

Financial Impacts of the COVID-19 Pandemic on the Cultural and Creative Industries: Evidence from Taiwan

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Abstract

In the past, it has been confirmed that the COVID-19 pandemic has had a significant negative impact on the cultural and creative industries (C&CIs), but most of this evidence comes from surveys of small and individual enterprises. To date, no study has focused on a financial review of listed firms. This study examines the impact of the COVID-19 pandemic on the financial and operational status of the C&CIs, focusing on 40 firms listed on the Taiwan Stock Exchange. During the 2015–2023 study period, the five categories of major financial indicators and operational indicators were used to test for the equality of means before and during the COVID-19 pandemic. It was empirically found that during the COVID-19 pandemic, the financial structure, solvency, operating capacity, and profitability of the sample firms changed significantly, but there were no significant changes in cash flows or operational indicators. There has not been a significant deterioration in the financial structure of the digital gaming industry (DGI), which has emphasised digitalisation. Although their profitability improved, they did not find the effect to be as significant as expected. The non-DGI group had significantly increased debt ratios and long-term fund-to-fixed-asset ratios, whereas their profitability decreased significantly. This evidence provides some support for the advantages and robustness of DGI in terms of financial performance during the COVID-19 pandemic. The combination of digital technology and securities market fundraising was beneficial to the development of the C&CIs, which were better able to cope with the risks arising from certain unknown and irresistible major events.

Key words

COVID-19, financial indicators, cultural and creative industries, digital game industry, publicly traded company.

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Introduction

Coronavirus disease 2019 (COVID-19) has recently become one of the most infectious diseases in the world, resulting in a widespread global pandemic from 2020 to 2022. The number of infections (over 600 million) has had a significant effect on people's livelihoods and economic development. Fortunately, the World Health Organisation (WHO) announced in 2023 that it would no longer consider the COVID-19 pandemic a public health emergency, marking a significant milestone in the fight against the epidemic. During the 2020–2022 pandemic, governments around the world adopted several antiepidemic policies to prevent the spread of the virus, including restricting travel and access to public places, working and attending classes from home, and

preventing people from entering and leaving cities freely (Kaźmierska-Jóźwiak et al., 2021; Snowball & Gouws, 2022; Lee & Liu, 2024). These policies restrict people's daily lives and activity space, affecting many economic activities and industry operations.

Numerous studies have confirmed the impact of the COVID-19 pandemic and other major infectious disease events on specific industries. The results revealed that these epidemics had varying directions and degrees of impact on different industries, and most were concluded to have had negative impacts. Examples include finance-related industries (Elnahass et al., 2021; Ullah, 2023; Liu, 2025a), the film industry (Lee & Liu, 2024), tourism (Liu & Lee, 2022a), and aviation (Rababah et al., 2020). However, some studies on the environmental protection industry (Zhang & Fang, 2022) and the logistics industry (Atayah et al., 2022) have reported positive findings. Nonetheless, some studies confirmed the divergence of views on the impact among hospital peers (Wang et al., 2022). Some studies on the C&CIs tend to reveal a negative impact (Snowball & Gouws, 2022; Kantor & Kubiczek, 2021), especially in terms of the music industry, festivals, and cultural events (Khlystova et al., 2022). However, there was evidence of a positive impact on creative industries related to IT and software (Khlystova et al., 2022). This evidence suggests that the impact of the epidemic on the C&CIs may vary in degree and direction among peers.

Past studies on the impact of the COVID-19 pandemic on the C&CIs have been limited to financial performance, and there is still a lack of extensive reviews of companies' financial and operational health. This study focuses on companies classified as cultural or creative stocks in the Taiwanese stock market, presenting empirical evidence based on annual financial statements and basic operating data released by these companies. These financial data were prepared by the company in accordance with the International Financial Reporting Standards (IFRS), audited and verified by a registered and qualified accountant, and published in accordance with government regulations, which lends them a certain degree of credibility and reference. The objectives of this study are as follows: 1) to explore the impact of the COVID-19 pandemic on industry through a review of corporate finance and operational fundamentals in the C&CIs. 2) Financial structure, solvency, operating ability, profitability, and cash flows (20 items in total) are tested on the basis of the five categories of major financial indicators, and firms' basic operational indicators (five items) are used to understand the impact of the COVID-19 pandemic on finance and operations. 3) The C&CIs are divided into the digital game industry (digital game group) and the remaining C&CIs (nondigital game group), and the test results of each group are used to further compare the groups. 4) The results of the study provide some reference for the financial planning and management of the C&CIs in the face of similar emergencies in the future.

The following sections of this paper are as follows: Section 1 presents a literature review, Section 2 presents the methodology, Section 3 presents the research results and discussion, and Section 4 presents the conclusions.

1. Literature review

Corporate sustainability has been a hot topic in recent years (Meuer et al., 2020; Grewal & Serafeim, 2020; Ardito, 2023; Skocdopole et al., 2023). However, business failure can affect the sustainable operation of enterprises (Amankwah-Amoah et al., 2021) and lead to market exit. One type of business failure is caused by sudden, unpredictable, and difficult-to-mitigate events (Petrucci & Milanesi, 2022). These major events and extreme environmental shocks (such as those caused by the COVID-19 pandemic and other global crises) have caused businesses to suddenly disappear or gradually face bankruptcy and failure. Numerous studies have confirmed that a firm's financial factors are among the primary reasons for business failure. Schalck and Yankol-Schalck (2021) confirmed the role of financial variables in predicting business failure, linking the important relationship between a firm's finances and business failure. Shpak et al. (2022) proposed assessing the financial status of enterprises to ensure their viability and reduce business failure. The risk of old firms closing down due to poor financial conditions is increasing again (Kücher et al., 2020). Dörr et

al. (2022) reported that Germany's COVID-19 policy response triggered a backlog of business failure, which was particularly pronounced among financially weak small firms. In addition, Ellul et al. (2020) explored the COVID-19 pandemic and corporate finance with three themes. First, businesses were able to raise substantial external financing through bank loans and access to public markets, a “dash for cash” in the early stages of the pandemic. Second, the impact of COVID-19 and the related lockdown on firms' liquidity and equity position was considered. As firms navigate the COVID-19 pandemic, they face significant hurdles, including equity shortfalls and debt overhangs, which could potentially lead to zombie lending issues. Third, they studied the firm characteristics (e.g. the firm's balance sheet and business models) that caused the stock prices of firms to react in the early stages of the pandemic. These are larger firms. However, due to the particularities of some smaller firms and cultural products in the C&CIs, it is generally not easy to raise funds through financial institutions or by issuing securities. Therefore, crowdfunding is a unique fundraising method for cultural and creative firms (Handke & Dalla Chiesa, 2022). Konhäusner et al. (2021) took the C&CIs of digital entertainment as an example, using crowdfunding as an alternative financing method to realise projects. They discussed the different benefits that crowdfunding brings to the organisations that run the campaigns.

1.1 Corporation Finance and Operational Fundamentals

Many studies in the past have focused on the financial performance of companies, highlighting the importance of corporate finance. Kyere and Ausloos (2021) examined the corporate governance mechanisms of the UK non-financial listed industry based on two financial performance indicators: return on assets (ROA) and Tobin's Q, and reported a significant relationship between corporate governance and financial performance. Cho et al. (2019) linked the relationship between corporate social responsibility (CSR) and corporate financial performance. Ekinici and Poyraz (2019) confirmed a negative correlation between credit risk and financial performance in the banking sector. Iqbal et al. (2019) analysed the relationship between corporate governance and the financial performance of Asian MFIs, identifying a bidirectional relationship between the corporate governance index and five financial performance indicators. Specifically, profitability and sustainability improved with good governance practices. In addition, we address the operational fundamentals. Lin et al. (2021) explored the impact of firm characteristics (firm size and revenue) on firm financial performance (ROA and return on equity (ROE)). Achim et al. (2022) reported that equity financing, effective liquidity management, and expansion of firm size during the COVID-19 pandemic underpinned the performance of ROE and ROA. Zhou et al. (2022) confirmed that improving a firm's ESG performance can increase the company's market value.

1.2 Impact of the COVID-19 Pandemic on the Market or Industry

Many studies have confirmed that the COVID-19 pandemic will have different impacts on different markets or industries. For example, in a European listed company, Mahssouni et al. (2023) reported that COVID-19 had a significant negative impact on financial performance, as measured by ROA and ROE. Liu and Lee (2022b) confirmed a significant increase in the systemic risk of Yuanta's Shanghai Stock Exchange 50 ETF traded in the Taiwan securities market following the COVID-19 pandemic, as well as a significant reduction in the fund's asset size. Chen and Liu (2023) examined the impact of the late COVID-19 pandemic on Taiwan's stock market, finding that stock price reactions varied across different markets and industries. The stock exchange market (SEM) has decreased, while the over the counter (OTC) market has increased. Meanwhile, the sports and prevention industries have decreased, and the restaurants and biotechnology industries have increased. Smrt et al. (2025) confirmed that the COVID-19 pandemic had a significant impact on stock prices in the global video game industry. Ullah (2023) confirmed that new COVID-19 information will have a negative impact on the daily returns of financial markets worldwide. Achim et al. (2022) reported that during the COVID-19 pandemic, net profit decreased by 37.43% across the market. However, smaller companies in agriculture, commerce, construction, IT research and development, and transportation and warehousing performed better financially.

Among SMEs, Rababah et al. (2020) reported that the financial performance of Chinese listed companies has been most affected by the COVID-19 pandemic, with tourism and aviation being the most affected. Elnahass et al. (2021) confirmed that the outbreak of COVID-19 has adversely affected the financial performance and financial stability of the global banking sector. Song et al. (2021) examined the impact of COVID-19 on the stock returns of U.S. restaurant companies and reported that international restaurant companies that used to be larger, more leveraged, have greater cash flow, and lower ROA were more resilient to COVID-19. Zhang and Fang (2022) reported that environmental protection companies performed better during the COVID-19 pandemic, while SMEs were less vulnerable than large enterprises were. The evidence suggests that the severity of the damage caused by COVID-19 depends on the size of the company and the investment in pollution abatement technologies. Environmentally friendly SMEs have been less affected by the pandemic, which may be related to the effectiveness of the government's relief programs for environmentally friendly SMEs. Atayah et al. (2022) investigated the correlation between the financial performance of listed logistics companies and COVID-19, and the results revealed that the financial performance of logistics companies was significantly greater in 2020. Finally, Wang et al. (2022) evaluated the changes in the financial performance of California hospitals related to the COVID-19 pandemic and reported that the impact on hospital finances was diverse, and they agreed that government assistance programs mitigated the economic losses of hospitals.

