

Has the COVID-19 Pandemic Permanently Modified Digital E-Commerce?

Evidence from Internet vs. Mobile Transactions

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Conflicts of interests/Competing interests

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Abstract:

Purpose – The COVID-19 pandemic represents a grand challenge that accelerated digital transformation across organizations and consumers, with lasting societal and market consequences. This study advances grand challenge management scholarship by examining the long-term durability of pandemic-induced changes in consumer behavior and retail strategies. Specifically, it investigates whether a systemic health crisis such as COVID-19 has permanently reshaped e-commerce, assessing how digital consumption patterns evolved and consolidated over time.

Methodology – The study focuses on South Korea, one of the world's largest and most digitally mature e-commerce markets. Treating COVID-19 as an external shock, product-level fixed-effects regression models capture the pandemic's dynamic and cumulative effects on online and mobile commerce transactions.

Findings – The results show that the impact of COVID-19 on e-commerce was cumulative and path-dependent rather than immediate. The pandemic consolidated rather than merely catalyzed digital consumption, with mobile commerce emerging as the main engine of sustained growth. Consumers balanced the convenience of online shopping with the experiential value of physical stores, while mobile platforms proved to be resilient infrastructures that sustained market access during disruption.

Originality – This is among the first studies to disentangle internet- and mobile-based e-commerce, revealing the centrality of mobile transactions in post-pandemic growth.

Practical Implications – First, firms prioritizing mobile-friendly interfaces, app-based engagement, and seamless payment systems are better positioned to capture and retain consumer demand in the face of grand challenges such as a pandemic. Second, for traditional brick-and-mortar stores, e-commerce—particularly mobile commerce—should no longer be viewed as a peripheral or short-term sales channel but as a strategic necessity. Third, retailers need to undertake phygital integration and must complement physical stores with digital touchpoints. Last, policymakers need to strengthen the digital infrastructure and regulatory frameworks that support inclusive and resilient commerce.

Keywords:

grand challenges; COVID-19; pandemics; e-commerce; digital transactions.

1. Introduction:

The COVID-19 pandemic has been widely depicted as the most disruptive global event of the early twenty-first century, with profound implications for business, society, and everyday life. Beyond its devastating public health consequences, the pandemic fundamentally altered how people work, consume, and interact with organizations. In this work we argue that one of its most visible and enduring effects has been the increasing adoption of digital technologies and digital platforms and an expansion of electronic commerce (e-commerce hereinafter) towards new companies, customers, and products (OECD, 2020). The introduction of social distancing measures in conjunction with lockdowns, restrictions on mobility, and heightened concerns about health and safety prompted consumers to shift rapidly from physical to online retail channels. For instance, 21% of adults in the United States started purchasing groceries online or mobile as a response to the pandemic. What was once a gradual transition toward e-commerce became an urgent necessity, creating both unprecedented opportunities and severe grand challenges for firms.

In June 2023, the World Health Organization (WHO) officially announced the end of the pandemics. If the pandemic acted only as a temporary shock, then one would expect consumption patterns to return to pre-pandemic equilibria as restrictions lifted in 2023. Yet, anecdotal evidence shows that the shift to online shopping has endured thus becoming a long-term phenomenon induced by the COVID-19 pandemic that in its turn has profoundly impacted commerce. Furthermore, it seems that the pandemic also catalyzed new forms of hybrid, or “phygital” consumption and commerce where the share of online is growing fast. From a practical point of view this has consequences for a number of stakeholders including consumers, retailers and the entire society.

From the perspective of management research, this question is not merely empirical but also deeply theoretical. Grand challenges scholarship highlights how systemic crises can reconfigure industries, reshape institutions, and generate paradoxical tensions that demand novel organizational responses (George, Howard-Grenville, Joshi, & Tihanyi, 2016). The pandemic represents a paradigmatic case of such a challenge. It forced organizations and consumers alike into a rapid process of digital transformation, whose long-term consequences are still unfolding. Understanding whether and how this transformation is permanent requires engaging with multiple theoretical frameworks and approaches—including systems and complexity theories, institutional theory, paradox perspectives, and collective action approaches—and in the specific case we analyze, insights from marketing research on consumer behavior, digital innovation, and phygital retail strategies.

This paper contributes to the management literature in three ways. First, it situates the COVID-19 pandemic within the broader debate on grand challenges, demonstrating how a health crisis can act as a catalyst for systemic market transformation. Second, it contributes to the e-commerce literature by measuring the durability of pandemic-induced changes in consumer behavior and retail strategies, making it clear that a phenomenon that could be transient has become a long lasting one. Third, it advances theoretical understanding of digital commerce by integrating perspectives from management and marketing, particularly those that address institutionalization, paradox, and consumer-brand relationships. Finally, it engages directly with the key research question: Has the COVID-19 pandemic permanently modified e-commerce? In doing so, the paper seeks to inform both academic inquiry and managerial practice, offering insights into how firms and consumers can navigate an era in which the boundaries between physical and digital commerce are increasingly blurred. More specifically we focus on a setting, South Korea, that is particularly relevant as today it represents the fourth country worldwide in terms of e-commerce market size and the second in terms of e-commerce penetration (Statista, 2025).

The remainder of this paper is structured as follows. The next section reviews the literature on grand challenges in management research, with attention to theoretical frameworks that help explain systemic transformations. Afterwards, we examine pandemics as catalysts for digital and phygital transformations of commerce and review studies that have dealt with the effect of the pandemic on e-commerce as well as mobile commerce (m-commerce). In section 3, we elucidate the empirical setting as well as the data and methodology deployed. In section 4 we illustrate the findings. Section 5 includes a discussion of the findings and elucidates the implications for managers and policy makers. Finally in section 6 we identify limitations of the study and outline avenues for future research.

2. Literature review and theoretical background

2.1 Grand Challenges in Management Research

The concept of "grand challenges" has become increasingly central in management research, particularly since the influential work by George, Howard-Grenville, Joshi, and Tihanyi (2016). They define grand challenges as "formulations of global problems that can be plausibly addressed through coordinated and collaborative effort," characterized by their scale, complexity, and societal importance. Such challenges are inherently wicked problems (Ferraro, Etzion, & Gehman, 2015): ambiguous, multi-causal, and resistant to simple solutions. Management scholars have been urged to contribute to these challeng-

es by moving beyond narrow, firm-level outcomes and engaging with issues of broad societal consequence, including climate change, inequality, poverty alleviation, technological disruption, and public health crises.

