion of digital technologies since the early 1990s has revolutionized societies around the world. Recognized as General Purpose Technologies (GPTs), these digital technologies are defined as "*a single generic technology, recognizable as such over its lifetime, that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spillover effects*" [1] (p. 98). Designed for multipurpose use rather than singular applications, GPTs have the potential to provide solutions to numerous economic,

social, and environmental challenges [2], with a significant impact on economies and societies worldwide if properly applied and managed. The economic and societal implications of this digital revolution underpinned by GPTs are the subject of intense debate among policymakers, economists, and business leaders. In this context, digital transformation is understood as a process that enables significant improvements through the synergistic application of information, computing, communication, and network technologies [3].

Since the 1990s, we have witnessed successive waves of complementary digital technologies, each with greater transformative potential than its predecessor. These include Artificial Intelligence (AI), the Internet of Things (IoT), robotics, 3D printing, and virtual and augmented reality. Their profound impact is being felt across all sectors of the economy. They have revolutionized manual tasks, automated services, and employment in the manufacturing sector, increasing productivity and market competitiveness. However, these benefits require a highly skilled workforce and significant changes in business models.

In theory, digital transformation could enable developing countries to leapfrog technologically and developmentally. However, the digital dividend is conditional. Given their different economic landscapes and varying access to technology, developing countries may experience a different trajectory of the fourth industrial revolution than developed countries. These differences are attributed to industry maturity, technology adoption, skills availability, human resources, and political governance. Nevertheless, the prevailing view strongly supports the notion that digital transformation will yield significant overall benefits. According to the International Telecommunication Union (ITU) [4], projected outcomes suggest that a modest increase of just 10 percent in mobile broadband access can lead to an average growth in Gross Domestic Product (GDP) by 1.5 percent. When this scenario is applied to Africa, the growth could be even more substantial, potentially reaching up to 2.5 percent.

Despite the widespread penetration of digitalization in societies, its productive and economic applications remain limited in Africa, which may explain the lack of substantial economic value creation and growth. Studying the diffusion of e-commerce among firms and its determinants can provide valuable insights into the impact of digitalization on economic performance.

Digital technologies have paved the way for online buying and selling, commonly known as e-commerce or electronic commerce. Vladimir [5], in one of the earliest studies of e-commerce, defined it as "*the sharing of business information, maintaining business relationships, and conducting business transactions through telecommunication networks*". However, this broad definition has since evolved and e-commerce is now understood as the use of the Internet to buy and sell products and services [6,7]. Goyal et al. [8] suggest that e-commerce is catalyzing a new era in marketing by converging with traditional commerce and providing opportunities to identify and understand customers and their needs in an expanded context. Encompassing both domestic and international markets, e-commerce is revolutionizing business and marketing practices across sectors.

E-commerce has the potential to be a significant driver of economic growth in developing countries by supporting international value chains, enhancing market access, improving market efficiency, and reducing operating costs [9–11]. Developing countries can benefit from adopting e-commerce by leveraging competitive advantages that do not exist in the "traditional economy", which is characterized by inefficient marketing and export channels dominated by multiple offline intermediaries. In particular, e-commerce can spur growth in developing countries by improving the transparency and efficiency of market operations and public institutions, ultimately fostering a more robust and sustainable economic landscape.

However, the adoption of e-commerce in African countries lags significantly behind other developing economies such as China and India. This lag is characterized by comparatively slower growth, higher transaction costs, and limited market demand. The case of Morocco illustrates this trend: despite progress in digital transformation, e-commerce is relatively underdeveloped in the country. As evidence, Morocco ranks 95th out of

152 countries in the United Nations Conference on Trade and Development (UNCTAD) Business-to-Consumer (B2C) E-commerce Index. Moreover, the proportion of Internet users who engage in online shopping activities remains low at 22%, and this figure drops to 14.2% when considering the total population [12]. The Moroccan National Telecommunications Regulatory Authority [13] further underscores this slow adoption, noting that online purchases by Moroccan businesses represent only 8.4% of total purchases. More strikingly, 95% of these digital transactions represent only 4% of total business purchases. Several potential barriers contribute to this underperformance. Among the most prominent are limited confidence in the legal guarantees of e-commerce transactions and low adoption of online payment solutions. Both factors discourage consumers and businesses from fully embracing e-commerce, thereby limiting its potential contribution to economic growth and development.

By addressing these challenges, Morocco can harness the transformative potential of e-commerce and digital technologies to drive economic growth, improve market efficiency, and enhance global competitiveness. Through this research, we contribute to the scarce literature on e-commerce adoption in Morocco and provide valuable insights for businesses, policymakers, and other stakeholders to promote e-commerce integration and reap its benefits.

The remainder of this paper is structured as follows: Section 1 examines digitalization trends in Morocco; Section 2 reviews relevant literature; Section 3 discusses digitalization and e-commerce in Morocco; Section 4 outlines the methodology and estimation strategy; Section 5 presents results and discusses the findings; and Section 6 concludes with policy implications.

2. Literature Review

Over the past two decades, e-commerce research has expanded considerably. For the most part, e-commerce studies are based on the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), or the Unified Theory of Acceptance and Use of Technology (UTAUT) [14–17]. However, UTAUT is used less frequently than other theories due to its more recent introduction in 2003 and the development of UTAUT2 in 2012.

Despite the extensive literature on e-commerce adoption, it was primarily focused on developed countries [18–20] and large firms. E-commerce had the potential to increase efficiency and productivity in various sectors, but skepticism existed about its applicability to developing countries. Using data from 107 countries, [21] applied Partial Least Squares (PLS) structural equation modeling and showed that mobile infrastructure and affordable mobile devices did not positively affect e-commerce use.

Goyal et al. [8] argued that the slow adoption of e-commerce in developing countries was due to inadequate infrastructure, poor socioeconomic conditions, and the lack of a national strategy, which prevented these countries from reaping the benefits of e-commerce. Goyal et al. [8] asserted that understanding the adoption and diffusion of e-commerce in developing countries required consideration of cultural factors.