1.3 Cultural and Creative Industries

Many studies have confirmed the importance of culture and the arts, as well as their vulnerability to economic shocks (Shin, 2025). Protogerou et al. (2022) reported that adverse economic conditions (COVID-19) contribute to the characteristics of creative industries: 1) highly international entrepreneurial teams with extensive overseas work and study experience and 2) companies that also combine creative expertise with management and marketing expertise. 3) Export oriented, able to serve a diverse customer base, and invest in digital technologies. Snowball and Gouws (2022) argued that lockdown rules and social distancing policies imposed by the COVID-19 pandemic had a negative effect on C&CIs in these countries. Kantor and Kubiczek (2021) explored the impact of the COVID-19 pandemic on the activities of cultural institutions and reported that the pandemic has reduced the income of cultural institutions, leading to a significant deterioration in their financial situation. Che Arshad and Irijanto (2023) reported that the creative industries contributed to the economic growth of Association of Southeast Asian Nations (ASEAN) countries during the COVID-19 pandemic, as the Sukuk bond market played a significant role in driving economic growth. Escalona-Orcao et al. (2021) explored the impact of the COVID-19 pandemic on the cultural and creative ecosystems of 81 cities in Spain. Nonmetropolises appear to be more vulnerable, whereas metropolises appear to be safer because of increased and accelerated digitalization.

Khlystova et al. (2022) revealed several positive impacts of the COVID-19 pandemic on creative industries (IT and software), as well as negative impacts on the music industry, festivals, and cultural events, via a literature review approach. Yue (2022) compared the combination of emergency resilience and ecological resilience that underpins the crisis of C&CIs and proposed that ecological resilience is characterized by a focus on transformation and resilience as a decentralized strategy and networked resources in the long term. Zhang et al. (2022) reported that the pandemic had a significant negative effect on the stock market returns of cultural industries, but there were significant differences in the degree of impact on each creative subsector. The results of the study suggest that digitalisation can effectively reduce the negative impact of COVID-19 on cultural companies, whereas the pandemic has had a greater negative impact on small and newly established cultural companies. Snowball and Gouws (2022) examined the impact of the COVID-19 pandemic on South Africa's Community and Constituency Institutions (C&Cs) through a survey of companies

and freelancers (2020 and 2021), as well as interviews with key stakeholders and a social accounting matrix for South Africa's C&Cs.

Vitálišová et al. (2021) identified and assessed the impact of the COVID-19 pandemic on C&CIs from a national perspective, evaluating the measures taken by governments to mitigate its consequences. Particular attention was given to the financing of the C&CIs, as well as the social impact on different groups of respondents. Wall-Andrews et al. (2021) examined the range of financial instruments (grants and subsidies) created by the Government of Canada during the pandemic to support C&CIs. On the basis of this support, the creative and cultural sector (CCS) has been able to succeed economically and socially, thereby avoiding the risk of collapse in the cultural ecosystem. Peñarroya-Farell and Miralles (2022) proposed a new framework in the context of the COVID-19 pandemic. The framework assumed a better understanding of business model adaptation under emergency management theory and improvisational capabilities. Joffe (2021) explored the impact of the COVID-19 pandemic on the modernisation and development of African cultures. Focusing on South Africa, COVID-19 offers opportunities to guide the cultural economy process in Africa.

Santoro et al. (2020) assess whether formal and informal modes of collaboration with C&CIs affect innovation performance and evaluate the moderating role of combining heterogeneous knowledge sources and absorptive capacity. Jeannotte (2021) proposed a conceptual framework comprising four parts (economic, social, creative, and sustainable) to study the direct impact of the COVID-19 pandemic on creators, curators, and the media, and discussed how governments and citizens evaluate the potential impact of the creative sector. Langevang et al. (2022) demonstrated the factors of digitalisation, diversification, and social engagement through a survey of workers in Ghana's creative industries during the COVID-19 pandemic. Cunningham et al. (2021) examined regional cultural and creative activities in Australia and presented three key findings relevant to the international cultural policy debate.

Bakhshi et al. (2023) conducted a weekly longitudinal survey of UK adults to examine consumption choices in terms of cultural content types during the first COVID-19 national lockdown (the Great Lockdown). Changes in the probability of consuming content across various cultural and creative genres (music, movies, TV, games, books, magazines, and audiobooks), as well as shifts in overall consumption types, were examined. It was found that consumption varies depending on the type of content. All else being equal, the likelihood of listening to music and playing games increases, whereas the likelihood of reading books decreases. The increase in the variety of consumption of people at the bottom of the socioeconomic status distribution confirmed the importance of gaining culture and creativity for this particular social segment during the lockdown. Shin (2025) assessed the extent to which the culture and arts industries had been adversely affected by the COVID-19 pandemic, quantitatively measuring the impact of COVID-19 on the cultural participation of the Korean people. COVID-19 significantly reduced the likelihood of Koreans participating in cultural and artistic activities. However, the pandemic has increased the likelihood that people will visit libraries, and the number of movies watched through digital media has increased.

Dümcke (2021) presented the impact of COVID-19 on the German Ministry of Culture and Creativity (CCS) from March to the end of July 2020, examining German responses (at the federal, state, and municipal levels) in three phases. Williams et al. (2024) examined the effects of COVID-19 on Australia's Tasmanian cultural and creative sector, including its implications for financial sustainability, health and well-being, and the future of work. The results revealed that individuals who received financial support during the pandemic were able to adapt or adjust their creative practices and experienced higher levels of health and well-being. Those who do not receive support have a significant negative impact on their health and creative practices. Finally, Lu and Chesbrough (2022) investigated the relationship between open innovation practices and a firm's financial

performance. The overall level of openness (innovation) of a company is associated with improved financial performance.

1.4 Digital Transformation and Business Models in C&CIs

Zhao et al. (2024) highlighted the digital economy as a new engine for global economic growth, finding that it significantly promotes the development of creative industries, with innovation efficiency playing a partial mediating role between the digital economy and the development of creative industries. Gustafsson and Lazzaro (2021) discussed four major social challenges facing C&CIs and highlighted the significant potential for innovation and smart growth in the EU. These social challenges are addressed by the four main pillars of the C&CI program: (1) European creativity, cultural diversity, and values; (2) European identity and cohesion; (3) European employment, economic resilience, and smart growth; and (4) Europe's external relations. Ryu et al. (2024) noted that traditional C&CIs are increasingly digitalising, with new concepts and business models emerging, such as digital and entertainment labour, the platform economy, media convergence, digital and self-publishing, user participation, and fan culture. The four core themes of the digital transformation of traditional C&CI are as follows: 1) changes in television and video culture; 2) the rise of the platform economy and participatory culture; 3) the transformation of the publishing industry and copyright issues; and 4) the relationship between digital labor and gender equality.

Lerro et al. (2022) highlighted the impacts of digital transformation (DT) on new business models, products and services, supply chain and operational configurations, customer orientation, and new ways of working. Research on digitally driven innovation and entrepreneurship has at least three major limitations. First, it involves theoretical issues, particularly the failure to incorporate a holistic approach beyond the realm of information systems, and the lack of a more interdisciplinary perspective within the management field. Second, few studies have explored how specific organisational characteristics and expertise at the organisational level may influence the adoption of digital technologies and tools, performance improvement, and sustainability. Third, current DT research on innovation and entrepreneurship focuses primarily on large companies and organizations and specific industries (e.g., automotive). Current DT research often emphasizes the challenges of transformation. Numerous digital technologies facilitate innovation opportunities and reduce the time required to create and launch new products and solutions, promoting widespread changes in business models. At the micro level, the focus is on how DT impacts business model innovation, thus influencing entrepreneurial dynamics. Digital technologies and related tools are transforming collaborative innovation (CCI) and fostering the emergence of new entrepreneurial and business models.

Nasta (2025) argued that digital technologies have had a significant impact on the business models and value chains of certain creative industries. He defined digital transformation as the integration of digital technologies into all business areas, fundamentally changing operations and the delivery of value. The key attributes of digital transformation include agility, customer centricity, data-driven decision-making, and fostering a digital culture. Digital transformation radically alters customer relationships, value propositions, distribution channels, revenue streams, key resources, activities, partnerships, and cost structures. It emphasised how digital platforms, data analytics, and personalised experiences enhance customer engagement and market reach while optimising operations. Peñarroya-Farell and Miralles (2022) discussed how many companies, under the impact of the COVID-19 pandemic, survived by adapting their business models through open innovation and leveraging the creative and improvisational capabilities of the cultural industry, thus creating new value to address environmental challenges and strategically responding to the crisis.

Khlystova and Kalyuzhnova (2023) reported that regions with a greater proportion of employees in creative industries are more resilient to short-term economic shocks than regions with a lower proportion. They reported the importance of digitalisation during crisis recovery. Hosseini and Rajabipoor Meybodi (2023) developed an integrated model for the sustainable development of

creative industries through digital transformation and explanatory structural modelling. The model identified key components, including digital technology, cultural values, environmental and industrial intelligence, digital work environments, and digital entrepreneurial ecosystems. They argued that focusing on digital infrastructure, including digital communication, essential technologies, and information security, is crucial for the sustainable development of creative industries, as these are the foundations for fostering creativity in the digital realm. Lazzeretti et al. (2025) argued that the digital revolution has not only permeated and transformed various industrial sectors but also altered society as a whole, leading to new expressions of cultural heritage, increased creative capacity, and the emergence of new market niches. Gao et al. (2024) investigated the relationship between C&CI and sustainable development, reporting a positive correlation between the density of the C&CI network and a city's performance in achieving various sustainable development goals. The relationship between the size of local C&CIs and a city's sustainable development performance was found to be an inverted "U" shape.

2. Methodology

2.1 Empirical Data

C&CIs are industries that combine culture and creativity, and there are special laws and regulations for them in Taiwan to protect and promote development. According to the Cultural and Creative Industries Development Law formulated by the local government, cultural creativity refers to the formation and use of intellectual property derived from creativity or cultural accumulation. The following industries have the potential to create wealth and employment opportunities; promote the aesthetic literacy of all the people; and improve the living environment of the people: visual arts; music and performing arts; cultural asset application and exhibition and performance facilities; crafts; film, radio and television; publishing; advertising; product design; visual communication design; design of brand fashion; architectural design; digital content; creative life; popular music and cultural content; and other industries designed by the Central Competent Authority. According to the 2019 Taiwan Cultural and Creative Development Annual Report, Taiwan's C&CIs account for approximately 4~5% of the overall annual GDP.

This study examines the impact of the COVID-19 pandemic on Taiwan's C&CIs by analysing corporations' financial and operational status. The study included 40 firms classified as C&CI stocks (code: M3200) in the Taiwan stock market, excluding those that had been suspended or ceased trading, as well as firms with insufficient or missing financial information. The condition for the selection of firms to become a sample firm is to be able to obtain the annual financial statements of the firm from before the onset of COVID-19 to the outbreak of the pandemic (2015-2022) (37 firms), and three firms are relaxed to 2016-2022. The structural composition of the subindustries to which these firms belong is shown in Figure 1. The subindustry classification standard here is based on the basic information of the sample firms (TEJ industry name) from the Taiwan Economic Journal Database (TEJD).

Digital games (leisure), which are mainly used in digital content in the software service industry (programming industry), accounted for 42%, and 10 firms in the television broadcasting industry accounted for 25%. The remaining 13 firms are wholesalers of department stores, dealing with manufacturers of stationery, art, and cultural ceramics, as well as pop music creation, advertising, and computer and peripheral manufacturers related to the industry. During the study period, from January 2015 to December 2023, a total of 397 samples were collected, and the observations included annual financial statement data and basic operating conditions of individual firms. The period is divided into five years before the COVID-19 pandemic (2015--2019), three years during the COVID-19 pandemic (2020--2022), and one year after the COVID-19 pandemic (2023). The data source is the "IFRS Finance-International Accounting Standards" database taken from the TEJD. It is a financial database that primarily collects data from Taiwan, Hong Kong, and China, specialising in providing information for fundamental analysis of securities and financial markets.