Subsequent scholarship has reinforced and expanded this framing. Buckley, Doh, and Benischke (2017) highlighted how globalization and interdependence amplify the relevance of grand challenges, particularly for international business and global governance. Howard-Grenville and Spengler (2021) emphasized the necessity of collective action and cross-sectoral collaboration, noting that management research must address both the opportunities and tensions of organizing under conditions of high uncertainty.

In responding to the call to address grand challenges, management scholars have drawn on diverse theoretical frameworks. One influential perspective is systems and complexity theory, which helps explain the interdependencies, feedback loops, and emergent properties of challenges such as climate change or pandemics. Relatedly, institutional theory has been employed to understand how norms, rules, and logics shape collective responses, highlighting both the enabling and constraining roles of institutions in mobilizing action (Ansari, Wijen, & Gray, 2013).

Another stream builds on paradox theory, which underscores how grand challenges often require organizations to embrace and navigate contradictory demands, such as simultaneously fostering collaboration and competition (Mariani, 2018), or pursuing short-term survival while investing in long-term societal impact (Smith & Lewis, 2011; Schad et al., 2016). The collective action lens is also prominent: Ferraro et al. (2015) argue that addressing grand challenges requires creating shared understandings, mobilizing distributed resources, and sustaining long-term engagement despite conflicting interests.

In marketing scholarship, grand challenges have been approached through adjacent frameworks, including transformative consumer research (TCR) and macromarketing, both of which explicitly consider how marketing systems intersect with societal well-being. For example, scholars have examined the role of marketing in addressing poverty alleviation, health crises, and climate change (Kotler et al., 2006). More recently, marketing research has taken up grand challenges such as sustainability transitions, responsible consumption, and the digital divide, applying theories of market systems, consumer culture, and stakeholder engagement (Katsikeas, Leonidou, & Zeriti, 2016; Gollnhofer & Schouten, 2017). These approaches reinforce the view that marketing, like management more broadly, must expand its scope beyond firm-centric outcomes to tackle systemic and societal problems.

Taken together, the theoretical approaches to grand challenges highlight the multilevel nature of these problems: they unfold across individuals, organizations, industries, and societies, requiring interdisciplinary integration and cross-sector collaboration. They also point to an ongoing tension: how to balance rigorous theory development with problem-solving relevance. While management and marketing scholars have made important advances, the field continues to debate how best to combine theoretical depth with societal engagement in order to meaningfully contribute to addressing grand challenges.

2.2 Pandemics and the Digital Transformation of Commerce

The COVID-19 pandemic has had a profound and enduring impact on patterns of commerce, most notably by accelerating the shift from physical to digital retail channels. Restrictions on mobility, consumer concerns about health and safety, and disruptions in global supply chains prompted widespread adoption of e-commerce during the pandemic. Even as restrictions have eased, the reliance on digital channels seem to have persisted, creating significant challenges for traditional brick-and-mortar retailers and reshaping the competitive dynamics of the retail sector. Theories of grand challenges provide useful lenses for interpreting why these shifts have proven durable.

From a systems and complexity theory perspective, the pandemic represented an exogenous shock that destabilized established retail systems and activated new feedback loops. Once consumers and firms adapted to online modes of exchange, reinforcing mechanisms such as network effects, improved logistics, and personalized digital experiences consolidated the digital-first equilibrium (Ivanov, 2020; Pantano et al., 2020). This systemic reconfiguration has made it difficult for traditional retailers to return to pre-pandemic patterns of foot traffic and in-store purchasing. The COVID-19 crisis also underscored the temporal interplay between rhetoric and collective action, as actors mobilized around digital solutions while grappling with shifting expectations and realities (Drori et al., 2025; Lantz et al., 2025).

Institutional theory helps explain the persistence of digital commerce. The pandemic catalyzed the institutionalization of e-commerce by embedding it in regulatory frameworks (e.g., support for contactless payments and delivery infrastructure), normative expectations (e.g., shopping online as safer and more convenient), and cognitive schemas (e.g., digital purchasing as "normal" shopping behavior) (Scott, 2013; Hinings, Gegenhuber, & Greenwood, 2018). In line with this view, scholars argue that policy-driven initiatives and projects played a vital role in empowering organizations to confront grand challenges (Ika et al., 2024) and build more resilient digital ecosystems.

The pandemic also accentuated the paradoxes of retail strategy. Firms must simultaneously maintain physical stores to provide experiential and relational value, while also investing heavily in digital transformation to ensure resilience and reach. This duality underscores the paradoxical demands of pursuing both stability and innovation, physical presence and virtual accessibility (Batat, 2024; Smith & Lewis, 2011; Schad, Lewis, Raisch, & Smith, 2016). The ambidexterity challenge faced by firms in balancing physical and digital strategies echoes wider findings about organizational ambidexterity, innovation performance, and social equity as critical factors in addressing pandemic-related grand challenges (Christofi et al., 2024).

Building on these shifts, scholars have highlighted the rise of phygital commerce—hybrid formats that blend physical and digital experiences. Research shows that the pandemic accelerated “retail phygitalization” as physical stores invested in digital channels and online retailers experimented with offline or hybrid strategies (Pantano & Willems, 2022). Phygital approaches enhance consumer–brand relationships by combining personalization, storytelling, and immersive experiences with the accessibility of digital platforms (Mele et al., 2024). At the same time, consumer studies indicate heterogeneity in adoption: some consumers act as “phygital integrators,” others prefer fully digital, while some remain anchored in physical shopping.

Finally, insights from ecosystem and collective action perspectives emphasize that the digital and phygital transitions were not achieved by firms or consumers alone, but through the coordinated evolution of an entire ecosystem of stakeholders. During the pandemic, value creation often relied on open innovation and collaborative responses—ranging from crowdsourcing initiatives like “EUvsVirus” to ecosystem effectuation strategies that leveraged cross-sectoral networks (Bertello, Bogers, De Bernardi, & Ferraris, 2022; Chesbrough et al., 2024). Such initiatives reinforced the durability of digital infrastructures by embedding them in broader innovation and governance systems. Furthermore, corporate social innovation efforts demonstrated how firms could leverage digital platforms to address societal needs while sustaining their own operations (Fu et al., 2024). Complementary work has argued that the pandemic underscores the necessity of adopting systems perspectives to understand sustainability and resilience in business models (Bansal, Grewatsch, & Sharma, 2021).