In developing countries, e-commerce was seen as an innovation. Jahanshahi et al. [22] identified security and privacy concerns, limited knowledge and understanding of e-commerce, and high maintenance costs as the main barriers to e-commerce adoption by small and medium-sized enterprises (SMEs) in Iran, Malaysia, and India. Mohammed and Tejay [23] examined the impact of national culture on the relationship between privacy and e-commerce adoption in Trinidad and Tobago. They argued that individual privacy concerns and societal acceptance of e-commerce were influenced by cultural values, regardless of technological and economic infrastructure. Their study also highlighted the importance of Internet security awareness, e-commerce acceptance, privacy, and personal interests in determining the intention to use online transactions.

Technology was the primary driver of e-commerce use and product accessibility [24]. Inadequate technological infrastructure in developing countries hindered technology dif-

fusion [25]. Jovanovic [26] attributed the lack of technological innovation in developing countries to high licensing costs.

The shift to online shopping depended on technology awareness. Dahbi and Benmoussa [27] concluded that technological barriers hindered e-commerce in less developed countries. The study by [10] supported this view, claiming that infrastructure was a major barrier to e-commerce adoption in developing countries and that access to technology was the most important infrastructural barrier.

E-commerce offers numerous benefits to both consumers and businesses. For consumers, it expands product choices, enabled shopping anytime, anywhere, and allows for product customization [28]. Organizations benefit through increased sales, operational efficiency, employee productivity, reduced costs, improved customer/supplier relationships, enhanced competitive advantage, and increased financial returns [28,29].

Goyal et al. [8] showed that e-commerce adoption in underdeveloped countries faced infrastructural challenges, including access to technology, connectivity, Internet access, secure online transactions, the presence of medium and large firms, a robust legal system, and adequate telecommunications infrastructure. In developed countries, the adoption of e-commerce was influenced by the quality and affordability of Internet connectivity, telecommunication services, and reliable electricity supply [30].

Some studies identified employment type as a variable affecting e-commerce adoption. Young et al. [31] found that online shoppers were wealthier than those who shopped in physical stores. The ability of e-commerce to increase welfare depended on various factors, including trust and payment methods, which were crucial for e-commerce adoption in African countries [32].

However, the transition to e-commerce was not without its challenges. In the Middle East and North Africa region, with a particular focus on Morocco, research highlighted the need to overcome these hurdles to fully exploit the economic potential of e-commerce. Kamel's [33] study in the context of Egypt identified potential barriers such as inadequate technological infrastructure, insufficient human capital, and an unsupportive legal and regulatory environment. Given similar development challenges across the region, these barriers were likely to be replicated in the Moroccan context. Similarly, Abdelkhalek et al. [34], focusing on Morocco, raised concerns about potential job losses and stunted growth due to digitization. They emphasized the need to formulate and implement proactive strategies to minimize these risks and overcome these obstacles. If left unaddressed, these challenges could significantly hinder the adoption and effectiveness of e-commerce. Extending the debate, Cusolito et al. [35] argued that the difference lay not in the mere use of digital tools, but in the broader adoption of a comprehensive digital economy. From their perspective, a limited understanding and underutilization of digital tools could create significant barriers to successful e-commerce adoption. To foster a thriving digital economy, they advocated strengthening digital infrastructure, establishing efficient digital payment systems, and formulating supportive regulatory frameworks.

Hajli et al. [36] identified barriers to e-commerce in Iran, such as a lack of awareness of its benefits and organizational issues related to its implementation. Hassen [37] conducted a qualitative study on factors influencing the adoption of e-commerce by SMEs in Algeria and found that electronic payment methods, banking readiness, legal protection, awareness of e-commerce benefits, and risk concerns were the main barriers.

Research on e-commerce adoption in the MENA region, and Morocco in particular, is not as extensive as in some other regions, but there were several important works to be acknowledged. Faccia et al. [38] emphasized the critical role of innovation and e-commerce models, highlighting the role of government support, investment, and opportunities in driving e-commerce growth and technology adoption in the United Arab Emirates. Similarly, Sebei [39] examined the scenario in Tunisia and found that despite widespread Internet use among students, the adoption of e-commerce still needed further encouragement.

In the Moroccan context, several studies provided valuable insights. Bighrissen [40] focused on understanding the main barriers to the adoption of e-commerce solutions by

cooperatives in the Agadir region. Their work, based on a conceptual model informed by previous research, used structural equation modeling on a sample of 102 cooperatives and found that technical, economic, and external factors were significant barriers. Another study by [41] discussed the barriers to e-commerce adoption within Moroccan agricultural cooperatives, identifying the main barriers as lack of information and low digital literacy. Despite these barriers, the cooperatives recognized the positive impact of e-commerce on their brand image and competitiveness, although they saw a lesser impact on the speed of operations. In addition, Dahbi and Benmoussa [27] conducted an exploratory study on the adoption of e-commerce among SMEs in Morocco, identifying the technological, financial, cultural, and organizational factors that influence e-commerce readiness. This study highlighted financial and technological factors as the most critical, followed by cultural and organizational factors. Together, these studies shed light on the complex landscape of e-commerce adoption in Morocco and highlighted the need to address technological and financial challenges in order to increase e-commerce adoption in the country.

3. Digitalization in Morocco: Key Developments and Trends

Morocco's digital landscape has undergone a major transformation since the privatization of its telecommunications infrastructure in the early 1990s and regulatory reforms in the mobile sector, resulting in a significant increase in Internet users. By early 2023, the number of Internet users in Morocco had risen to 33.18 million, representing an Internet penetration rate of 88.1%, up from 84% the previous year. In addition, there were 21.30 million active social media users, representing 56.6% of the total population, and 50.19 million active mobile connections, representing 133.3% of the population. Despite these impressive statistics, there remains a disparity in the quality of network access between rural and urban areas. The number of Internet users in Morocco increased by 341 thousand (+1.0%) between 2022 and 2023, leaving 4.47 million people, or 11.9% of the population, offline at the beginning of the year [42].

The government's focus on developing technology parks and industrial zones has attracted significant foreign direct investment (FDI) into the country, enabling the growth of advanced manufacturing industries. This has resulted in the IT sector showing strong growth potential, characterized by a burgeoning number of technology start-ups and innovation hubs. The Moroccan Agency for Digital Development (ADD) has played a key role in fostering the local tech ecosystem by supporting innovative projects [43].