This data source has been utilised in numerous studies (Chen & Liu, 2022; Chen et al., 2022, 2023; Ding et al., 2024; Yang et al., 2024; Liu, 2021 & 2025b). The period of the COVID-19 pandemic is defined on the basis of the fact that from the first case of infection in Taiwan in the first quarter of 2020 to the end of 2022, the cumulative number of confirmed cases was more than 8.83 million (the local population was approximately 23 million). In 2023, a variety of vaccines were widely administered so that the epidemic could be gradually controlled, and at the same time, people's various life restrictions were gradually relaxed and returned to normal nonepidemic periods.

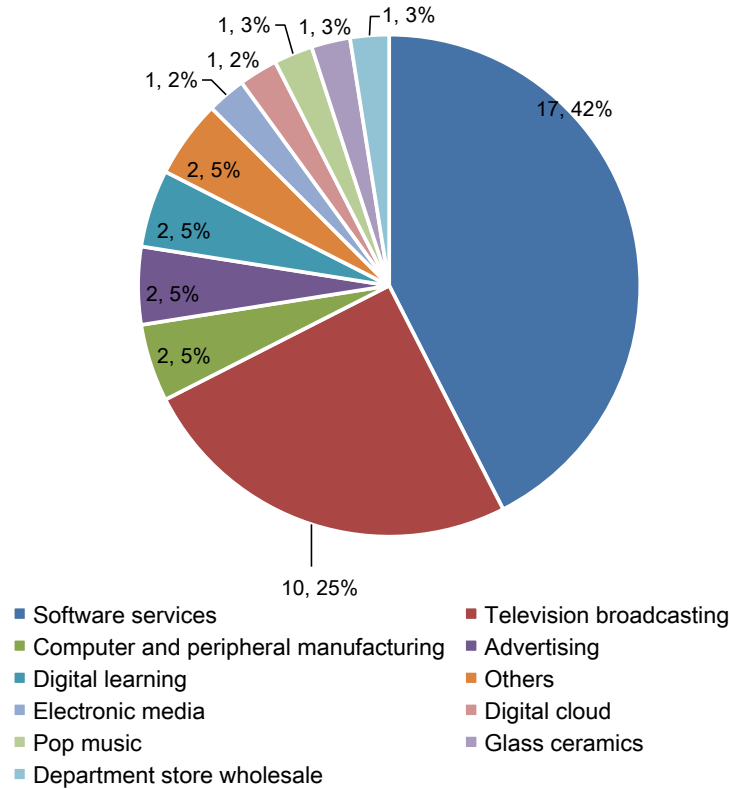


Figure 1. A circular scale chart of the industrial structure of the sample firms.

Source: Own elaboration on the basis of TEJD.

2.2 Study Variables

This study is based on an analysis of five categories of major financial indicators, which measure a firm's 1) financial structure; 2) solvency; 3) operating ability; 4) profitability; and 5) cash flows, with 20 financial indicators. The names, calculation forms, and symbols of the 20 financial indicators are summarised in Table 1. This table facilitates the understanding of each indicator's definition, practical application, and classification within the five established categories of financial indicators. The basic operating status of the firm is based on five indicators: annual operating revenue (NTD thousand), revenue growth rate (%), book value per share (NTD/share), number of employees (person), and paid-in capital (NTD thousand).

Table 1. Symbols and calculation forms of financial indicators.

No.	Financial Indicator	Symbol	Calculating Form (Unit)
1. Financial Structure			
1.1	Debt Ratio	DR_{it}	Total Liabilities/Total Assets $\times 100$ (%)
1.2	Fixed Assets to Total Assets Ratio	$FATAR_{it}$	Net Fixed Assets/Total Assets $\times 100$ (%)
1.3	Long-term Funds to Fixed Assets Ratio	$LFFAR_{it}$	(Shareholders' Equity + Long-term Liabilities)/Net Fixed Assets $\times 100$ (%)
2. Solvency			
2.1	Working Capital to Total Assets Ratio	$WCTAR_{it}$	(Current Assets - Current Liabilities)/Total Assets $\times 100$ (%)

2.2	Current Ratio	CR _{it}	Current Assets/Current Liabilities ×100 (%)
2.3	Quick Ratio	QR _{it}	(Current Assets - Inventories - Prepaid Expenses)/Current Liabilities ×100 (%)
2.4	Cash to Current Liabilities Ratio	CCLR _{it}	(Cash & Cash Equivalents + Short-term Investments)/Current Liabilities ×100 (%)
2.5	Times Interest Earned	TIE _{it}	(Net Profit before Tax + Interest Expense)/Interest Expense (times)
3. Operating Ability			
3.1	Receivables Turnover	RT _{it}	Annual Operating Income/Average Accounts Receivable and Bills for each period (times)
3.2	Inventory Turnover	IT _{it}	Cost of Goods Sold/Average Inventory (times)
3.3	Fixed Asset Turnover Ratio	FATR _{it}	Net sales/Net Fixed Assets ×100 (%)
3.4	Asset Turnover Ratio	ATR _{it}	Net Sales/Total Assets ×100 (%)
4. Profitability			
4.1	Return on Assets	ROA _{it}	[After-tax Profit and Loss + Interest Expense × (1 - Tax Rate)]/Average Total Assets ×100 (%)
4.2	Return on Equity	ROE _{it}	Profit and Loss after Tax/Average Net Shareholders' Equity ×100 (%)
4.3	Profit Margin	PM _{it}	Net Profit(Loss) after Tax/Operating Income×100(%)
4.4	Operating Income Margin	OIM _{it}	Operating Profit/Operating Income ×100 (%)
4.5	Earning Per Share	EPS _{it}	(Net Income after Tax - Preferred Stock Dividend)/Weighted Average Number of Shares Outstanding (NTD/share)
5. Cash Flows			
5.1	Cash Flow Ratio	CFR _{it}	Net cash flow from operating activities/current liabilities ×100 (%)
5.2	Cash Flow Adequacy Ratio	CFAR _{it}	Net cash flow from operating activities for the last five years/The sum of capital expenditures, inventory additions, and cash dividends for the last five years ×100 (%)
5.3	Cash Reinvestment Ratio	CRR _{it}	(Net cash flow from operating activities - cash dividends)/(Gross fixed assets + long-term investments + other assets + working capital)×100(%)

Source: Own elaboration.

2.3 Testing Methods

This study explored the impact of the COVID-19 pandemic on selected financial and operational indicators by dividing the empirical data into two independent groups: the pre-COVID-19 period and the pandemic period. The population means for each indicator were treated as unknown, and statistical tests were conducted to evaluate whether significant differences existed between the two groups.

Let X denote a study variable, with corresponding population means μ_{preCOV} and $\mu_{pandemic}$ for the pre-COVID-19 and pandemic periods, respectively. The hypothesis testing framework was defined as follows:

The null hypothesis $H_0: \mu_{pandemic} = \mu_{preCOV}$ (or $\mu_{pandemic} - \mu_{preCOV} = 0$) indicates that the pandemic did not significantly affect the mean of the variable.

The alternative hypothesis $H_1: \mu_{pandemic} \neq \mu_{preCOV}$ (or $\mu_{pandemic} - \mu_{preCOV} \neq 0$) suggests a statistically significant change in the variable's mean due to the pandemic.

When the population variances were unknown and assumed to be equal ($\sigma_{preCOV}^2 = \sigma_{pandemic}^2 = \sigma^2$), the difference in means between the pre-COVID-19 and pandemic periods was evaluated via the mean difference t-test for the two independent samples. The test statistic was defined as follows:

$$t = \frac{(\bar{X}_{pandemic} - \bar{X}_{preCOV}) - 0}{\hat{S} \cdot \sqrt{\frac{1}{N_{pandemic}} + \frac{1}{N_{preCOV}}}} \quad (1)$$

In equation (1), $\bar{X}_{pandemic}$ and $\bar{X}_{preCOV}$ are the sample means in the pandemic period and pre-COVID-19 period, respectively. $\hat{S}$ represents the sample standard deviation ($\hat{S}_{preCOV}^2 = \hat{S}_{pandemic}^2 = \hat{S}^2$). N_{preCOV} and $N_{pandemic}$ are the group samples from the pandemic and pre-COVID-19 periods, respectively. The null hypothesis $H_0: \mu_{pandemic} = \mu_{preCOV}$ (or $\mu_{pandemic} - \mu_{preCOV} = 0$) was rejected at the 5% significance level ($\alpha=0.05$) if the

absolute value of the test statistic exceeded the critical value from the t-distribution $|t| > t_{(1-\frac{\alpha}{2}, N_{preCOV}+N_{pandemic}-2)}$.

When the population variances of the two groups were unknown and assumed to be unequal, the mean difference between the two independent samples was tested via the Satterthwaite–Welch t-test (Karim et al., 2023) in the form of

$$t_{SW} = \frac{(\bar{X}_{pandemic} - \bar{X}_{preCOV}) - 0}{\sqrt{\frac{\hat{s}_{pandemic}^2}{N_{pandemic}} + \frac{\hat{s}_{preCOV}^2}{N_{preCOV}}}} \quad (2)$$

In equation (2), $\hat{s}_{preCOV}^2$ and $\hat{s}_{pandemic}^2$ denote the sample variances of the pre-COVID-19 and pandemic periods, respectively. In accordance with the calculation method used by Satterthwaite–Welch, the combined degrees of freedom were

$$v \approx \frac{\left(\frac{\hat{s}_{pandemic}^2}{N_{pandemic}} + \frac{\hat{s}_{preCOV}^2}{N_{preCOV}} \right)^2}{\frac{(\hat{s}_{pandemic}^2/N_{pandemic})^2}{v_{pandemic}} + \frac{(\hat{s}_{preCOV}^2/N_{preCOV})^2}{v_{preCOV}}} \quad (3)$$

In equation (3), $v_{pandemic}$ and v_{preCOV} denote the degrees of freedom of the pandemic and pre-COVID-19 periods, respectively. The inference here was similar to paragraph (1) above and was not repeated.

Finally, using the results of Levene's test for the equality of variances, it can be concluded that the results of the t test ($\sigma_{preCOV}^2 = \sigma_{pandemic}^2$) or the Satterthwaite–Welch t test ($\sigma_{preCOV}^2 \neq \sigma_{pandemic}^2$) were used in the tests for the equality of means, i.e., checking k ($k \geq 2$; this study is $k=2$) to determine whether the number of variances was the same between groups. Here, the null hypothesis was $H_0: \sigma_1^2 = \sigma_2^2 = \dots = \sigma_k^2 = \sigma^2$, whereas the alternative hypothesis was $H_1: \sigma_i^2 \neq \sigma_j^2$, where $i \neq j$, and $1 \leq i, j \leq k$. Assuming that the j -th observation of group i was X_{ij} , $i=1,2,3,\dots,k$, and $j=1,2,\dots,n_i$, n_i was the number of samples in group i . Therefore, the absolute error of the random variable X_{ij} and the mean $\bar{X}_i$ of group i was $Y_{ij} = |X_{ij} - \bar{X}_i|$. This condition was equivalent to one-way ANOVA with a test of the F statistic. The definition was as follows:

$$F = \frac{\frac{\sum_{i=1}^k n_i (\bar{Y}_i - \bar{\bar{Y}})^2}{k-1}}{\frac{\sum_{i=1}^k \sum_{j=1}^{n_i} (Y_{ij} - \bar{Y}_i)^2}{\sum_{i=1}^k (n_i - 1)}} \quad (4)$$

In equation (4), $\bar{Y}_i = \sum_{j=1}^{n_i} Y_{ij} / n_i$ is the mean absolute error of group i . $\bar{\bar{Y}} = \sum_{i=1}^k \sum_{j=1}^{n_i} Y_{ij} / N$ is the mean absolute error, the degrees of freedom are $v_1 = k - 1$ and $v_2 = N - k$, then $N = \sum_{i=1}^k n_i$, and the significance level is $\alpha=0.05$.