To summarize, pandemics such as COVID-19 exemplify how grand challenges can accelerate systemic transformations. The digital and phygital transformations of commerce illustrate how shocks can reconfigure market systems, institutionalize new practices, and intensify paradoxical tensions in strategy. For management and marketing research, this

underscores the importance of theoretical approaches that account for systemic, institutional, paradoxical, and ecosystemic dynamics when analyzing the long-term impact of health crises on commerce.

2.3 E-commerce after the outbreak of COVID-19

Previous research has consistently shown that COVID-19 accelerated the growth of e-commerce. Since the virus spreads through contact and droplets, people reduced face-to-face interactions and increasingly relied on "untact" transactions (Cho et al., 2020). Consequently, e-commerce became a strong alternative to in-person shopping by minimizing physical and social contact (Aryani et al., 2021).

Scholars have examined how the pandemic influenced e-commerce across regions. For example, Ghandour and Woodford (2020) reported a positive effect in the United Arab Emirates (UAE), based on a survey of 125 retailers. While consumer demand remained stable, the purchasing channel shifted from offline to online. In India, Sharma (2020) observed a 17% increase in e-commerce use following the pandemic, with further growth anticipated. In the United States, online retail sales rose by 68% as of mid-April, while orders grew by 129% and total online retail transactions by 146% (Columbus, 2020). Indonesia saw supermarket and hypermarket revenues decline by 12–15%, but e-commerce sales increased by 22% (Kanter, 2020). Similarly, Lithuania experienced a wider range of e-commerce services despite economic decline (Usas et al., 2021).

Other studies focused on the expansion of e-commerce across industries and product categories. During the pandemic, online platforms played a crucial role in ensuring food access and home delivery (Chang & Meyerhoefer, 2021). In China, Guo et al. (2022) reported sharp increases in food and agricultural sales through e-stores, largely driven by a shift in shopping behavior. In the U.S., Nielsen (2020) highlighted a positive correlation between local infection rates and online purchases of groceries, cleaning supplies, and diapers. In India, electronics, fashion, health, and pharmacy products recorded an average growth of 133% (Sharma, 2020). Germany also experienced rapid increases in online sales of groceries and medicines, although overall online sales fell 18% in March 2020 compared to the prior year (OECD, 2019). Korea recorded a 15.8% increase in e-commerce transaction value between July 2019 and July 2020 (OECD, 2020), with particularly strong gains in food services (66.3%), household goods (48%), and food and beverages (46.7%). In contrast, online spending on leisure, culture, and travel dropped by 67.8% and 51.6%, respectively. Panel data from Japan showed that demand for grocery goods grew significantly, while categories like software and media only saw modest improvements (Kawasaki et al., 2022).

Nonetheless, some studies present counterarguments. Although e-commerce surged,

many consumers continued to prefer traditional shopping. Aryani et al. (2021), using survey data from 200 Malaysian and Indian respondents, confirmed that offline shopping remained the favored method, even during the pandemic. Similarly, Dannenberg et al. (2020) noted that while online grocery sales increased disproportionately, the overall shift from physical to online grocery retail was limited. In Malaysia, reliance on trade with China led to a major economic slowdown at the beginning of the outbreak, which also hindered the growth of e-commerce (Hasanat et al., 2020).

Taken together, prior studies reveal mixed perspectives on the pandemic's impact on e-commerce. Moreover, the long-term implications of COVID-19 remain underexplored. Further research is therefore needed to examine how e-commerce patterns evolve before, during, and after the pandemic.

2.4. E-Commerce and M-Commerce

Within the broader rise of e-commerce, a clear shift toward mobile commerce (m-commerce) has emerged. Over the last decade, m-commerce has driven unprecedented increases in online traffic. Its share of global e-commerce sales rose from 52.4% in 2016 to 70.4% in 2020 and was projected to reach 72.9% in 2021 (Meghisani-Toma et al., 2021). In the Asia-Pacific region, m-commerce accounted for nearly 80% of e-commerce retail sales in 2022, reflecting the dominance of mobile devices in consumer transactions.

While the pandemic accelerated e-commerce adoption, the expansion of m-commerce is also linked to its inherent advantages—convenience, speed, and accessibility regardless of location. These features position m-commerce as the future primary channel for online activity (Paraschiv et al., 2022). Although some studies have addressed m-commerce as part of global trade trends during COVID-19 (Dumanska et al., 2021; Paraschiv et al., 2022), research is still lacking on its long-term trajectory in the post-pandemic context.

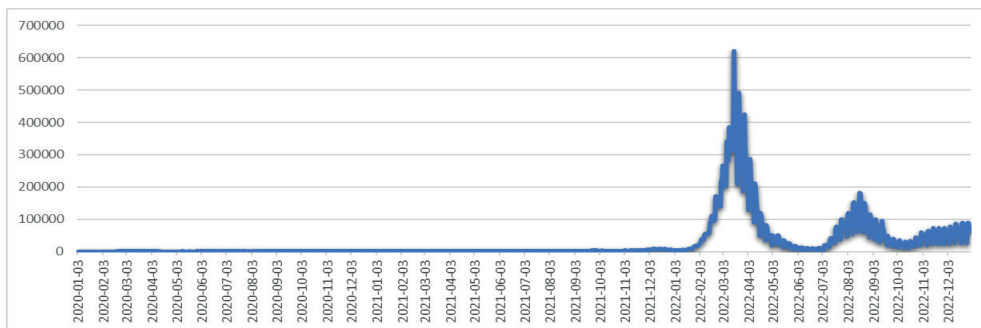
3. Empirical setting data and methods

3.1. Stylized Facts of COVID-19 in South Korea

This study focuses on the consequences of the COVID-19 pandemics on e-commerce in South Korea, that today is the fourth country worldwide in terms of e-commerce market size and the second in terms of e-commerce penetration (Statista, 2025). Figure 1 illustrates the daily confirmed cases of COVID-19 in South Korea. It demonstrates a noticeable surge in the number of confirmed cases from early March 2020. However, it is worth noting that after the first confirmed case on January 19, 2020, until June 2021, the number of newly confirmed cases remained within the range of three dig-