Morocco's innovation ecosystem is growing rapidly and, according to the Global Innovation Index 2022 [44], the country ranks second in North Africa and 67th globally in terms of competitiveness in new technologies. Since 2012, Morocco has been pursuing a cluster development strategy to boost productivity and innovation. The Innov-Investment Fund and the Mohammed VI Investment Fund further support this growth by offering comprehensive financing and support programs [40].

The rise in Internet penetration and mobile connectivity has also fostered a rapid increase in e-commerce adoption in Morocco. By 2021, e-commerce revenues will reach $300 million, representing a growth rate of 40% [42]. This trend has been facilitated by the availability of digital payment options and the government's introduction of e-payment systems, such as m-wallet.

Government initiatives, such as the Digital Morocco 2020 strategy and the regulatory role of the national telecommunications regulatory agency (ANRT), have been instrumental in shaping Morocco's digital landscape. These efforts have fostered the growth of the digital economy, the use of e-government services, and the development of digital infrastructure [43].

Despite significant progress in digitalization, Morocco still faces challenges in bridging the digital divide, especially between urban and rural areas. There are also issues related to ensuring affordable Internet access for all and addressing the digital skills gap. In response, the government has launched several initiatives, including the National Digital

Inclusion Program, which aims to provide affordable Internet access and digital training to disadvantaged populations.

As digitalization grows, so does the need for a robust cybersecurity infrastructure. To address this issue, the government established the National Agency for Cybersecurity (ANAC) in 2017. The agency is responsible for developing a comprehensive cybersecurity strategy and promoting best practices to ensure the security of digital transactions and data.

Although these advances mark significant progress in Morocco's digital landscape, challenges remain in bridging the digital divide between urban and rural areas, ensuring affordable Internet access for all, and addressing the digital skills gap. These challenges underscore the need for further research into the determinants of Moroccan firms' adoption of online commercial activities.

4. Methodology

When dealing with a dependent variable that is qualitative (either dichotomous or involves multiple choices), it is imperative to use an approach alternative to simple or multiple linear regression models. For dichotomous variables, binary models offer a more appropriate solution that accounts for the binary nature of the dependent variable, which indicates the presence or absence of a probabilistic event.

Although there are three main models to consider—the probit model, the logit model, and the linear probability model—the probit and logit models are often preferred. The error distribution function of the probit model adheres to a reduced centered normal distribution, whereas the logit model adheres to a logistic distribution [45]. These models have differences in their distribution functions and the variances of their random deviations. For example, the variance of the random deviations in the normalized probit model is unity (1), in contrast to the logit model where it is $\pi 2/3$ [46].

We start our analysis with the logistic regression model supported by a probit model. This choice is justified by the advantages offered by the logit model, including alternative interpretations of results (e.g., signs of coefficients, marginal effects, and odds ratios) [47] and its ability to assign higher probabilities to "extreme" events compared to the normal distribution [45]. The simple logit regression model can be expressed as:

$$EA_i = \beta_0 + \beta_1 FC_i + \beta_i X_i + \varepsilon_i \quad (1)$$

where EA_i is a binary variable with a value of 1 if the firm has adopted an e-commerce system and 0 otherwise. FC_i is a dummy variable representing the firm's technological support for e-commerce adoption, and X_i is a vector of observed characteristics that are expected to influence the firm's decision to adopt e-commerce. These variables, including firm size, age, location, economic sector, digital skills of the workforce, and product innovation, were selected based on a comprehensive review of the literature on the determinants of e-commerce adoption [25–27,40,41], including those specific to Morocco.

Previous research underscores the importance of addressing selection bias and endogeneity issues when examining the determinants of digital technology adoption, including e-commerce. E-commerce adoption is not a random firm decision; firms with favorable facilitating conditions are more likely to adopt e-commerce. The endogeneity of the facilitating conditions variable could bias our estimates, especially if factors related to the availability of organizational and technical infrastructure also affect e-commerce adoption decisions.

To address these concerns, we will estimate Equation (1) using the two-stage probit model within the conditional mixed process with the heteroskedasticity-robust standard errors (CMP) framework proposed by [48]. This method is commonly used in analyses of the determinants of digital technology adoption and employs a seemingly unrelated regression (SUR) technique to simultaneously estimate the determinants of e-commerce adoption and the facilitating conditions.

Recent studies have validated the effectiveness of these methods in exploring digital technology adoption. For instance, [49] used a two-stage probit model within the CMP framework to analyze farmers' willingness to adopt farmland conservation technology.

Similarly, [50] adopted a CMP approach to examine the influence of e-skills on the use of e-services in the hospitality industry. Furthermore, [51] tested the effectiveness of these methods by examining the impact of digital finance on the adoption of sustainable agricultural practices among smallholder farmers.

The CMP model consists of two correlated error equations:

$$EA_i = \beta_0 + \beta_1 FC_i + \beta_i X_i + \omega_i \quad (2)$$

$$FC_i = \gamma_0 + \gamma_i Z_i + \mu_i \quad (3)$$

The CMP method consists of a two-stage regression analysis. In the first stage (Equation (3)), the instrumental variables related to the explanatory variable are identified and their correlation is evaluated. In the second stage (Equation (2)), the exogeneity of the explanatory variable is tested using the endogeneity test parameter (atanhrho_12) by including the instrumental variables in the regression model. If the endogeneity test parameter is significantly different from 0, indicating the presence of an endogeneity problem, the estimation result of the CMP method is more reliable. If the endogeneity test parameter is not significantly different from 0, the basic regression estimation result can be used.

In these equations, Z_i represents the instrument (i.e., the availability of computers, websites, and IT staff), X_i is a vector of explanatory variables excluding the instrumental variables, and μ_i and ω_i are the error terms. By estimating these equations, we aim to obtain more consistent estimates of the determinants of e-commerce adoption by Moroccan firms.