3. Research results

3.1 Descriptive Statistics

Table 2 presents descriptive statistics, which estimate the mean $\pm$ standard deviation of 25 basic financial and operational indicators for 40 C&CI firms from 2015 to 2023. The period is divided into three subperiods: pre-COVID-19 (2015-2019), the COVID-19 pandemic (2020-2022), and the post-pandemic (2023), to observe the changes in these indicators before the occurrence of COVID-19, during the pandemic, and after the pandemic.

Table 2. Descriptive statistics.

Indicator	Mean±S.D.			
	Whole period (2015-2023)	Pre-COV-19 (2015-2019)	Pandemic (2020-2022)	Postpandemic (2023)
1.1 DR _{it}	38.896±21.881	38.614±22.136	39.511±21.028	38.389±23.746
1.2 FATAR _{it}	13.244±17.119	13.859±17.555	12.281±16.670	13.129±16.527
1.3 LFFAR _{it}	9521.12±32480.58	5133.41±15318.85	14822.06±48932.29	15453.35±29541.56
2.1 WCTAR _{it}	32.983±32.871	32.993±34.182	32.529±31.068	34.405±32.328
2.2 CR _{it}	320.857±287.639	326.821±315.891	304.778±241.262	341.576±273.927
2.3 QR _{it}	254.129±248.201	251.880±270.661	248.103±209.518	285.521±244.124
2.4 CCLR _{it}	60.194±23.732	55.878±23.015	65.104±24.002	67.023±22.433
2.5 TIE _{it}	783.375±8490.266	204.515±2812.983	813.035±10313.109	3143.425±15286.535
3.1 RT _{it}	12.284±19.582	11.298±18.018	13.539±22.693	13.298±16.400
3.2 IT _{it}	1354.41±15728.69	1894.70±19952.27	890.68±9195.91	69.276±193.975
3.3 FATR _{it}	55.828±112.723	43.322±88.807	68.936±126.609	77.875±161.129
3.4 ATR _{it}	0.690±0.548	0.800±0.612	0.574±0.446	0.500±0.346
4.1 ROA _{it}	-0.679±18.340	-0.226±18.307	-1.012±18.532	-1.934±18.307
4.2 ROE _{it}	-1.898±53.728	4.665±57.419	-8.098±44.498	-14.965±58.286
4.3 PM _{it}	-193.993±2120.260	-21.534±98.612	-497.699±3606.743	-116.790±543.054
4.4 OIM _{it}	-153.992±1685.732	-18.357±87.265	-387.760±2866.234	-109.647±468.902
4.5 EPS _{it}	1.758±7.404	1.612±5.863	2.024±9.165	1.662±8.372
5.1 CFR _{it}	13.639±79.794	14.244±83.914	17.454±71.515	-1.886±83.462
5.2 CFAR _{it}	-209.156±2157.367	-265.974±2193.716	-255.920±2331.611	183.151±1239.377
5.3 CRR _{it}	-7.009±169.406	-13.400±226.277	2.706±21.211	-4.504±24.762
Operating Revenue	1259918.0±2592412.1	1250108.4±2561075.3	1224265.2±2537351.0	1426718.4±2975831.5
Revenue Growth Rate	29.546±171.493	38.637±200.891	12.386±99.065	38.538±192.150
Book Value Per Share	19.001±16.173	19.131±14.657	19.048±18.243	18.163±17.077
Number of Employees	200.716±274.214	200.662±275.037	198.950±272.250	206.730±283.603
Paid in Capital	604994.45±677620.04	605755.66±679239.44	596488.40±674349.16	628569.89±697595.42

Source: Own elaboration.

In Figure 2, histograms were created using the means of the financial indicators from Table 2 to facilitate comparisons of financial changes during the pre-COVID-19 period, the COVID-19 pandemic, and the post-pandemic period.

The financial indicators are divided into five categories:

Financial structure: The means of the debt ratio (DR_{it}), fixed assets to total assets ratio (LFFAR_{it}), and long-term funds to fixed assets ratio (LFFAR_{it}) were 38.896%, 13.244%, and 9,521.12%, respectively. The mean LFFAR_{it} rose markedly from 5,133.41% in the pre-COVID-19 period to 14,822.06% during the pandemic period and further to 15,453.35% in the post-pandemic period. This increase was accompanied by greater variance, indicating elevated financial risk during the pandemic. The results revealed that the average LFFAR_{it} during the pandemic increased while also exacerbating the standard deviation (risk); however, the mean of the indicator did not decrease, but the standard deviation (risk) decreased. In contrast, DR_{it} and FATAR_{it} exhibited relatively minor fluctuations across the three periods, suggesting limited impact from the pandemic.

Solvency: The means of the working capital to total assets ratio (WCTAR_{it}), current ratio (CR_{it}), quick ratio (QR_{it}), cash to current liabilities ratio (CCLR_{it}) and number of times interest earned (TIE_{it}) over the whole period were 32.983%, 320.857%, 254.129%, 60.194% and 783.375 times, respectively. During the COVID-19 pandemic, WCTAR_{it}, CR_{it}, and QR_{it} declined slightly, whereas CCLR_{it} and TIE_{it} increased significantly to 65.104% and 813.035 times, respectively, indicating improved short- and long-term solvency. Finally, the means of these five indicators were greater than those before and during the pandemic (2023), possibly because companies strengthened their control of financial risk management to cope with potential future crises, resulting in improvements in solvency after the pandemic.

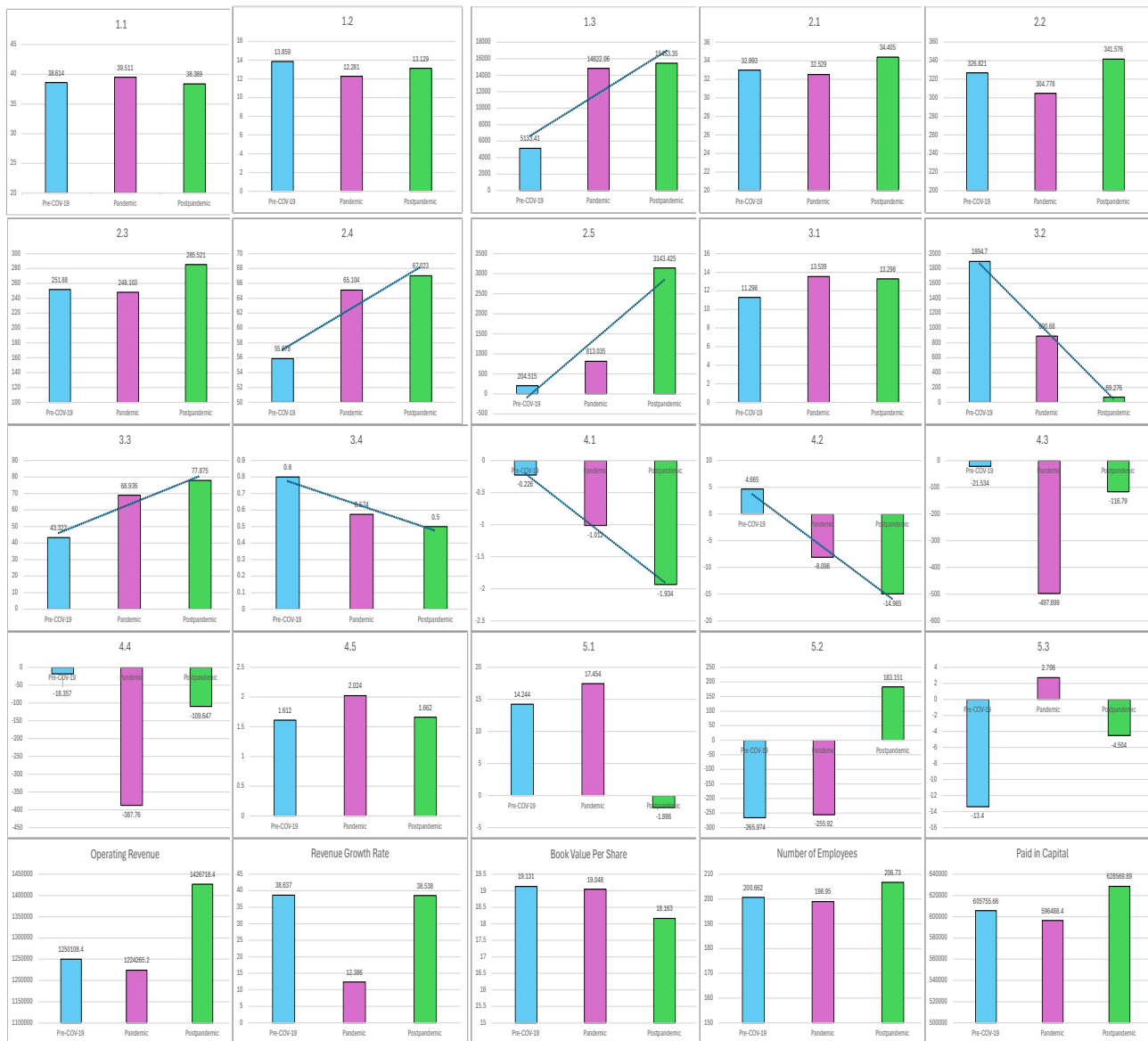


Figure 2. Histogram comparing the means of various financial indicators during the pre-COVID-19 period, the COVID-19 pandemic, and the post-pandemic period.

Source: Own elaboration based on TEJD.

Operating ability: The means of receivable turnover (RT_{it}), inventory turnover (IT_{it} 1,354.41 times), and the fixed asset turnover ratio ($FATR_{it}$ 55.828%), and the asset turnover ratio (ATR_{it} 0.690%) were calculated. The means of IT_{it} and ATR_{it} during the pandemic decreased, but the means of RT_{it} and $FATR_{it}$ increased. This shows that the impact of the epidemic on the indicators of operating ability was inconsistent.