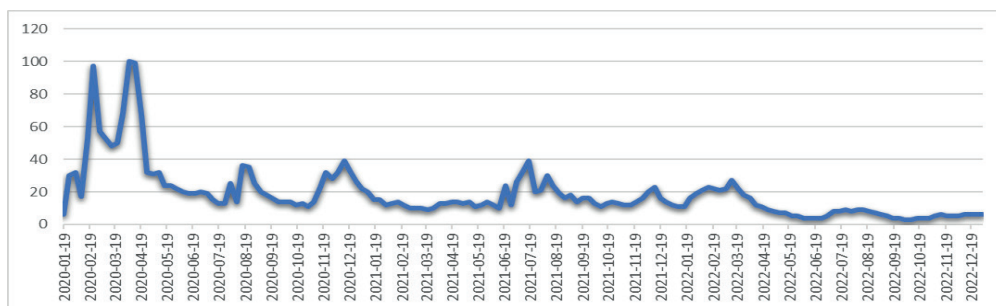
its. However, starting in July 2021, the country began to see four-digit figures in terms of confirmed cases. The number of cases increased steadily, reaching its peak at 621,328 on March 17, 2022, and has since been showing a downward trend.

Figure 1. Daily Confirmed Cases of COVID-19



On the other hand, Figure 2 illustrates the weekly Google Trends index for COVID-19 in South Korea. The index began to garner attention in mid-January 2020 and reached its peak in March and April 2020, indicating a significant surge in public interest during that period. This signals that the COVID-19 pandemic captured the attention of the Korean population starting in January 2020. Afterward, there was a consistent decline in interest. While the highest number of new confirmed COVID-19 cases was recorded in March 2022, the peak level of public interest was observed from late February to early April 2020. In the latter half of 2022, despite the number of confirmed cases in South Korea being in the double digits, the government started gradually easing the lockdown policies. Therefore, based on prior research (Guthrie et al., 2021), if the lockdown policies had an impact on e-commerce, it is predicted that the changes in these policies would have also influenced e-commerce. In this study, we extend prior research by examining the dynamic pattern of such impacts over time through a series of empirical models.

Figure 2. Weekly Google Trends Index for COVID-19



3.2. Data Description

We collected electronic commerce transaction data from the Korean Statistical Information Service⁽¹⁾, which provides transaction amounts categorized by online shopping platforms and product categories. The collected data covers monthly electronic commerce transaction amounts from January 2017 to December 2022. The online shopping platforms include Internet and mobile shopping. Our research specifically focuses on examining the dynamic impacts of COVID-19 on shopping patterns through these platforms. The analysis encompasses 23 different product categories. The product list are provided in the Appendix. The total transaction amount represents the combined sum of both internet and mobile transaction amounts. It reflects the overall transaction amount across all platforms, encompassing both internet and mobile channels. The average total transaction amount is 544,141.1 (in million Korean won). Specifically, the average transaction amount for internet shopping is 173,696.5 (in million Korean won), while the average transaction amount for mobile shopping is 370,444.6 (in million Korean won). These figures indicate that mobile transactions played an increasingly significant role in electronic commerce, contributing to a higher average transaction amounts compared to internet shopping. These variables are used as the dependent variables in this study. Table 1 shows the summary statistics of the dependent variables.

Table 1. Summary Statistics

Variables	Average	.S. D	Min	Max
Total Transaction Amount	544141.1	518539.9	7,443	2,575,567
Internet Transaction Amount	173696.5	165911.8	3,484	709,524
Mobile Transaction Amount	370,444.6	404025.1	3,959	2,443,537

where S.D. is standard deviation

In this study, we consider the period as the independent variable. As discussed in section 3.1, there was a significant surge in the interest in COVID-19 starting from

(1) https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1KE10071

mid-January 2020, and the interest in COVID-19 reached its peak in February and April. Given that we utilized quarterly data for the analysis in this study, we define the COVID-19 period as starting from January 2020. Consequently, we categorize the period from January 2017 to December 2019 as the pre-COVID-19 period, while the period from January 2020 to December 2022 is regarded as the COVID-19 period. By distinguishing these periods, we aim to analyze and compare the effects of COVID-19 on electronic commerce in dynamic and comprehensive manner.

Table 2 presents the findings from a t-test conducted on the dependent variables. The results indicate a significant increase in the total transaction amount during the COVID-19 period. Additionally, both the internet and mobile transaction amounts also showed significant increases during this period. It is important to note that the increase in the total transaction amount can be attributed to the growth in both internet and mobile transactions. However, it is crucial to determine whether these increases remain significant when controlling for various other factors. Economic variables, in particular, may have an impact on the transaction increases, highlighting the need to include them as control variables in our analysis. By doing so, we can assess the sustained effects of COVID-19 on transaction patterns while considering the broader economic context.

Table 2. T-test

Variables	Pre-COVID-19	COVID-19	t-statistic	p-value
Total Transaction Amount	411,499.2	669,613.2	10.44	000.
Internet Transaction Amount	161,691	185,053.1	2.87	000.
Mobile Transaction Amount	249,808.2	484,560.1	12.34	000.

3.3 Model Specification

In this study, our primary objective is to investigate the dynamic effects of COVID-19 on electronic commerce, specifically focusing on internet and mobile transactions over a span of three years. To accomplish this, our approach involves employing a model that can effectively capture the dynamic patterns observed in transactions influenced by COVID-19. By utilizing such a model, we can gain valuable insights into the evolving nature of electronic commerce in response to the pandemic.

We adopt a methodology inspired by Garthwaite (2014), who examined the effects of celebrity endorsements on book sales. Garthwaite utilized linear regression models with time dummy variables to analyze the influence of celebrity endorsements on book sales within a specific time period. Celebrity endorsements were considered external factors

or “outer shocks” due to their random nature. By incorporating time dummy variables into the linear regressions, Garthwaite aimed to evaluate the impact of celebrity endorsements on book sales. Significant impacts of celebrity endorsements on book sales would be captured by the time dummy variables. This approach allowed for the analysis of the causal relationship between celebrity endorsements and book sales while considering the random occurrence of these endorsements.