5. Results

5.1. Descriptive Statistics

This study is based on primary data collected from 807 Moroccan firms between April and August 2022. The data are part of the Enterprises' Digitization Survey (ENT/SED), an ERF initiative conducted in two phases in Jordan, Morocco, and Egypt. This dataset provides comprehensive insights into access, usage, and affordability of Internet and mobile services. It also sheds light on the accessibility of online payments and e-commerce platforms. It also covers key regional characteristics such as population density, income levels, and urbanization rates. It also presents measures of transportation infrastructure, such as road density and logistics performance, and human capital indicators, such as the share of skilled workers or the level of education of the workforce. Table 1 presents descriptive statistics for the qualitative variables. They show that less than a third of the surveyed firms have adopted e-commerce (31.23%), as measured by the proportion of firms that buy and/or sell online (see Figure 1). Moreover, 79.80% of the companies have less than 15 employees. In terms of firm age, 25.99% of the sample are young firms (less than 5 years old) and 36.58 have been in the market between 6 and 10 years. Table 1 also shows that 20.06% of the firms are between 11 and 15 years old and only 17.37% of the firms are older than 15 years.

The descriptive analysis shows that 44.24% of the surveyed firms are located in the Casablanca-Settat region, 14.75% in the Rabat-Salé-Kénitra region, 10.66% in the Marrakech-Safi region, 9.67% in the Fez-Meknes region, and 8.05% in the Tangier-Tetouan-Al Hoceima region. These five regions represent 87.37% of the sampled firms. The largest sector is "accommodation and food services" (21.81%), followed by "retail or wholesale or services of motor vehicles" (19.58%). The least represented industries are "chemicals and chemical products" and "petroleum products, plastics and rubber", with 0.99% and 0.5%, respectively. In terms of higher education (university degree), 32.71% of the enterprises in the sample have less than 25% of their workforce with a university degree, whereas only 17.35% of the enterprises have more than 75% of their workforce with a university degree. Most enterprises (80.79%) are managed or owned by men. In the sample, 48.94% have an information technology infrastructure to support sales and customer service activities, 55.90% and 48.74% use social media and smartphones, respectively, for business purposes, 68.65% have a website, 46.70% have Internet access, 5.57% do not use computers for

business purposes, 40.52% are engaged in product innovation activities, and 7.81% are listed on digital platforms. Finally, 60.15% of the sample did not consider digital skills to be a requirement for employment in their organization.

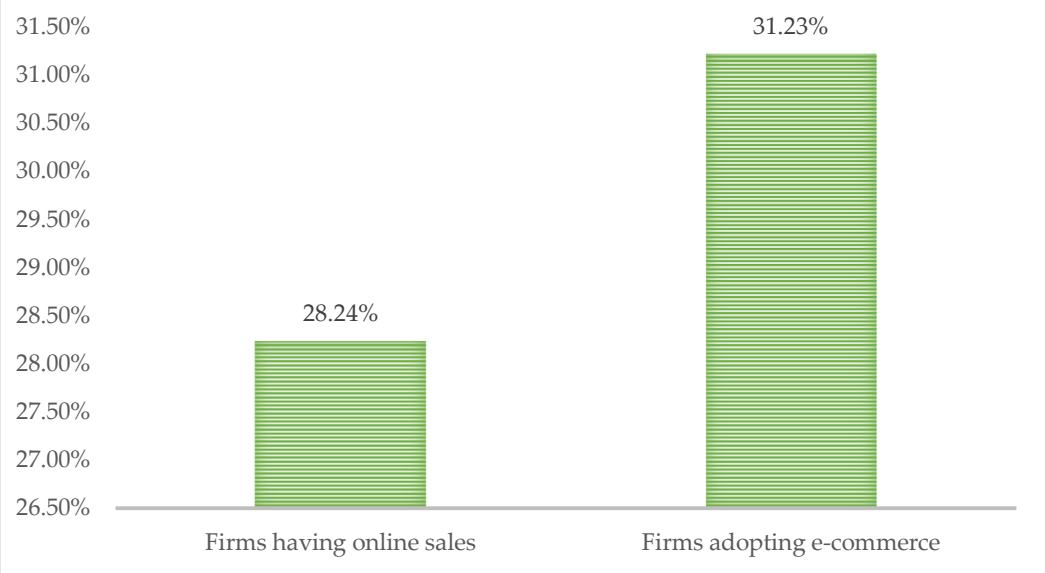

Figure 1. Adoption of e-commerce.

Table 1. Descriptive statistics.

Variable	Frequency	Percentage	Cumulative Percentage
E-commerce adoption			
Non-adopters	555	68.77	68.77
Adopters	252	31.23	100.00
Firm size			
5 employees or less	313	38.79	38.79
6 to 10 employees	244	30.24	69.02
11 to 15 employees	87	10.78	79.80
More than 15 employees	163	20.20	100.00
Firm age			
5 years or less	184	25.99	25.99
6 to 10 years	259	36.58	62.57
11 to 15 years	142	20.06	82.63
More than 15 years	123	17.37	100.00
Firm location			
Tanger-Tetouan-Al Hoceima	65	8.05	8.05
Oriental	21	2.60	10.66
Fès-Meknès	78	9.67	20.32
Rabat-Salé-Kénitra	119	14.75	35.07
Béni Mellal-Khénifra	15	1.86	36.93
Casablanca-Settat	357	44.24	81.16
Marrakech-Safi	86	10.66	91.82
Drâa-Tafilalet	7	0.87	92.69
Souss-Massa	47	5.82	98.51
Guelmim-Oued Noun	6	0.74	99.26
Laayoune-Sakia El Hamra	4	0.50	99.75
Eddakhla-Oued Eddahab	2	0.25	100.00