Profitability: The means of ROA (ROA_{it}), ROE (ROE_{it}), profit margin (PM_{it}), operating income margin (OIM_{it}), and EPS (EPS_{it}) were -0.679%, -1.898%, -193.993%, -153.992% and 1.758 NTD/share, respectively; only the mean of EPS_{it} was positive, and the other four indicators were negative, indicating that the average profit level of the industry was a loss. In addition, the means of ROA_{it} , PM_{it} , and OIM_{it} were negative during the pre-COVID-19 period, whereas the negative values worsened during the COVID-19 pandemic, and ROE_{it} changed from positive to negative. These findings indicate that the average profitability of the industry has declined during the pandemic. These results are similar to the arguments of Mahssouni et al. (2023) and Rababah et al. (2020) that the pandemic tends to have a significant negative effect on firms' financial performance. However, the EPS_{it} from the mean before COVID-19 was 1.612 NTD/share during the COVID-19

pandemic, but it increased to 2.024 NTD/share. Finally, the average of these indicators after the pandemic had not fully recovered to the pre-COVID-19 average, especially ROA_{it} and ROE_{it} , which were worse than those during the COVID-19 pandemic, indicating that profitability has not yet recovered.

Cash flows: The means of the cash flow ratio (CFR_{it}), cash flow adequacy ratio ($CFAR_{it}$), and cash reinvestment ratio (CRR_{it}) were 13.639%, -209.156%, and -7.009%, respectively. Only the average CRR_{it} was negative before COVID-19 (-13.400%), but it became positive during the COVID-19 pandemic (2.706%), which changed to a greater extent. Finally, the means of CFR_{it} and CRR_{it} during the postpandemic period decreased, whereas $CFAR_{it}$ increased and turned from negative to positive, and the directions of the changes in these indicators were inconsistent.

Regarding the firms' basic operational status, the means and standard deviations for the entire observation period were as follows: operating revenue, 1,259,918.0 and 2,592,412.1 thousand NTD; revenue growth rate, 29.546 and 171.493%; book value per share, 19.001 and 16.173 NTD/share; number of employees, 200.716 and 274.214 persons; and paid-in capital, 604,994.45 and 677,620.04 thousand NTD. The firm's average annual operating income and revenue growth rate were approximately NT\$1.26 billion and 19%, respectively, with an average of 200 sales staff. During the COVID-19 pandemic, the revenue growth rate declined significantly from 38.637% to 12.386%, indicating a slowdown in growth. In contrast, the other four indicators showed minimal variation between the prepandemic and pandemic periods. These findings diverge from the broader economic downturn reported by Kantor and Kubiczek (2021), possibly due to effective government interventions, including relief and revitalization measures. Postpandemic averages were comparable to prepandemic levels, with operating income, employee numbers, and paid-in capital even exceeding prepandemic figures, suggesting a gradual recovery in operational performance.

This study revealed that these C&CI firms already have stocks listed on the securities market, making it easier for them to obtain financing from financial institutions or raise funds through the issuance of securities (this case tends to be consistent with the first situation mentioned by Ellul et al. (2020)). Therefore, during the COVID-19 pandemic, the financial structure and basic operating conditions of C&CI firms have largely remained unchanged.

3.2 Test for equality of means

Table 3 presents the results of testing for the equality of means of financial indicators and basic operating status during the pandemic vs. pre-COVID-19 periods.

Table 3. Tests for the equality of means of indicators during the pandemic vs. pre-COVID-19 periods.

Indicator	Mean Difference (Pandemic – Pre)	Equality of Means		Equality of Variances
		t test (p value)	Satterthwaite-Welch t test* (p value)	Levene's test (p value)
1.1 DR_{it}	0.897	0.722	0.719	0.931
1.2 $FATAR_{it}$	-1.578	0.430	0.425	0.600
1.3 $LFFAR_{it}$	9688.656	0.011	0.037	0.000
2.1 $WCTAR_{it}$	-0.465	0.904	0.901	0.575
2.2 CR_{it}	-22.044	0.513	0.486	0.161
2.3 QR_{it}	-3.777	0.896	0.890	0.363
2.4 $CCLR_{it}$	9.226	0.001	0.001	0.577
2.5 TIE_{it}	608.520	0.481	0.531	0.009
3.1 RT_{it}	2.241	0.336	0.361	0.146
3.2 IT_{it}	-1004.027	0.605	0.548	0.327
3.3 $FATR_{it}$	25.614	0.037	0.054	0.002
3.4 ATR_{it}	-0.226	0.001	0.000	0.012
4.1 ROA_{it}	-0.786	0.714	0.715	0.495
4.2 ROE_{it}	-12.763	0.040	0.030	0.352
4.3 PM_{it}	-476.165	0.068	0.153	0.000
4.4 OIM_{it}	-369.403	0.074	0.163	0.001
4.5 EPS_{it}	0.412	0.628	0.661	0.077
5.1 CFR_{it}	3.210	0.728	0.718	0.651

5.2 CFAR _{it}	10.054	0.971	0.971	0.936
5.3 CRR _{it}	16.105	0.444	0.329	0.213
Operating Revenue	-25843.174	0.931	0.931	0.754
Revenue Growth Rate	-26.251	0.186	0.129	0.273
Book Value Per Share	-0.083	0.965	0.966	0.588
Number of Employees	-1.712	0.957	0.957	0.873
Paid in Capital	-9267.265	0.906	0.906	0.890

Note: * indicates that the test allows for unequal cell variances.

Source: Own elaboration.

The first column shows the difference between the average indicators during the COVID-19 pandemic and the average indicators during the pre-COVID-19 period. The p values of the second and third columns are the t test and Satterthwaite–Welch t test, respectively, and the Satterthwaite–Welch t test is the result of the test performed under conditions that allow for unequal cell variances, which is the test of the mean difference. The fourth column shows the results of Levene's test for equality of variances. At the 5% significance level, the following conclusions can be drawn:

Financial structure: The mean difference in the ratio of long-term funds to fixed assets (LFFAR_{it}) was 9688.656%, and the p value was $0.037 < 0.05$ for the Satterthwaite–Welch t test, with a p value = $0.000 < 0.05$ for Levene's test. The results confirmed a significant difference between the means of these indicators in the pandemic and pre-COVID-19 periods, indicating that the means increased substantially during the pandemic.

Solvency: The mean difference in the cash-to-current liabilities ratio (CCLR_{it}) was 9.226%, and the p value was $0.001 < 0.05$ for the t test under the condition of a p value = $0.577 > 0.05$ for Levene's test. It was confirmed that there was a significant difference between the means during the pandemic and pre-COVID-19 periods and that the mean during the pandemic was significantly greater than that during the pre-COVID-19 periods. Possible reasons and industry players increased the company's cash and cash equivalents offered during the epidemic (the average during the pre-COVID-19 period was 437,253.1 NTD thousand; the average value during the pandemic period was 628,291.0 NTD thousand).

Operating ability: The mean difference in the asset turnover ratio (ATR_{it}) was -0.226%, and the p value of the Satterthwaite–Welch t test was $0.000 < 0.05$ when the p value of Levene's test was $0.012 < 0.05$. As a result, the mean will be significantly lower during the pandemic.

Profitability: The mean difference in the ROE (ROE_{it}) was -12.763%, and the p value of the t test was $0.040 < 0.05$ when the p value of Levene's test was $0.352 > 0.05$. The mean was confirmed to be significantly smaller (decrease) during the pandemic.

Cash flows and basic operating status: There is no evidence to support the means of cash flows and basic operating status, indicating that there is a significant difference between the COVID-19 pandemic and pre-pandemic periods. Therefore, it is not possible to support the fact that the COVID-19 pandemic has had a significant effect on the cash flow and basic operating status of C&CI firms.

On the basis of the above results, C&CIs, when faced with major infectious disease events, experienced significant changes in a few financial indicators due to numerous government relief policies and the advantages of listed companies in issuing securities and obtaining financing from financial institutions. The firms' financial condition and basic operating status did not undergo comprehensive changes in the face of the significant impact of major events. There are even signs that the firms were more capable of resisting the impact of major crisis events and making financial adjustments (e.g., financial structure (LFFAR_{it}) and solvency (CCLR_{it})).

3.3 Tests for Equality of Means in Digital vs. Nondigital Game Companies

DT has been proven to be important for financial performance (Stefanovic et al., 2021; Kantor & Kubiczek, 2021; Zhang et al., 2022), and it has significant positive effects (Mahssouni et al., 2023). Similarly, the impact of innovative practices on financial performance is also significant (Kurniawan et al., 2023). Digital gaming is a cross-cutting industry that blends various elements of technology,

entertainment, culture, and social networking. This industry accounts for more than 40% of the C&CIs on Taiwan's stock market, and under the many control measures that restrict people's work, school, and public living spaces and places during the epidemic, people's time in family life has increased significantly, and it is expected to increase the time spent on online leisure, so it is generally expected to have a positive impact on the digital game industry. Therefore, this study further divides the sample firms into digital game industries (groups) that focus on digital content, including software and related hardware. In addition, after digital game firms are excluded, the remaining C&CI firms are classified into nondigital game groups, which tend to be negative or neutral because of the impact of the epidemic. This study categorises firms into digital game and nondigital game groups to examine the impact of the COVID-19 pandemic. Table 4 presents tests for the equality of means of financial indicators and basic operating status during the COVID-19 pandemic compared to pre-COVID-19 periods, based on digital versus nondigital game groups.

Table 4. Tests for the equality of means on digital vs. nondigital game groups.

Indicator	Digital Game Group				Non-Digital Game Group			
	Mean Difference	t test p value	Satt.-Welc.* p value	Leve. test p value	Mean Difference	t test p value	Satt.-Welc.* p value	Leve. test p value
1.1 DR _{it}	-5.302	0.137	0.100	0.057	7.773	0.028	0.042	0.035
1.2 FATAR _{it}	-2.685	0.100	0.079	0.009	-0.419	0.908	0.907	0.916
1.3 LFFAR _{it}	3486.111	0.200	0.168	0.165	16552.772	0.026	0.079	0.000
2.1 WCTAR _{it}	4.864	0.392	0.368	0.482	-6.342	0.210	0.212	0.449
2.2 CR _{it}	22.079	0.467	0.476	0.771	-71.380	0.254	0.213	0.122
2.3 QR _{it}	22.904	0.353	0.353	0.975	-33.569	0.540	0.509	0.258
2.4 CCLR _{it}	10.670	0.001	0.001	1.000	7.666	0.096	0.100	0.664
2.5 TIE _{it}	2531.678	0.093	0.121	0.004	-1532.945	0.053	0.107	0.000
3.1 RT _{it}	1.559	0.096	0.127	0.035	2.941	0.536	0.556	0.213
3.2 IT _{it}	-1869.435	0.612	0.555	0.346	-20.190	0.687	0.639	0.513
3.3 FATR _{it}	10.959	0.501	0.500	0.562	41.997	0.024	0.053	0.000
3.4 ATR _{it}	-0.259	0.011	0.006	0.015	-0.186	0.002	0.001	0.024
4.1 ROA _{it}	4.210	0.186	0.180	0.563	-6.342	0.024	0.029	0.091
4.2 ROE _{it}	-6.267	0.537	0.482	0.513	-19.976	0.003	0.009	0.002
4.3 PM _{it}	10.218	0.103	0.124	0.776	-1023.672	0.062	0.148	0.000
4.4 OIM _{it}	-12.593	0.217	0.309	0.022	-771.120	0.077	0.171	0.001
4.5 EPS _{it}	1.921	0.196	0.247	0.120	-1.256	0.073	0.078	0.332
5.1 CFR _{it}	8.700	0.391	0.400	0.367	-2.889	0.856	0.845	0.266
5.2 CFAR _{it}	-0.165	0.999	0.999	0.599	65.817	0.908	0.909	0.831
5.3 CRR _{it}	31.102	0.444	0.325	0.189	-0.071	0.985	0.985	0.511
Operating Revenue	8184.000	0.988	0.988	0.617	-67505.461	0.686	0.688	0.902
Revenue Growth Rate	-36.517	0.257	0.175	0.220	-14.758	0.500	0.486	0.984
Book Value Per Share	2.053	0.525	0.549	0.549	-2.411	0.101	0.098	0.974
Number of Employees	-1.139	0.977	0.977	0.927	-2.164	0.966	0.966	0.890
Paid in Capital	-8375.432	0.939	0.939	0.949	-10272.751	0.929	0.928	0.898

Note: * indicates that the test allows for unequal cell variances.