In our study, the occurrence of COVID-19 can be considered as a random event, similar to an external shock. This provides us with an opportunity to investigate the impacts of the pandemic on the dependent variables of interest. To incorporate this analysis into our regression models, we introduce time dummy variables that capture the period affected by COVID-19, referred to as the “COVID-19 period.” These dummy variables allow us to examine the specific effects of the pandemic on the variables under investigation and assess the statistical significance of these effects. By considering COVID-19 as an external shock and incorporating it into our regression models, we can gain valuable insights into the impacts of the pandemic on the variables of interest.

By utilizing a product-level fixed-effects model, we are able to accurately capture the dynamic effects of the pandemic on electronic commerce and gain a comprehensive understanding of its effects over time. This is the specification of the model that we deploy:

Dependent Variables

$$\begin{aligned}
 &_{-iq} = \alpha + \sum_0^{11} \beta_l * I\{l^{th} _quarter_from_January_2020\} + \sum_1^{12} \gamma_m * I\{Month\} \\
 &+ \sum_1^6 \delta_n * I\{Year\} + \varepsilon_{it}
 \end{aligned}$$

where i =product and q =quarter. In the above model specification, we consider the dependent variables (Dependent Variables $_{iq}$) to be the total transaction amount, internet transaction amount, and mobile transaction amount. To convert the monthly data into quarterly data (3-month intervals), we calculated the average of the data for each three-month period. We also include a stochastic error term (it) to account for any unexplained variation in the dependent variables. By examining the relationships between the independent variables, such as the COVID-19 period and other control variables, and the dependent variables, we can assess the impacts and dynamics of COVID-19 on these transaction amounts.

The β_m coefficients in our model capture the changes in transaction amount for a specific quarter "1" since the outbreak of COVID-19. To represent this impact, we introduce an indicator function called $I_{1,t}$, which takes a value of 1 if transaction happened within the "1" quarter of the pandemic's outbreak and 0 otherwise. By including these indicator variables in our regression model, we can assess the persistence of the impact of COVID-19 on electronic commerce transactions over a three-year period since the outbreak. We expect to observe noticeable changes in the transaction patterns, which will be reflected in statistically significant coefficients β_m in our estimates.

To address potential confounding factors and control for additional influences on the transactions, we incorporate indicator variables and $I_{1,t}$ into our analysis. These variables allow us to account for any month-specific or year-specific impacts that could affect the transactions independently of the COVID-19 pandemic. By including these control variables, we can isolate and examine the specific impact of COVID-19 on the transactions, while considering and adjusting for other time-related variations in the data. This helps us to obtain a more accurate understanding of the unique effects of COVID-19 on electronic commerce. In addition, we incorporated the log-transformed gross domestic product per capita and household internet penetration rate as economic variables(2).

4. Empirical results and findings

In this section we illustrate our findings. More specifically, Table 3 shows empirical results. The dependent variables of the columns, (1), (2), and (3) are the log-transformed total, internet, and mobile transaction amounts, respectively. Upon examination of the first column (1) in Table 3 and the top-left graph of Figure 3, it is evident that the estimated coefficients consistently exhibit a positive trend. Notably, this positive trend intensifies as the analyzed period progresses, extending until the end of 2022. Especially, the estimated coefficients of Fourth Quarter 2020, First Quarter 2021, Second Quarter 2021, Third Quarter 2021, Fourth Quarter 2021, First Quarter 2022, Second Quarter 2022, Third Quarter 2022, and Fourth Quarter 2022 are significantly positive ($\beta_{\text{Fourth Quarter 2020}}=.255, p<.01, \beta_{\text{First Quarter 2021}}=.339, p<.01, \beta_{\text{Second Quarter 2021}}=.393, p<.01, \beta_{\text{Third Quarter 2021}}=.394, p<.01, \beta_{\text{Fourth Quarter 2021}}=.504, p<.01, \beta_{\text{First Quarter 2022}}=.423, p<.01, \beta_{\text{Second Quarter 2022}}=.483, p<.01, \beta_{\text{Third Quarter 2022}}=.500, p<.01, \beta_{\text{Fourth Quarter 2022}}=.538, p<.01$, respectively). These findings suggest a dynamic increase in the total transaction amount over time. Specifically, the increase becomes more pronounced, indicating that the impact of the pandemic on the total transaction amount was not

(2) https://www.index.go.kr/unity/potal/main/EachDtlPageDetail.do?idx_cd=1345

immediate but gradually intensified.

In contrast, the results of the second column (2) indicate that the increase in the total transaction amount is not primarily driven by the internet transaction (β First Quarter 2020=-.015, $p>.01$, β Second Quarter 2020=-.039, $p>.01$, β Third Quarter 2020=.021, $p>.01$, β Fourth Quarter 2020=.108, $p>.01$, β First Quarter 2021=.155, $p>.01$, β Second Quarter 2022=.205, $p>.01$, β Third Quarter 2022=.183, $p>.01$, and β First Quarter 2022 =.106, $p>.01$, respectively). Most of the estimated coefficients for internet transactions are not statistically significant, except for the year 2020. These findings highlight the need for a more comprehensive and longer-term analysis to explore the dynamic impacts of COVID-19 on internet transactions.

On the other hand, the results from the third column (3) provide insights into the positive impacts of COVID-19 on transaction amounts, particularly in the context of mobile transactions. Starting from the first two quarters, the impacts of COVID-19 on mobile transaction amounts become significantly positive (β Third Quarter 2020=.234, $p<.01$, β Fourth Quarter 2020=.321, $p<.01$, β First Quarter 2021=.383, $p<.01$, β Second Quarter 2021=.424, $p<.01$, β Third Quarter 2021=.446, $p<.01$, Fourth Quarter 2021=.578, $p<.01$, β First Quarter 2022=.554, $p<.01$, β Second Quarter 2022=.603, $p<.01$, β Third Quarter 2022=.614, $p<.01$, and Fourth Quarter 2023 =.649, $p<.01$, respectively). Moreover, the magnitude of these impacts increases over time, indicating a strengthening effect of COVID-19 on mobile transaction amounts. This suggests that the surge in mobile transactions is the primary driver of the positive impacts of COVID-19 on overall transaction amounts.