Table 1. *Cont.*

Variable	Frequency	Percentage	Cumulative Percentage
Economic sector			
Agriculture, fishing, or mining	12	1.49	1.49
Textile and garments	27	3.35	4.83
Industry of food	39	4.83	9.67
Industry of mechanics or electronics or vehicles	25	3.10	12.76
Leather products	15	1.86	14.62
Chemicals and chemical products	8	0.99	15.61
Petroleum products, plastics, and rubber	4	0.50	16.11
Non-metallic mineral products	15	1.86	17.97
Basic metals, metal products, wood products, furniture, paper, and publishing	53	6.57	24.54
Construction or utilities	26	3.22	27.76
Retail, wholesale, or services of motor vehicles	158	19.58	47.34
Transportation and storage	30	3.72	51.05
Accommodation and food services	176	21.81	72.86
Information and communication or IT	48	5.95	78.81
Financial activities or real estate	30	3.72	82.53
Education	40	4.96	87.48
Health	55	6.82	94.30
Other manufacturing or services	46	5.70	100.00
Highly educated workers			
25% or less	264	32.71	32.71
26% to 50%	261	32.34	65.06
51% to 75%	142	17.60	82.65
More than 75%	140	17.35	100.00
Women in the workforce			
25% or less	281	34.82	34.82
26% to 50%	328	40.64	75.46
51% to 75%	159	19.70	95.17
More than 75%	39	4.83	100.00
Gender of the firm's owner			
Female	155	19.21	19.21
Male	652	80.79	100.00
Managerial staff digital skills			
Digital skills not important	144	27.85	27.85
Digital skills important	373	72.15	100.00
Workers digital skills			
Digital skills not important	311	60.15	60.15
Digital skills important	206	39.85	100.00
Facilitating conditions			
Not having information technology support	264	51.06	51.06
Having information technology support	253	48.94	100.00
Social media use			
Do not use social media for business purposes	228	44.10	44.10
Use social media for business purposes	289	55.90	100.00
Digital platform use			
Firm not listed on app or website	744	92.19	92.19
Firm listed on app or website	63	7.81	100.00
Product innovation			
Do not have product innovation activities	480	59.48	59.48
Having product innovation activities	327	40.52	100.00

Table 1. *Cont.*

Variable	Frequency	Percentage	Cumulative Percentage
Smartphone use			
Not using smartphones for business	265	51.26	51.26
Using smartphones for business	252	48.74	100.00
Firm's website			
Do not have a website	554	68.65	68.65
Having own website	253	31.35	100.00
Having Internet access			
Firm does not have access to the Internet	290	46.70	46.70
Firm has access to the Internet	331	53.30	100.00
Using computers for business purposes			
Do not use computers for business purposes	28	5.57	5.57
1–25% of employees	185	36.78	42.35
26 to 50% of employees	144	28.63	70.97
51 to 75% of employees	40	7.95	78.93
76 to 100% of employees	106	21.07	100.00

5.2. Estimation Results

Table 2 presents the estimates of the determinants of e-commerce adoption using logit, probit, and conditional mixed-process probit models. As these are binary models, the coefficients cannot be interpreted directly. Instead, the signs of these coefficients indicate whether the associated variables have a positive or negative effect on the probability of adopting e-commerce. To measure the sensitivity of the probability of adopting e-commerce in the logit model, we use the odds ratio.

The CMP estimation methodology, as described in [48], accounts for potential endogeneity due to self-selection bias. The covariance of the error terms in the two equations employed is captured by the statistic atanhrho_12, as reported at the bottom of the table. The negative significance of atanhrho_12 suggests that there are unobserved factors that negatively affect both the dependent variable (e-commerce adoption) and the endogenous variables (facilitating conditions). However, these unobserved factors have been accounted for in the estimation. Furthermore, the insignificance of rho_12 (p-value > 0.1) indicates that firms' e-commerce adoption decisions are not significantly affected by unobserved characteristics, which reinforces the robustness of our model.

The analysis of the coefficients, odds ratios, and their probabilities showed that most of the variables contribute significantly to the likelihood of e-commerce adoption. The calculation of McFadden's pseudo R^2 values, which were 0.2661 for the logit model and 0.2668 for the probit model, showed a good model fit in accordance with the criteria established by [52] (p. 35), where a pseudo R^2 value in the range from 0.2 to 0.4 indicates a high level of model fit. This analysis also showed comparable results for logit, probit, and CMP models, highlighting the robustness of these results. However, for ease of interpretation, the following discussion will focus primarily on the odds ratios derived from the logit model.

In Morocco, the age of the firm, the location of the firm in the Oriental, Casablanca-Settat, or Souss-Massa regions, and having between 51% and 75% of employees with higher education all contribute to this probability. In addition, management's level of digital skills, facilitating conditions, the use of social media for business purposes, the use of digital platforms, product innovation, and the use of smartphones for business purposes significantly affect a firm's likelihood of adopting e-commerce. However, firm size, the proportion of female employees, female managers or owners, and the level of digital skills of employees do not affect the probability of adopting e-commerce in Morocco.

Table 2. Regression results for logit, probit, and CMP models.