Source: Own elaboration.

The left/right halves of Table 4 show the mean differences for the digital/nondigital game group and the results of the t tests and Satterthwaite-Welch t tests of the equality of means and Levene's tests for the equality of variances. Judging from the results of the indicator testing of the five categories of major financial indicators:

Financial structure: The mean difference in the debt ratio (DR_{it}) in the digital/nondigital game group was -5.302%/7.773%, indicating that the firms in these two groups changed in different

directions during the pandemic. Under the condition of $p \text{ value} = 0.035 < 0.05$ for the t test of Levene's tests of the nondigital game group, the p value of the Satterthwaite–Welch t test was $0.042 < 0.05$, thus confirming that the debt ratio (DR_{it}) of the nondigital game group was significantly greater during the COVID-19 pandemic than during the pre-COVID-19 period. The mean difference in the ratio of fixed assets to total assets ($FATAR_{it}$) in the digital/nondigital game groups was $-2.685\%/-0.419\%$, indicating that the means for both groups decreased during the COVID-19 pandemic; however, the differences were not statistically significant. The mean difference in the long-term funds to fixed assets ratio ($LFFAR_{it}$) in the digital/nondigital game group was $3486.111\%/16552.772\%$, indicating that the mean of both groups increased during the COVID-19 pandemic, but the difference was not statistically significant. The above results provide evidence that the COVID-19 pandemic significantly increased financial default risk (as measured by the debt ratio) for nondigital game groups; however, there is no evidence that the pandemic had a significant impact on the financial structure of digital game groups.

Solvency: The mean differences in the working capital-to-total assets ratio ($WCTAR_{it}$), current ratio (CR_{it}), quick ratio (QR_{it}) and number of times interest earned (TIE_{it}) in the digital/nondigital game group were $4.864\%/-6.342\%$, $22.079\%/-71.380\%$, $22.079\%/-33.569\%$ and $2531.678 \text{ times}/-1532.9455 \text{ times}$, respectively, indicating that the direction of change in these indicators between the two types of firms during the epidemic was inconsistent (up/down). Second, the mean difference in the cash-to-current liabilities ratio ($CCLR_{it}$) in the digital/nondigital game group was $10.670\%/7.666\%$, the p value of Levene's test was $1.000/0.664 > 0.05$, and the p value of the t test was $0.001 < 0.05/0.096 > 0.05$. Therefore, the mean cash-to-current liabilities ratio ($CCLR_{it}$) in the two groups during the COVID-19 pandemic period will be significantly higher, which may be related to the increase in the firm's cash ratio (amount) in response to the epidemic's impact. Among these groups, the digital game groups yielded particularly significant results, suggesting that digital game groups may have been better positioned to manage their cash flow during the COVID-19 pandemic than nondigital game groups were. Taken together, there is evidence to support some significant impacts (changes) of the COVID-19 pandemic on the solvency of digital game groups. In general, the solvency of the digital game group tends to be positive, especially in terms of the cash-to-current liabilities ratio, which has a significant positive effect (increase). However, for the nondigital game group, there was a negative response in the working capital-to-total assets ratio ($WCTAR_{it}$), current ratio (CR_{it}), quick ratio (QR_{it}), and number of interest earned (TIE_{it}), but for the cash-to-current liabilities ratio ($CCLR_{it}$), there was a significant positive reaction. However, the nondigital game group showed a negative reaction, but it was not statistically significant.

Operating ability: The mean differences in inventory turnover (IT_{it}) and the asset turnover ratio (ATR_{it}) in the digital/nondigital game group were negative: $-1869.435 \text{ times}/-20.190 \text{ times}$ and $-0.259\%/-0.186\%$, respectively. The asset turnover ratio ($ATR_{it}ATR$) of the digital/nondigital game groups was $p = 0.015/0.024 < 0.05$ for Levene's test and $p = 0.006/0.001 < 0.05$ for the Satterthwaite–Welch t-test, indicating a significantly smaller (decrease) mean during the COVID-19 pandemic. Therefore, only one indicator yielded significant results, supporting the impacts of the epidemic on operating ability.

Profitability: The mean difference in ROA (ROA_{it}) was -6.342% , where the p value for the t test was $0.024 < 0.05$ ($p \text{ value} = 0.091 > 0.05$ for Levene's test), and the mean difference in ROE (ROE_{it}) was -19.976% , where the p value for the Satterthwaite–Welch t test was $0.009 < 0.05$ ($p \text{ value} = 0.091 > 0.05$ for Levene's test) in the nondigital game group. This confirms that the means of these two measures of profitability decreased significantly during the COVID-19 pandemic (negative effect). In addition, the mean differences in ROA (ROA_{it}), profit margin (PM_{it}), and EPS (EPS_{it}) in the digital game group were positive, but it cannot be confirmed that there was a significant difference between the COVID-19 pandemic period and the pre-COVID-19 period. The results confirmed that the pandemic had a significant negative effect on two (partial) indicators of profitability for the

nondigital game group, whereas for the digital game group, although the mean differences for the three indicators were positive, none of them reached statistical significance.

Cash flows: There was no evidence that the pandemic would significantly change (impact) the cash flows of the digital/nondigital game group, as it was not significant in the measurement of the equality of means for all three indicators of cash flows.

Finally, the indicators of the basic operating status are included. The operating revenue of digital/nondigital game groups during the COVID-19 pandemic has increased/decreased, the revenue growth rate has decreased/decreased, the book value per share has increased/decreased, the number of employees has slightly decreased/slightly decreased, and the paid-in capital has increased/decreased. Comparing the results of the two groups, there is a positive mean difference in the operating revenue of the digital game group, although no significant results are achieved, which tends to be a positive result for the digital game group during the pandemic.

These results are based on the fact that C&CIs have greater access to financing from financial institutions and by issuing securities on the securities market. This confirms that these firms experience some differences in their financial performance compared with their peers following major events. Some confirm that the digital gaming industry performed relatively better than did the nondigital gaming industry during the COVID-19 pandemic in terms of financial structure (DR_{it}), solvency ($CCLR_{it}$), and profitability (ROA_{it} and ROE_{it}). These financial advantages provide evidence that digital technology-focused C&CIs (digital gaming) outperform their peers during similar major events.

3.4 Tests for the Same Median and Distribution in Two Groups

Tables 3 and 4 present the results of statistical tests for the equality of means between groups (pandemic period and pre-COVID-19 period) for the C&CI group, the digital game group, and the nondigital game group. These tests were used to determine whether the means of the two independent groups were significantly different. To further investigate whether the COVID-19 pandemic had a significant effect on the median and distribution of these two independent groups, this study used the nonparametric Mann-Whitney test to compare the medians of the two groups. Additionally, the two-sample Kolmogorov-Smirnov test was used to determine whether the distributions of the financial indicators were the same in the pre-COVID-19 and pandemic periods. These tests provided further insights into the impact of the COVID-19 pandemic on other statistical characteristics of the indicators.

Table 5 presents the results of the Mann-Whitney tests and Kolmogorov-Smirnov tests for the C&CI, digital game, and non-digital game groups. The Mann-Whitney test assumes that the null hypothesis is that the medians of two independent groups (pandemic period and pre-COVID-19 period) are the same, whereas the Kolmogorov-Smirnov test assumes that the distributions of the two independent groups are the same. In the Mann-Whitney tests, for C&CI, $CCLR_{it}$ (p value < 0.001) and (p value = 0.001) was significantly different, which is consistent with the results in Table 3 and indicates that the medians of these two indicators differed between the pandemic and pre-COVID-19 periods. Similarly, the p value of the revenue growth rate (p value = 0.021 < 0.05) also supported a significant difference in the median between the two periods. For the digital game group, $CCLR_{it}$ (p value = 0.026 < 0.05) and ATR_{it} (p value = 0.042 < 0.05) were significantly different, which is consistent with Table 4. Additionally, $FATAR_{it}$ (p value = 0.001 < 0.05) and $LFFAR_{it}$ (p value = 0.020 < 0.05) also significantly differed, indicating that the medians of these four indicators differed between the two periods. For the nondigital game group, ATR_{it} (p value = 0.002 < 0.05), ROA_{it} (p value = 0.017 < 0.05), and ROE_{it} (p value = 0.007 < 0.05) were significantly different, which is consistent with Table 4. Additionally, EPS_{it} (p value = 0.007 < 0.05) was significantly different, indicating that the medians of these four indicators differed between the pandemic and pre-COVID-19 periods.

Finally, the results of the C&CI Kolmogorov-Smirnov test revealed that $CCLR_{it}$ and ATR_{it} were statistically significant, which is consistent with the results in Table 3 and the results of the

Mann-Whitney tests. Similarly, $FATAR_{it}$, OIM_{it} , and $CFAR_{it}$ were significant, suggesting that the distributions of these five indicators differed between the pandemic period and the pre-COVID-19 period.

Table 5. Results of the Mann-Whitney and Kolmogorov-Smirnov tests.