However, it is important to note that there are also positive impacts on internet transactions starting from the second quarter of 2022, indicating the need for a more extended analysis to fully understand the impact. In conclusion, COVID-19 has brought positive impacts on electronic commerce, although it is not explicitly clear whether these impacts are solely attributed to mobile transactions. The impacts of COVID-19 on internet and mobile transactions are visualized in Figure 3, specifically in the top-right and bottom-left graphs, respectively.

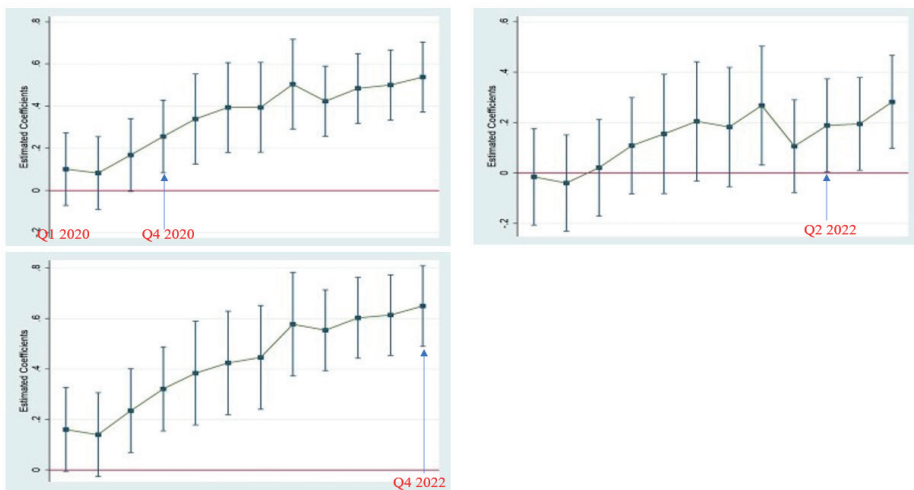
Table 3. Empirical Results

	(Model (1 DV: log(Total Transac- tion Amount	(Model (2 DV: log(Internet Transaction Amount	(Model (3 DV: log(Mobile Trans- action Amount
First Quarter 2020	101. (066.)	015.- (073.)	160. (064.)
Second Quarter 2020	082. (066.)	039.- (073.)	139. (064.)
Third Quarter 2020	168. (066.)	021. (073.)	***234. (064.)
Fourth Quarter 2020	***255. (066.)	108. (073.)	***321. (064.)
First Quarter 2021	***339. (082.)	155. (091.)	***383. (079.)
Second Quarter 2021	***393. (082.)	205. (091.)	***424. (079.)
Third Quarter 2021	***394. (082.)	183. (091.)	***446. (079.)
Fourth Quarter 2021	***504. (082.)	***267. (091.)	***578. (079.)
First Quarter 2022	***423. (064.)	106. (071.)	***554. (061.)
Second Quarter 2022	***483. (064.)	***189. (071.)	***603. (061.)
Third Quarter 2022	***500. (064.)	***194. (071.)	***614. (061.)
Fourth Quarter 2022	***538. (064.)	***282. (071.)	***649. 061.
(log(GDP Per Capita	Included	Included	Included
(log(HIPR	Included	Included	Included
Intercept	Included	Included	Included

	(Model (1 DV: log(Total Transac- tion Amount	(Model (2 DV: log(Internet Transaction Amount	(Model (3 DV: log(Mobile Trans- action Amount
Month-fixed Effect	Included	Included	Included
Year-fixed Effect	Included	Included	Included
R-squared	53.19%	16.65%	65.92%
of Observation #	552	552	552

where HIPR is household internet penetration rate. *** <math><0.01</math>.

Figure 3. Graphical Representation



5. Discussion of the findings

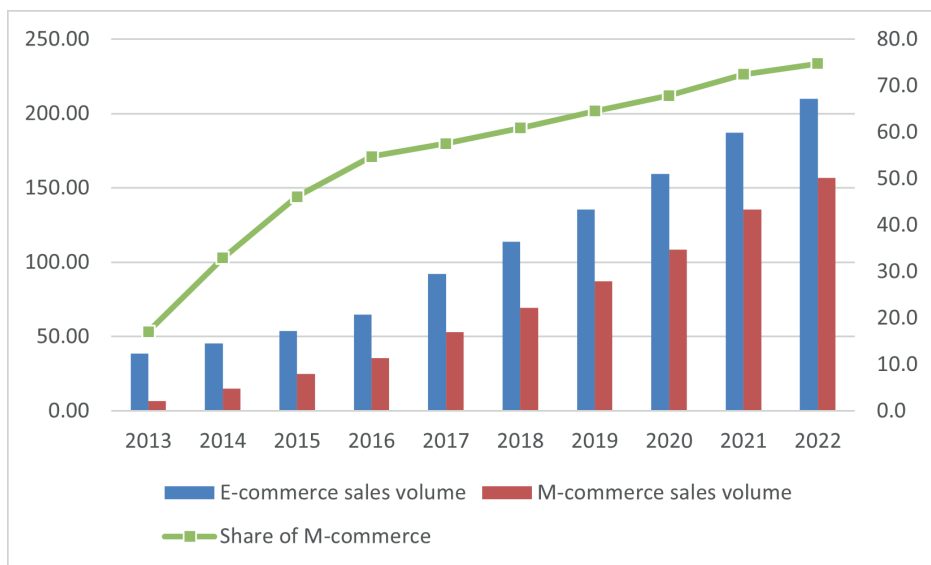
Our study demonstrates a dynamic increase in online transactions over time. In particular, the fact that the increase became more prominent suggests that the impact of the pandemic on the total transaction amount was not immediate but gradually strengthened. This result is in line with and supports the argument of previous studies that while some changes in demand may only be temporary, others are likely to have long-lasting effects on e-commerce. OECD (2020) suggests elderly consumers who began using e-commerce to maintain social distancing might remain loyal to these practices. At the onset of COVID-19, 21 percent of adults in the United States have started ordering groceries

online or through an app from a local store, and the percentage remains close to the same (19 percent) among only the elderly (OECD 2020). Not only the older users, but also the overall consumers have become more aware of the economic and environmental benefits of e-commerce platforms as a result of the pandemic-induced fear (Tran, 2021). As Mathur et al. (2003) found, traumatic events such as terrorist attacks, natural disasters, and pandemics have long-term ramifications, including behavioral changes and a shift in consumer lifestyles to adjust to their new reality. Given that convenience has always been a key incentive for e-commerce engagement, it is likely that many new users will continue to purchase some goods online in the future (OECD 2019).