Variable	Logit		Probit	CMP
	Coefficient	**Odds Ratio**		
Firm size				
5 employees or less	(Ref.)	(Ref.)	(Ref.)	(Ref.)
6 to 10 employees	−0.3131	0.7311	−0.1758	−0.2244
	(0.2763)	(0.2020)	(0.1592)	(0.1369)
11 to 15 employees	−0.2639	0.7681	−0.1368	−0.3601
	(0.6131)	(0.4709)	(0.3448)	(0.3212)
More than 15 employees	0.6493	1.9143	0.4434	0.3265
	(1.3377)	(2.5608)	(0.7478)	(0.5790)
Firm age				
5 years or less	(Ref.)	(Ref.)	(Ref.)	(Ref.)
6 to 10 years	−0.5392 *	0.583 *	−0.310 *	−0.3046 *
	(0.3193)	(0.186)	(0.185)	(0.1648)
11 to 15 years	−0.7578 **	0.469 **	−0.465 **	−0.4077 **
	(0.3923)	(0.184)	(0.223)	(0.1927)
More than 15 years	−1.3204 ***	0.267 ***	−0.792 ***	−0.6907 ***
	(0.3712)	(0.099)	(0.217)	(0.1991)
Firm location				
Tanger-Tetouan-Al Hoceima	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Oriental	−1.0947	0.3347	−0.6588	−0.5909
	(0.7236)	(0.2422)	(0.4253)	(0.4015)
Fès-Meknès	−0.7791	0.4588	−0.4230	−0.4135
	(0.5697)	(0.2614)	(0.3149)	(0.2617)
Rabat-Salé-Kénitra	−0.3110	0.7327	−0.1709	−0.1571
	(0.5284)	(0.3872)	(0.2993)	(0.2549)
Béni Mellal-Khénifra	−0.0025	0.9975	0.0480	0.0628
	(0.7424)	(0.7406)	(0.4569)	(0.4352)
Casablanca-Settat	−0.8414 *	0.4311 *	−0.4874 *	−0.4126 *
	(0.4591)	(0.1979)	(0.2574)	(0.2176)
Marrakech-Safi	−0.7576	0.4688	−0.4221	−0.3677
	(0.6104)	(0.2862)	(0.3341)	(0.2683)
Drâa-Tafilalet	−1.0348	0.3553	−0.5903	−0.4661
	(0.9261)	(0.3291)	(0.5866)	(0.6078)
Souss-Massa	−2.0786 ***	0.1251 ***	−1.2346 ***	−1.1137 ***
	(0.6422)	(0.0803)	(0.3707)	(0.3763)
Guelmim-Oued Noun and Laayoune-Sakia El Hamra and Eddakhla-Oued Eddahab	−0.9960	0.3694	−0.5661	−0.6899
	(1.1737)	(0.4335)	(0.6855)	(0.5708)
Economic sector				
Agriculture, fishing, or mining	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Textile and garments	1.9003	6.6877	1.1098	0.5424
	(1.3454)	(8.9976)	(0.7593)	(0.6288)
Industry of food	0.2435	1.2757	0.0962	−0.2422
	(1.3505)	(1.7228)	(0.7612)	(0.6273)
Industry of mechanics or electronics or vehicles	1.4374	4.2095	0.8003	0.3184
	(1.3278)	(5.5894)	(0.7563)	(0.5801)
Leather products	3.2087 **	24.7472 **	1.8567 **	1.3308
	(1.4139)	(34.9893)	(0.7945)	(0.6417)
Chemicals and chemical products	3.8332 **	46.2104 **	2.2360 **	1.2595
	(1.7081)	(78.9341)	(0.9540)	(0.8013)
Petroleum products, plastics, and rubber	0.9891	2.6887	0.5428	0.2460
	(1.7900)	(4.8130)	(1.0922)	(0.9960)
Non-metallic mineral products	2.7625 *	15.8398 *	1.6075 *	0.8570
	(1.5892)	(25.1726)	(0.8782)	(0.7077)
Basic metals, metal products, wood products, furniture, paper, and publishing	3.0818 ***	21.7982 ***	1.8289 ***	1.2329 **
	(1.3048)	(28.4412)	(0.7342)	(0.5878)

Table 2. *Cont.*

Variable	Logit		Probit	CMP
	Coefficient	**Odds Ratio**		
Construction or utilities	1.3719	3.9427	0.8036	0.3898
	(1.4061)	(5.5438)	(0.7831)	(0.5943)
Retail, wholesale, or services of motor vehicles	2.2189 *	9.1975 *	1.2901 *	0.7551
	(1.2376)	(11.3828)	(0.6918)	(0.5235)
Transportation and storage	2.3003 *	9.9774 *	1.3604 *	0.7261
	(1.2926)	(12.8963)	(0.7288)	(0.5891)
Accommodation and food services	2.0337 *	7.6421 *	1.1398 *	0.6838
	(1.2305)	(9.4036)	(0.6877)	(0.5149)
Information and communication or IT	2.1938 *	8.9693 *	1.3033 *	0.7159
	(1.2643)	(11.3396)	(0.7082)	(0.5532)
Financial activities or real estate	1.0778	2.9383	0.6448	0.1513
	(1.3484)	(3.9619)	(0.7510)	(0.5564)
Education	3.5088 ***	33.4069 ***	2.0336 ***	1.4422 ***
	(1.3918)	(46.4970)	(0.7679)	(0.5998)
Health	2.7243 **	15.2450 **	1.5953 **	0.9677 *
	(1.3218)	(20.1501)	(0.7341)	(0.5736)
Other manufacturing or services	2.3431 *	10.4133 *	1.3519 *	0.8359
	(1.2736)	(13.2623)	(0.7154)	(0.5611)
Highly educated workers				
25% or less	(Ref.)	(Ref.)	(Ref.)	(Ref.)
26% to 50%	0.2957	1.3441	0.1568	0.0640
	(0.3172)	(0.4264)	(0.1831)	(0.1591)
51% to 75%	1.0877 ***	2.9675 ***	0.6039 ***	0.3972 **
	(0.4083)	(1.2116)	(0.2310)	(0.1946)
More than 75%	0.1100	1.1163	0.0481	−0.1042
	(0.4089)	(0.4565)	(0.2302)	(0.1908)
Women in the workforce				
25% or less	(Ref.)	(Ref.)	(Ref.)	(Ref.)
26% to 50%	−0.0872	0.9165	−0.0563	−0.0419
	(0.2972)	(0.2724)	(0.1684)	(0.1394)
51% to 75%	−0.3690	0.6914	−0.1951	−0.1647
	(0.3712)	(0.2566)	(0.2123)	(0.1777)
More than 75%	0.0265	1.0269	−0.0477	−0.0385
	(0.6374)	(0.6545)	(0.3834)	(0.3227)
Gender of the firm's owner				
Female	(Ref.)		(Ref.)	(Ref.)
Male	0.4595	1.583	0.2596	0.2650
	(0.3180)	(0.504)	(0.1851)	(0.1731)
Managerial staff digital skills				
Digital skills not important	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Digital skills important	0.4967 *	0.6085 *	0.2897 *	−0.3373 **
	(0.3082)	(0.1875)	(0.1755)	(0.1473)
Workers digital skills				
Digital skills not important	(Ref.)		(Ref.)	(Ref.)
Digital skills important	0.2131	1.2375	0.1358	0.0904
	(0.2762)	(0.3418)	(0.1573)	(0.1338)
Facilitating conditions				
Not having IT support	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Having IT support	0.5235 *	1.6879 *	0.3017 *	1.3709 ***
	(0.2975)	(0.5022)	(0.1673)	(0.2340)
Social media use				
Do not use social media for business purposes	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Use social media for business purposes	1.1709 ***	3.2248 ***	0.6928 ***	0.5234 ***
	(0.2600)	(0.8383)	(0.1500)	(0.1438)