Indicator	C&CI				Digital Game Group				Non-Digital Game Group			
	1		2		1		2		1		2	
	z stat.	p value	z stat.	p value	z stat.	p value	z stat.	p value	z stat.	p value	z stat.	p value
1.1DR _{it}	-0.611	0.541	1.204	0.110	-0.651	0.515	0.873	0.431	-1.685	0.092	0.894	0.401
1.2FATAR _{it}	-1.962	0.050	1.486	0.024	-2.231	0.026	1.339	0.055	-0.670	0.503	1.095	0.182
1.3LFFAR _{it}	-1.761	0.078	1.326	0.059	-2.324	0.020	1.279	0.076	-0.051	0.960	0.808	0.532
2.1WCTAR _{it}	-0.306	0.760	0.807	0.533	-0.657	0.511	0.626	0.828	-0.859	0.390	1.082	0.193
2.2CR _{it}	-0.176	0.860	0.796	0.551	-0.478	0.633	0.742	0.641	-0.715	0.475	0.825	0.505
2.3QR _{it}	-0.576	0.565	0.807	0.533	-0.987	0.324	0.808	0.531	-0.082	0.935	0.766	0.601
2.4CCLR _{it}	-3.564	0.000	2.072	0.000	-3.343	0.001	2.054	0.000	-1.855	0.064	1.163	0.134
2.5TIE _{it}	-0.272	0.785	0.947	0.331	-1.151	0.250	1.046	0.224	-1.818	0.069	1.379	0.045
3.1RT _{it}	-0.940	0.347	0.897	0.396	-1.337	0.181	0.946	0.333	-0.020	0.984	0.459	0.984
3.2IT _{it}	-1.073	0.283	0.779	0.579	-0.755	0.450	0.761	0.609	-0.595	0.552	0.777	0.581
3.3FATR _{it}	-1.139	0.255	1.219	0.102	-1.171	0.241	0.892	0.404	-0.123	0.902	0.860	0.450
3.4ATR _{it}	-3.381	0.001	1.561	0.015	-2.029	0.042	1.208	0.108	-3.050	0.002	1.441	0.032
4.1ROA _{it}	-0.830	0.406	1.108	0.172	-1.006	0.315	0.781	0.575	-2.381	0.017	1.620	0.010
4.2ROE _{it}	-1.389	0.165	1.177	0.125	-0.588	0.556	0.648	0.795	-2.678	0.007	1.862	0.002
4.3PM _{it}	-0.343	0.732	1.104	0.175	-1.606	0.108	1.091	0.184	-1.726	0.084	1.732	0.005
4.4OIM _{it}	-1.297	0.195	1.575	0.014	-0.024	0.981	0.707	0.700	-1.591	0.112	1.732	0.005
4.5EPS _{it}	-1.229	0.219	1.076	0.197	-0.708	0.479	0.978	0.294	-2.676	0.007	1.833	0.002
5.1CFR _{it}	-0.436	0.663	0.546	0.927	-0.783	0.434	0.843	0.476	-0.145	0.885	0.596	0.869
5.2CFAR _{it}	-1.647	0.100	2.121	0.000	-1.509	0.131	1.564	0.015	-0.997	0.319	1.482	0.025
5.3CRR _{it}	-0.203	0.839	0.548	0.925	-0.418	0.676	0.694	0.721	-0.287	0.774	0.536	0.936
Operating Revenue	-1.342	0.179	1.015	0.254	-0.975	0.329	0.649	0.794	-1.035	0.301	0.852	0.462
Revenue Growth Rate	-2.309	0.021	1.307	0.066	-1.812	0.070	0.913	0.375	-1.409	0.159	1.028	0.241
Book Value Per Share	-0.743	0.458	0.884	0.415	-0.260	0.795	0.653	0.787	-1.394	0.163	1.347	0.053
Number of Employees	-0.109	0.913	0.133	1.000	-0.040	0.968	0.064	1.000	-0.141	0.888	0.132	1.000
Paid in Capital	-0.147	0.883	0.127	1.000	-0.130	0.897	0.092	1.000	-0.141	0.888	0.132	1.000

Note: 1 - Mann-Whitney test (Null hypothesis : the medians were equal across both periods); 2 - Kolmogorov-Smirnov test (Null hypothesis : the distributions were equal across both periods).

Source: Own elaboration.

For the digital game group, $CCLR_{it}$ was significant, which is consistent with the results of Table 4 and the Mann-Whitney tests, and $CFAR_{it}$ (p value = $0.015 < 0.05$) was significant, indicating that only two indicators showed significant differences in distribution between the two periods and thus had a limited impact. For the nondigital game group, ATR_{it} , ROA_{it} , and ROE_{it} were significant, which is consistent with Table 4 and the results of the Mann-Whitney tests. Additionally, TIE_{it} , PM_{it} , OIM_{it} , EPS_{it} , and $CFAR_{it}$ were significant, suggesting that the distributions of these eight indicators differed between the pandemic and pre-COVID-19 periods and thus had broader impacts.

Conclusions

This study explored the impact of major infectious disease events on C&CI firms in Taiwan's stock market and focused on the changes in financial statement data and basic operating status disclosed by companies during the COVID-19 pandemic (2020--2022). Because this annual statement is regulated by the relevant laws and regulations of the local government and the financial information of the firm issued by a registered and qualified accountant, it has considerable credibility. In addition, the C&CI firms in the Taiwan stock market are based mainly on digital

content and emphasize technology, especially in the field of digital games. The impact of COVID-19 was analyzed by testing the equality of means during the pre-COVID-19 (2015--2019) and COVID-19 pandemics from the five categories of major financial indicators of individual firms, including financial structure, solvency, operating ability, profitability, and cash flows, as well as basic operating status. The data from the postpandemic period (2023) were compared to observe the postpandemic industry, which showed recovery. Second, according to the characteristics of the industrial structure and the expected impact of the epidemic on the DGI, the sample firms were divided into digital game groups and nondigital game groups for group testing to understand the actual results of the impact of the epidemic on the digital game industry and the differences between the groups. The results of this study can be used as a reference for the financial management of C&CIs in dealing with similar major events in the future and as a supporting document for the industry to examine the advantages of the DGI in the financial performance of major infectious diseases.

Through empirical evidence, the following conclusions were drawn: 1) Financial structure: only the mean and standard deviation (risk) of the ratio of long-term funds to fixed assets increased during the COVID-19 pandemic, whereas the mean did not decrease, but the standard deviation decreased during the postpandemic period. The rest of the indicators did not change much, and the impact of the epidemic was limited. It was confirmed that the mean ratio of long-term funds to fixed assets during the COVID-19 pandemic was significantly greater than that during the pre-COVID-19 period. During the COVID-19 pandemic, the debt ratio of the nondigital game group was significantly greater than that of the digital game group, whereas no significant differences were observed in the financial structure indicators of the digital game group. There was evidence suggesting that the digital game group had an advantage in financial structure over the nondigital game group. 2) Solvency: The average cash-to-current liabilities ratio of the overall industry increased significantly during the COVID-19 pandemic. The solvency indicators in the postpandemic period were all greater than they were before the COVID-19 pandemic, indicating their strategies to improve their solvency to cope with the impact of similar emergencies. The cash-to-current liabilities ratio for the digital game group was significantly greater than that for the pre-COVID-19 group, indicating that the digital game group significantly increased its cash and cash equivalents during the COVID-19 pandemic as a financial strategy to cope with the uncertainties and risks associated with the pandemic. 3) Operating ability: The direction of the impact of industry overall on the indicators of operating ability during the COVID-19 pandemic has been inconsistent. During the COVID-19 pandemic, asset turnover rates were significantly lower, and this result was consistent across both the digital gaming and nondigital gaming groups. 4) Profitability: Only the EPS of the overall industry had a positive mean, and the other four indicators had negative averages, indicating that the profits did not simply come from the operation of the business and may have contributed from outside the business. Only EPS increased during the COVID-19 pandemic, whereas the rest declined. Since the pandemic, profitability has yet to recover to pre-COVID-19 levels and continues to decline. It has been confirmed that ROE will be significantly lower than pre-COVID-19 levels during the COVID-19 pandemic. Second, the ROA and ROE of the nondigital game group were significantly lower than those of the pre-COVID-19 group during the COVID-19 pandemic, whereas the digital game group did not exhibit a significant change in profitability during the same period. The decrease in profitability during the pandemic period was largely due to the nondigital game group. Finally, the profitability of digital game groups did not change significantly during the COVID-19 pandemic, which was contrary to market expectations. 5) Cash flows: The cash reinvestment ratio of the industry as a whole changed to a greater extent, with a negative mean during the pre-COVID-19 pandemic but a positive mean during the COVID-19 pandemic. There was no evidence to support a significant change (difference) in cash flows during the COVID-19 pandemic, and the results were approximately the same for both the digital game groups and the nondigital game groups. In terms of basic operating status, the revenue growth rate of the overall

industry decreased from 38.637% during the pre-COVID-19 pandemic to 12.386% during the COVID-19 pandemic. The means of the other indicators did not change much during the COVID-19 pandemic. Second, the basic situation of postpandemic operations gradually returned to the pre-COVID-19 level, and some indicators even exceeded the average level of the past. Finally, there was no evidence to support a significant change in the fundamentals of a firm's operations during the COVID-19 pandemic, and consistent results were observed for both digital game groups and non-digital game groups.

The limitations of this study were as follows: 1) Limitations of the sample firms: This study used the annual financial statements of the firms listed on the Taiwan stock market as the analysis data, and these firms had a certain degree of credibility and credibility due to the supervision of qualified accountants and government regulations; however, the sample firms belong to the local peers who prefer to have scale, so they cannot be discussed for some small-scale or sole proprietorship cultural entrepreneurs. In addition, C&CIs' stocks listed on the Taiwan stock market had a biased industrial structure toward digital technology and creativity, raising doubts about the underrepresentation of cultural companies. 2) The data source for this study was a paid database of TEJD. Although this professional financial database was compiled from statistics based on the Taiwan Securities and Financial Markets and the research data had considerable credibility and accuracy, bias may still exist and was therefore considered an uncontrollable condition. 3) Limitations of the empirical methods: In this study, the financial data of 40 firms for 9 years were used to test the individual study variables. The important priorities of the changes in financial indicators caused by the epidemic should be further explored in the future as a reference for management decision-making. 4) In this study, the study variables (indicators) were classified purely according to the pre-COVID-19 and COVID-19 pandemic periods for empirical testing, without considering policy or other potential external factors. In particular, the impact and benefits of some relief policies and revitalization programs implemented by the government on local C&CIs have not been considered and excluded in the empirical process, and future follow-up studies should further consider the impact of policy benefits.

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Reference

1. Achim, M. V., Safta, I. L., Văidean, V. L., Mureșan, G. M., & Nicolae Sorin Borlea, N. S. (2022). The impact of COVID-19 on financial management: evidence from Romania. *Economic Research-Ekonomska Istraživanja*, 35(1), 1807–1832. <https://doi.org/10.1080/1331677X.2021.1922090>.
2. Amankwah-Amoah, J., Khan, Z., & Wood, G. (2021). COVID-19 and business failures: the paradoxes of experience, scale, and scope for theory and practice. *European Management Journal*, 39(2), 179–184. <https://doi.org/10.1016/j.emj.2020.09.002>.
3. Ardito, L. (2023). The influence of firm digitalization on sustainable innovation performance and the moderating role of corporate sustainability practices: an empirical investigation. *Business Strategy and the Environment*, 32(8), 5252–5272. <https://doi.org/10.1002/bse.3415>.