Our study also demonstrates the positive impact of COVID-19 on transaction amounts, especially with respect to mobile transactions. The lasting positive effect of COVID-19 on m-commerce presents its dominant position that leads to the growth of the entire e-commerce industry.

As shown in Figure 4, although the mobile shopping sales volume in South Korea increased continuously every year since 2013, sales have experienced a substantial surge during the last two years after the pandemic outbreak. The mobile shopping share accounted for 74.8% in 2022, that is, the largest share of entire online shopping transactions.

Figure 4. Sales Volume of E-commerce and M-commerce in South Korea from 2013 to 2022



Notably, the category with the highest value for online shopping transactions in Korea was the food service sector, with a value of over 26 trillion won (Statista 2023). The largest part of that figure came from mobile shopping for food services. We recall previous research that focused on the positive impact of COVID-19 on the food and e-grocery industries. In a similar context, the effect of COVID-19 on m-commerce in Korea might be explained by the growth of the e-grocery industry, especially through mobile transactions. Given the predominant trend of m-commerce in South Korea, further research is necessary regarding the divergent impact of COVID-19 on internet-based and mobile-based transactions on a specific product type basis.

6. Conclusion

6.1 Theoretical contributions

Our findings contribute to the growing body of research on grand challenges and the digital transformation of commerce in several ways. First, we extend the literature on pandemics as grand challenges by demonstrating how the effects of COVID-19 on consumer behavior were not immediate, but rather cumulative and path-dependent. While prior studies have highlighted the sudden disruptions caused by exogenous shocks (Ivanov, 2020; Pantano et al., 2020), our results show that the full impact of COVID-19 on e-commerce materialized gradually and over a long span of time, as consumers increasingly routinized online purchasing. In addition to pointing out that the pandemic's effect on e-commerce displays a long-lasting nature, this insight aligns with complexity and systems theory perspectives (Ferraro et al., 2015), which emphasize feedback loops and reinforcing mechanisms, but adds nuance by showing that such dynamics unfold over extended time horizons rather than instantaneously.

Second, we contribute to institutional theory by highlighting how the pandemic not only catalyzed but also consolidated digital consumption practices, particularly among consumer groups previously resistant to online shopping, such as the elderly. This finding illustrates how crisis-induced adoption can become institutionalized as new norms and cognitive schemas (Scott, 2013; Hinings et al., 2018). By demonstrating that elderly consumers, once motivated by social-distancing imperatives, continue to engage in e-commerce, we provide empirical evidence of the institutional stickiness of digitally mediated consumption. Our study thus advances research on how temporary shocks contribute to lasting institutional change in consumer markets.

Third, our findings deepen paradox theory's application to digital commerce. Prior scholarship has highlighted how firms must balance offline and online channels (Smith & Lewis, 2011; Schad et al., 2016), but our results indicate that consumers themselves also navigate paradoxical demands—valuing both the convenience of digital shopping and the relational or experiential benefits of physical stores. By documenting the rapid acceleration of m-commerce in South Korea, particularly in the food and grocery sectors, we show that the paradox of stability and innovation manifests not only at the firm level but also at the consumer level, where individuals continuously renegotiate their consumption practices between digital and physical contexts.

Fourth, we add to the literature on ecosystem perspectives of grand challenges by underscoring the centrality of mobile commerce (m-commerce) as a driver of broader systemic transformation. While previous work has emphasized the role of ecosystems in enabling digital transitions (Bertello et al., 2022), our findings suggest that m-commerce acts as an anchoring mechanism that accelerates ecosystem-wide change. The dominance of mobile platforms in food services demonstrates how sectoral shifts in consumer demand can restructure entire digital ecosystems, reinforcing interdependencies between technological infrastructure, consumer practices, and industry evolution.

Fifth, our study contributes to the emerging discussion on the long-term effects of grand challenges on consumer behavior. While prior research has questioned whether pandemic-induced changes are transitory or enduring (Dannenberg et al., 2020; Aryani et al., 2021), our findings support the view that certain behavioral adjustments—particularly those tied to convenience and accessibility—are likely to persist. In doing so, we extend the literature on consumer adaptation to traumatic events (Mathur et al., 2003) by illustrating how health crises not only accelerate technological adoption but also permanently alter the structure of consumer lifestyles.

Sixth, we advance the literature on sectoral differentiation within digital transformation by showing that the pandemic's impact was uneven across product categories, with food services and e-groceries emerging as primary drivers of mobile transaction growth. While prior studies have examined overall increases in e-commerce (e.g., Sharma, 2020; Usas et al., 2021), our findings reveal the importance of distinguishing between industries to understand how grand challenges redistribute demand within market systems. This contributes to marketing scholarship on transformative consumer research (Mick et al., 2012) by highlighting how crises reconfigure consumption hierarchies and accelerate the digitalization of essential goods.

Seventh, we contribute to the debate on resilience and sustainability in commerce by positioning m-commerce not only as a convenience-driven channel but also as an adaptive infrastructure that enables continuity under crisis conditions. In line with research on organizational resilience (Bansal et al., 2021; Scherer et al., 2020), our results suggest that mobile platforms are more than technological tools: they represent resilient market architectures capable of absorbing shocks and ensuring consumer access to essential goods. This insight enriches systems and collective action theories by emphasizing the infrastructural dimension of resilience in addressing grand challenges.

Eight, this study extends e-commerce literature (Bawack et al., 2022; Maseeh et al. 2021) by providing a different viewpoint: that of m-commerce. To the best of our knowledge, this is an initial attempt to unpack and break down analytically e-commerce transactions into internet-based and mobile-based to specifically analyze their dynamics over time. In particular, we demonstrated that mobile transactions were the main driver of overall e-commerce growth after the COVID-19 pandemic. This indicates that m-commerce has become a growing landscape where consumers act in the post-pandemic period.