Table 2. *Cont.*

Variable	Logit		Probit	CMP
	Coefficient	**Odds Ratio**		
Digital platforms use				
Firm not listed on app or website	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Firm listed on app or website	0.9447 **	2.5720 **	0.5804 ***	0.4421 **
	(0.4161)	(1.0702)	(0.2298)	(0.2048)
Product innovation				
Do not have product innovation activities	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Having product innovation activities	0.6055 ***	1.8321 ***	0.3539 ***	0.3272 ***
	(0.2418)	(0.4429)	(0.1392)	(0.1219)
Smartphone use				
Not using smartphones for business	(Ref.)	(Ref.)	(Ref.)	(Ref.)
Using smartphones for business	1.2270 ***	3.4111 ***	0.7283 ***	0.5700 ***
	(0.2742)	(0.9351)	(0.1561)	(0.1441)
Constant	−2.8391 **	0.0585 **	−1.6544 **	−1.3615 **
	(1.3026)	(0.0762)	(0.7326)	(0.5716)
Facilitating conditions				
Computers use				
Not using computers for business				(Ref.)
Using computers for business				0.1610 ***
				(0.0492)
Firm's website				
Do not have own website				(Ref.)
Having own website				0.6731 ***
				(0.1082)
Internet access				
Firm does not have access to the Internet				(Ref.)
Firm has access to the Internet				0.0816 ***
				(0.1200)
Constant				−1.2083 ***
				(0.1897)
Observations	462	462	462	512
Log pseudolikelihood	−234.7048	−234.7048	−234.4637	−539.3411
Prob > chi2	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.2661	0.2661	0.2668	
atanhrho_12				−0.9456 ***
				(0.2995)
rho_12				−0.7378
				(0.1365)

Notes: Asterisks (***) denote significance at the 1% level, (**) indicate significance at the 5% level, and (*) represent significance at the 10% level. The term "Ref." refers to the modality thresholds. Values in parentheses represent robust standard errors.

Regarding the sectors of activity of our sample firms, we observed significant differences in the likelihood of adopting e-commerce. Firms in "basic metals, metal products, wood products, furniture, paper and publishing", "education", and "health" sectors are 21.79, 33.40, and 15.24 times more likely to adopt e-commerce, respectively, at the 1% significance level. In addition, the "leather products", and "chemicals & chemical products" sectors are 1.86 and 2.24 times more likely, respectively, to adopt e-commerce at the 5% level. Finally, sectors such as "non-metallic mineral products", "retail or wholesale or services of motor vehicles", "transportation and storage", "accommodation and food services", "information and communication or IT", and "other manufacturing or services" have 1.61, 9.20, 9.98, 7.64, 8.97, and 10.41 times higher odds of adopting e-commerce at the 10% level, respectively.

The age of the firm seems to be crucial for the adoption of e-commerce, as evidenced by its negative and significant coefficient in all models. The odds ratio values in the logit model suggest that in Morocco, newer firms are more likely to adopt e-commerce. Indeed, firms aged 11–15 years and those older than 15 years are less likely to adopt e-commerce, at 0.46 and 0.26 times, respectively, than firms younger than five years. This finding is coherent with several previous studies that have examined the role of firm age in the adoption of e-commerce and similar technological innovations. Amornkitvikai et al. [25] specifically found a negative relationship between firm age and e-commerce sustainability in the context of Thai micro-, small-, and medium-sized enterprises (MSMEs). Similarly, Nair et al. [53], although discussing IT adoption in general, recognized the significant influence of a firm's age on its willingness to adopt technological innovations. Walker et al. [54], in their study of e-commerce adoption among Slovakian SMEs, found that younger firms were more likely to adopt e-commerce, reinforcing our observations regarding the impact of firm age.

In the context of regional disparities, our study shows that firms located in the Oriental, Casablanca-Settat, and Souss-Massa regions are less likely to adopt e-commerce than their counterparts in the Tangier-Tetouan-Al Hoceima region. There is no discernible impact of other location factors on e-commerce adoption in Morocco. This confirms the observations of [41], who reported similar regional differences in e-commerce adoption among Moroccan agricultural cooperatives. However, potential barriers such as Internet accessibility, lack of information, and cost of technology in the Rabat-Salé-Kenitra, Fes-Meknes, Rabat-Salé-Kenitra, and Beni Mellal-Khenifra regions are implied but not explicitly identified in our study. Given the findings of [41], which highlight low digital literacy as a major barrier, these challenges may be key to understanding the lower rates of e-commerce adoption in these regions.

Regarding the gender of owners, managers, and employees, these variables do not have a significant impact on the adoption of e-commerce in Morocco. Similarly, the size of the firm does not affect the likelihood of adopting e-commerce, as its coefficients are not statistically significant.

On the other hand, the educational level of the employees has a significant impact on the adoption decision. The results show that firms with a significant proportion of employees with a university degree are more likely to adopt e-commerce in Morocco. Specifically, firms where 51–75% of employees have a university degree are 2.96 times more likely to adopt e-commerce. This is because the use of technologies related to e-commerce requires a certain level of cognitive and technological skills. Such findings are aligned with the observations of [55], who identified cognitive and technical barriers to e-commerce adoption in Palestine, indicating the need for a well-educated workforce for successful implementation. Similarly, [56] highlighted perceived technological challenges as a major barrier to e-commerce adoption among SMEs in developing countries, again emphasizing the role of education in overcoming such barriers. Furthermore, Liu et al. [57] have found that the level of education is a significant factor influencing the decision to adopt e-commerce among rural farmers in China. Their study also highlighted the indirect costs and necessary skills associated with e-commerce adoption, underscoring the role of education in facilitating successful e-commerce use.

Moreover, the results indicate that the level of digital skills required for new hires has an insignificant statistical effect on the probability of e-commerce adoption by Moroccan firms. It appears that e-commerce adoption depends on the level of digital skills of employees. Limited digital cognitive skills may limit the use of ICTs required for e-commerce activities to rudimentary uses without added value, revealing the low importance given to e-commerce among all digital technologies.