Taken together, these contributions highlight how the COVID-19 pandemic, as a grand challenge, catalyzed a multi-level transformation of commerce. By combining systems, institutional, paradox, ecosystem, sectoral, and resilience perspectives, our study advances theoretical understanding of how exogenous shocks produce enduring change in both consumer behavior and market structures.

6.2 Managerial implications

Our study offers several practical implications for managers and consumers in navigating the post-pandemic digital commerce landscape. First, for managers, the findings highlight the importance of investing strategically in m-commerce platforms and mobile-first strategies. The dominance of mobile transactions, especially in essential sectors such as food services, suggests that firms prioritizing mobile-friendly interfaces, app-based engagement, and seamless payment systems are better positioned to capture and retain consumer demand. Beyond convenience, mobile platforms allow firms to leverage personalization, push notifications, and location-based services, enhancing customer loyalty in a competitive digital market.

Second, for e-commerce companies and brick-and-mortar retailers, our findings emphasize that the pandemic-driven demand shifts are not merely temporary but are likely to endure. This has two important implications. For traditional brick-and-mortar stores, e-commerce—particularly mobile commerce—should no longer be viewed as a peripheral

or short-term sales channel but as a strategic necessity. For firms that already possess a digital presence, our results underscore the need to build and strengthen mobile sales infrastructures and workforce capabilities that ensure long-term competitiveness in a mobile-dominated retail environment.

Third, for managers and retailers in traditional sectors, the gradual but lasting shift toward digital consumption underscores the need for phygital integration. While many consumers will continue to value physical stores, these must be complemented by digital touchpoints such as click-and-collect, digital loyalty programs, and omnichannel service options. Firms that fail to balance physical and digital channels risk losing consumers who increasingly view hybrid shopping as the norm.

Last, for consumers, the findings suggest that the pandemic has accelerated awareness not only of convenience but also of the economic and environmental benefits of e-commerce. Increased reliance on digital and mobile platforms can reduce travel, lower transaction costs, and in some cases promote sustainability by consolidating logistics. However, consumers must remain vigilant about challenges such as data privacy, over-consumption, and the carbon footprint of delivery services. Public awareness campaigns and consumer education can support responsible digital consumption practices. Furthermore, consumers should be given access to the Internet thus reducing the digital divide to make sure they can benefit from online shopping.

6.3 Implications for policy makers

Our study offers also several practical implications for policymakers in navigating the post-pandemic digital commerce landscape. First, for policymakers, our results demonstrate the need to strengthen the digital infrastructure and regulatory frameworks that support inclusive and resilient commerce. The institutionalization of digital shopping practices—especially among elderly and previously underserved consumers—calls for targeted policies that expand broadband access, ensure secure digital payment systems, and provide consumer protections against fraud. Moreover, fostering competitive ecosystems requires balancing innovation incentives with consumer safeguards to prevent market concentration and digital exclusion.

Second, for policymakers, the differentiated impact of COVID-19 across industries highlights the necessity of sector-specific strategies. For instance, food services and e-grocery have emerged as key growth drivers of m-commerce, requiring investments in cold-chain

logistics, last-mile delivery, and cross-sector collaboration between retailers, tech providers, and regulators. By contrast, sectors such as leisure, travel, and culture require tailored recovery strategies that combine digital channels with physical experiences to rebuild demand. A one-size-fits-all approach to digital transformation risks overlooking the unique needs of different industries and consumer groups.

Third, our findings suggest that policymakers could explicitly integrate mobile commerce into broader digital resilience and sustainability agendas. The dominance of m-commerce, particularly in essential sectors such as food services, indicates that mobile platforms function as critical infrastructures during systemic shocks rather than merely as optional commercial channels. Policymakers should therefore support the development of interoperable, energy-efficient, and scalable mobile ecosystems that can maintain continuity of access to essential goods in future crises. This includes encouraging standardization across platforms, promoting data portability, and aligning digital commerce policies with environmental and urban planning objectives, such as reducing delivery-related emissions. By treating m-commerce as part of national resilience planning, policymakers can better leverage digital markets to address future grand challenges while balancing efficiency, sustainability, and social inclusion.

The aforementioned managerial and policymaking implications conjointly stress that post-pandemic commerce requires coordinated action across firms, consumers, and policymakers. Firms must embrace mobile-first and phygital strategies, consumers must adopt responsible digital behaviors, and policymakers must create enabling environments for inclusive and sustainable digital ecosystems.

6.4 Limitations and Future Research

This study is not without limitations. First, we focused on one country, South Korea, that today is the fourth country worldwide in terms of e-commerce market size and the second in terms of e-commerce penetration (Statista, 2025). In future studies it might be interesting to analyze more countries in order to enhance generalizability of the results, first by comparing the South Korean market with other large e-commerce markets (such as the US and Chinese one) and also with a group of markets where e-commerce is less developed. Second, it is plausible that not all online or mobile sellers and product categories in countries benefitted from the surge in e-commerce (OECD, 2020). Accordingly, future research could compare the changing patterns in e-commerce across not only countries, but also product categories and sellers.

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Appendix

Domestic Online Shopping Categories	Duty-Free Shopping Categories
1. Computers and Peripherals	1. Home Appliances, Electronics, and Telecommunication Devices
2. Home Appliances, Electronics, and Telecommunication Devices	2. Software
3. Books	3. Books
4. Office Supplies and Stationery	4. Office Supplies and Stationery
5. Clothing	5. Music, Videos, and Musical Instruments
6. Shoes	6. Clothing and Fashion-related Products
7. Bags	7. Sports and Leisure Goods
8. Fashion Accessories and Apparel	8. Cosmetics
9. Sports and Leisure Goods	9. Children and Baby Products
10. Cosmetics	Food and Beverages .10
11. Children and Baby Products	,Agricultural, Livestock.11 and Fishery Products
12. Food and Beverages	Household and Automotive Goods .12
13. Agricultural, Livestock, and Fishery Products	Other .13
14. Household Goods	
15. Automotive and Auto Supplies	
16. Furniture	
17. Pet Supplies	
18. Travel and Transportation Services	
19. Culture and Leisure Services	
20. E-coupon Services	
21. Food Services	
22. Other Services	
23. Other	