The importance of digital skills in managerial staffing decisions is statistically significant at the 10% level and affects the willingness to adopt e-commerce, with an odds ratio value of 0.60. This suggests that firms are not aware of the impact of digital skills on e-commerce adoption decisions. Consistent with our findings, Walker et al. [54] in their

study of Slovakian SMEs concluded that organizational readiness, including readiness in terms of digital skills, is a significant factor influencing e-commerce adoption. Furthermore, Muathe and Muraguri-Makau [58], in their examination of SMEs in the Kenyan healthcare sector, found that the CEO's ICT knowledge was a primary determinant of e-commerce adoption. This underscores the importance of digital skills among managers for firms considering e-commerce adoption.

The positive coefficient of facilitating conditions in all models highlights the importance of having the necessary organizational and technical infrastructure to support the use of technology or systems to increase the likelihood of e-commerce adoption by firms. In particular, the odds ratio derived from our logit estimation results suggests that firms with such facilitating infrastructure are 1.68 times more likely to adopt e-commerce. In addition, our CMP methodology finds that instrumental variables such as "computer use", "firm website", and "Internet access" are significantly associated with facilitating conditions. Thus, these instrumental variables can be seen as important precursors that further the cause of enabling conditions that ultimately increase the likelihood of e-commerce adoption among firms.

Our findings also highlight the increased propensity to adopt e-commerce among firms that are listed on apps, websites, or digital platforms such as Amazon or Jumia, demonstrating the significant role played by these online commerce networks. Specifically, firms within such networks are 2.57 times more likely to adopt e-commerce. Offering a wealth of resources, guides, and tutorials, these platforms enhance the user experience and present a compelling proposition for businesses exploring e-commerce. The large user base of these platforms further enhances their appeal to businesses looking to venture into e-commerce. In addition, trust in technology is critical in influencing the adoption of digital platforms, as pointed out by Dahmani and Ben Youssef [59]. Their study, which examines the drivers of platform economy adoption in Tunisia, highlights the role of technological trust in facilitating the adoption of the platform economy. Analogously, the credibility established by renowned platforms such as Amazon and Jumia could strengthen e-commerce adoption [59].

Moreover, the logit model indicates that the probability of e-commerce adoption increases significantly (at the 1% level) with employees' use of social media and smartphones for business purposes. Specifically, the odds ratios for these two variables show that the probability of adoption increases by factors of 3.22 and 3.41, respectively. This implies a strong correlation between employees' use of modern technologies and a firm's likelihood of adopting e-commerce, which is consistent with several studies in the existing literature. For example, Rahayu and Day [29] reported that the use of e-commerce by Indonesian SMEs is dominated by marketing and purchasing activities, which can be easily conducted via social media and smartphones. Similarly, Apergis [60] found that individuals in family-owned businesses often combine both tablets and smartphones in their purchases, underscoring the importance of these technologies in the context of e-commerce. In addition, the work of [61] demonstrates the significant role of social media as a medium for e-commerce, particularly for microenterprises. Her findings show that the adoption of e-commerce using social media has a positive impact on business performance, including increased profits, growing sales volumes, and expanded marketing areas. It is important to note, however, that these positive outcomes were not significantly influenced by the owner's characteristics of knowledge and skills in information technologies. Rather, they were primarily driven by perceived benefits and the external environment. Considering these findings, our results highlight the need for firms to encourage the use of social media and smartphones among their employees in order to increase the probability of successful e-commerce adoption.

Finally, engaging in product innovation activities has a positive impact on the probability of adoption, with statistical significance at the 1% level in all models. Firms that introduce new products/services or implement production process innovations experience a 1.83-fold increase in the probability of e-commerce adoption.

6. Conclusions and Recommendations

This study has attempted to analyze the adoption of e-commerce by firms in Morocco. Using logit, probit, and CMP models, we identified the main factors influencing the adoption of e-commerce by Moroccan firms. Although digitalization is progressing in Morocco, the adoption of e-commerce remains low. Most firms do not prioritize e-commerce development, and there is a lack of skills required for e-commerce adoption in Moroccan firms.

This paper presents five main findings. First, firm age is an important indicator of e-commerce adoption, with younger firms more likely to adopt e-commerce due to their openness to innovation and change. Second, e-commerce adoption depends on the level of education, and firms with a higher proportion of educated employees are more likely to adopt e-commerce. Third, the level of digital skills required of new hires does not affect the likelihood of adopting e-commerce, suggesting that Moroccan firms place a low priority on adopting e-commerce and believe that digital skills are not a prerequisite for new hires. Fourth, being listed on a digital platform increases the likelihood of adopting e-commerce. Fifth, innovation activities and the introduction of new products and services influence the adoption of e-commerce in Moroccan firms.

Therefore, based on our findings, we recommend several strategies aimed at increasing the adoption and efficiency of e-commerce among Moroccan firms and at the policy level.

At the firm level, investment in digital skills training is essential. Although our results indicate that the digital skills of new hires are not a determinant of e-commerce adoption, the successful implementation of an e-commerce strategy always requires these skills. Therefore, firms should prioritize training their employees to improve their digital skills and e-commerce capabilities. Firms should also seek to be listed on digital platforms, which can increase their visibility, expand their reach, and tap into the growing pool of online consumers. In addition, firms can stimulate demand for e-commerce and maintain their competitive edge by promoting and selling innovative products and services online.

At the policy level, the government could facilitate the transition to e-commerce by providing financial assistance to firms to invest in essential physical capital, such as computer systems and reliable Internet services. Improving the quality and affordability of these Internet services can motivate more firms to adopt e-commerce. Strengthening the institutional and regulatory framework for e-commerce is another important step, as it would foster a more secure and trustworthy digital business environment. Finally, it is crucial to remove bottlenecks caused by security concerns and uncertainties, which can be achieved by raising awareness about data security, training businesses to protect their e-commerce platforms, and establishing reliable online transaction mechanisms.

It is important to note that this study has its limitations, including the ERF survey methodology and a high proportion of missing values in the responses. Future research could aim to further explore these areas.

By following these recommendations, Moroccan businesses and public institutions can harness the potential of e-commerce and reap benefits such as increased market reach, improved customer satisfaction, and potentially higher sales volumes. These recommendations, based on the findings of our study, provide a concrete roadmap for improving e-commerce adoption in Morocco.

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