4. Atayah, O. F., Dhiaf, M. M., Najaf, K., & Frederico, G. F. (2022). Impact of COVID-19 on financial performance of logistics firms: evidence from G-20 countries. *Journal of Global Operations and Strategic Sourcing*, 15(2), 172–196. <https://doi.org/10.1108/JGOSS-03-2021-0028>.
5. Bakhshi, H., Di Novo, S., & Fazio, G. (2023). The “Great Lockdown” and cultural consumption in the UK. *Journal of Cultural Economics*, 47, 555–587. <https://doi.org/10.1007/s10824-022-09463-6>.
6. Che Arshad, N., & Irijanto, T. T. (2023). The creative industries effects on economic performance in the time of pandemic. *International Journal of Ethics and Systems*, 39(3), 557–575. <https://doi.org/10.1108/IJOES-10-2021-0199>.
7. Chen, C. W., Sutton, N. K., Yi, B., & Zheng, Q. (2023). The connection between gender diversity and firm performance: evidence from Taiwan. *International Review of Financial Analysis*, 89, Article 102763. <https://doi.org/10.1016/j.irfa.2023.102763>.
8. Chen, Y. C., & Liu, J. T. (2022). Seasoned equity offerings, return of capital and agency problem: empirical evidence from Taiwan. *Asia Pacific Management Review*, 27(2), 92–105. <https://doi.org/10.1016/j.apmr.2021.05.006>.
9. Chen, Y. C., & Liu, Y. S. (2023). Market efficiency and stock investment loss aversion guide during COVID-19 pandemic events: the case for applying data mining. *SAGE Open*, 13(4). <https://doi.org/10.1177/21582440231215956>.
10. Cho, S. J., Chung, C. Y., & Young, J. (2019). Study on the relationship between CSR and financial performance. *Sustainability*, 11(2), Article 343. <https://doi.org/10.3390/su11020343>.
11. Cunningham, S., McCutcheon, M., Hearn, G., & Ryan, M. D. (2021). ‘Demand’ for culture and ‘allied’ industries: policy insights from multi-site creative economy research. *International Journal of Cultural Policy*, 27(6), 768–781. <https://doi.org/10.1080/10286632.2020.1849168>.
12. Ding, Y. J., Guo, J. L., & Tsai, C. W. (2025). The influence of ESG performance on credit risk and financial distress: an empirical study on Taiwan corporate sustainability. *Applied Economics*, 57(12), 1351–1367. <https://doi.org/10.1080/00036846.2024.2312262>.
13. Dörr, J. O., Licht, G., & Murmann, S. (2022). Small firms and the COVID-19 insolvency gap. *Small Business Economics*, 58, 887–917. <https://doi.org/10.1007/s11187-021-00514-4>.
14. Dümcke, C. (2021). Five months under COVID-19 in the cultural sector: a German perspective. *Cultural Trends*, 30(1), 19–27. <https://doi.org/10.1080/09548963.2020.1854036>.
15. Ekinci, R., & Poyraz, G. (2019). The effect of credit risk on financial performance of deposit banks in Turkey. *Procedia computer science*, 158, 979–987. <https://doi.org/10.1016/j.procs.2019.09.139>.
16. Ellul, A., Erel, I., & Rajan, U. (2020). The COVID-19 pandemic crisis and corporate finance. *Review of Corporate Finance Studies*, 9(3), 421–429. <https://doi.org/10.1093/rcfs/cfaa016>.
17. Elnahass, M., Trinh, V. Q., & Li, T. (2021). Global banking stability in the shadow of Covid-19 outbreak. *Journal of International Financial Markets, Institutions and Money*, 72, Article 101322. <https://doi.org/10.1016/j.intfin.2021.101322>.
18. Escalona-Orcao, A., Barrado-Timón, D. A., Escolano-Utrilla, S., Sánchez-Valverde, B., Navarro-Pérez, M., Pinillos-García, M., & Sáez-Pérez, L. A. (2021). Cultural and creative ecosystems in medium-sized cities: evolution in times of economic crisis and pandemic. *Sustainability*, 13(1), Article 49. <https://doi.org/10.3390/su13010049>.
19. Gao, Y., Turkina, E., & Van Assche, A. (2024). The nexus between the cultural and creative industries and the sustainable development goals: a network perspective. *Regional Studies*, 58(4), 841–859. <https://doi.org/10.1080/00343404.2023.2252474>.
20. Grewal, J., & Serafeim, G. (2020). Research on corporate sustainability: review and directions for future research. *Foundations and Trends® in Accounting*, 14(2), 73–127. <http://dx.doi.org/10.1561/14000000061>.

21. Gustafsson, C., & Lazzaro, E. (2021). The innovative response of cultural and creative industries to major European societal challenges: toward a knowledge and competence base. *Sustainability*, 13(23), Article 13267. <https://doi.org/10.3390/su132313267>.
22. Handke, C., & Dalla Chiesa, C. (2022). The art of crowdfunding arts and innovation: the cultural economic perspective. *Journal of Cultural Economics*, 46, 249–284. <https://doi.org/10.1007/s10824-022-09444-9>.
23. Hosseini, E., & Rajabipoor Meybodi, A. (2023). Proposing a model for sustainable development of creative industries based on digital transformation. *Sustainability*, 15(14), Article 11451. <https://doi.org/10.3390/su151411451>.
24. Iqbal, S., Nawaz, A., & Ehsan, S. (2019). Financial performance and corporate governance in microfinance: evidence from Asia. *Journal of Asian Economics*, 60, 1–13. <https://doi.org/10.1016/j.asieco.2018.10.002>.
25. Jeannotte, M. S. (2021). When the gigs are gone: valuing arts, culture and media in the COVID-19 pandemic. *Social Sciences & Humanities Open*, 3(1), Article 100097. <https://doi.org/10.1016/j.ssaho.2020.100097>.
26. Joffe, A. (2021). Covid-19 and the African cultural economy: an opportunity to reimagine and reinvigorate? *Cultural Trends*, 30(1), 28–39. <https://doi.org/10.1080/09548963.2020.1857211>.
27. Kantor, A., & Kubiczek, J. (2021). Polish culture in the face of the COVID-19 pandemic crisis. *Journal of Risk and Financial Management*, 14(4), Article 181. <https://doi.org/10.3390/jrfm14040181>.
28. Karim, S., Iqbal, M. S., Ahmad, N. et al. (2023). Gene expression study of breast cancer using Welch Satterthwaite t-test, Kaplan-Meier estimator plot and Huber loss robust regression model. *Journal of King Saud University - Science*, 35(1), Article 102447. <https://doi.org/10.1016/j.jksus.2022.102447>.
29. Kaźmierska-Jóźwiak, B., Sekuła, P., & Socha, B. (2021). Analysis of the effects of COVID-19 on companies listed on the Warsaw Stock Exchange. *Forum Scientiae Oeconomia*, 9(4), 99–116. https://doi.org/10.23762/FSO_VOL9_NO4_5.
30. Khlystova, O., Kalyuzhnova, Y., & Belitski, M. (2022). The impact of the COVID-19 pandemic on the creative industries: a literature review and future research agenda. *Journal of business research*, 139, 1192–1210. <https://doi.org/10.1016/j.jbusres.2021.09.062>.
31. Khlystova, O., & Kalyuzhnova, Y. (2023). The impact of the creative industries and digitalization on regional resilience and productive entrepreneurship. *The Journal of Technology Transfer*, 48(5), 1654–1695. <https://doi.org/10.1007/s10961-023-10020-2>.
32. Konhäuser, P., Semmerau, S. M., & Grunert, M. (2021). Microtransactions in games – an analysis of a crowdfunding perspective. *Forum Scientiae Oeconomia*, 9(4), 31–58. https://doi.org/10.23762/FSO_VOL9_NO4_2.
33. Kücher, A., Mayr, S., Mitter, C., Duller, C., & Feldbauer-Durstmüller, B. (2020). Firm age dynamics and causes of corporate bankruptcy: age dependent explanations for business failure. *Review of Managerial Science*, 14(3), 633–661. <https://doi.org/10.1007/s11846-018-0303-2>.
34. Kurniawan, -, Maulana, A., & Iskandar, Y. (2023). The effect of technology adaptation and government financial support on sustainable performance of MSMEs during the COVID-19 pandemic. *Cogent Business & Management*, 10(1), Article 2177400. <https://doi.org/10.1080/23311975.2023.2177400>.
35. Kyere, M., & Ausloos, M. (2021). Corporate governance and firms financial performance in the United Kingdom. *International Journal of Finance & Economics*, 26(2), 1871–1885. <https://doi.org/10.1002/ijfe.1883>.
36. Langevang, T., Steedman, R., Alacovska, A., Resario, R., Kilu, R. H., & Sanda, M.-A. (2022). The show must go on!: hustling through the compounded precarity of Covid-19 in the creative industries. *Geoforum*, 136, 142–152. <https://doi.org/10.1016/j.geoforum.2022.09.015>.

37. Lazzeretti, L., Oliva, S., Innocenti, N., & Capone, F. (2025). Rethinking culture and creativity in the digital transformation. *European Planning Studies*, 33(5), 671–679. <https://doi.org/10.1080/09654313.2022.2052018>.
38. Lee, L., & Liu, Y. S. (2024). The impact of major infectious disease events and government relief packages on the film industry: evidence from Taiwan. *Humanities & Social Sciences Communications*, 11, Article 1434. <https://doi.org/10.1057/s41599-024-03981-8>.
39. Lerro, A., Schiuma, G., & Manfredi, F. (2022). Entrepreneurial development and digital transformation in creative and cultural industries: trends, opportunities and challenges. *International Journal of Entrepreneurial Behavior & Research*, 28(8), 1929–1939. <https://doi.org/10.1108/IJEBr-11-2022-008>.
40. Lin, C. W., Tan, W. P., Lee, S. S., & Mao, T. Y. (2021). Is the improvement of CSR helpful in business performance? Discussion of the interference effects of financial indicators from a financial perspective. *Complexity*, 2021(1), Article 4610097. <https://doi.org/10.1155/2021/4610097>.
41. Liu, Y. S. (2021). Investor sentiment, trading activity and effect of the open-market share repurchase basing on firm characteristics. *Spanish Journal of Finance and Accounting*, 50(1), 39–64. <https://doi.org/10.1080/02102412.2019.1706882>.
42. Liu, Y. S., & Lee, L. (2022a). Policy and political effects on tourism development. *Tourism Analysis*, 27(4), 437–445. <https://doi.org/10.3727/108354222X16586121615173>.
43. Liu, Y. S., & Lee, L. (2022b). Are modifications in the ETF's investment performance and risks during the COVID-19 pandemic event?. *Review of Applied Socio-Economic Research*, 23(1), 5–17. <https://doi.org/10.54609/reaser.v23i1.202>.
44. Liu, Y. S. (2025a). The impact of organizational reform on the operational performance of Taiwan's commercial bank: assessment using the CAMELS rating system. *ECONOMICS-Innovative and Economic Research Journal*, 13 (2). <https://doi.org/10.2478/eoik-2025-0050>.
45. Liu, Y. S. (2025b). The impact of major infectious disease events on shareholder wealth and risks in cultural and creative industries. *Journal of Open Innovation: Technology, Market, and Complexity*, 11(3), Article 100582. <https://doi.org/10.1016/j.joitmc.2025.100582>.
46. Lu, Q., & Chesbrough, H. (2022). Measuring open innovation practices through topic modelling: revisiting their impact on firm financial performance. *Technovation*, 114, Article 102434. <https://doi.org/10.1016/j.technovation.2021.102434>.
47. Mahssouni, R., Makhroue, M., Touijer, M. N., & Elabjani, A. (2023). Dual perspectives on financial performance: analyzing the impact of digital transformation and COVID-19 on European listed companies. *Journal of Risk and Financial Management*, 16(8), Article 371. <https://doi.org/10.3390/jrfm16080371>.
48. Meuer, J., Koelbel, J., & Hoffmann, V. H. (2020). On the nature of corporate sustainability. *Organization & Environment*, 33(3), 319–341. <https://doi.org/10.1177/1086026619850180>.
49. Nasta, L. (2025). Understanding digital transformation in creative and cultural industries: a review. *Navigating the Paradoxes of Digital Transformation in the Creative and Cultural Industries: Embracing Innovation*, 7–22. https://doi.org/10.1007/978-3-031-77473-7_2.
50. Peñarroya-Farell, M., & Miralles, F. (2022). Business model adaptation to the COVID-19 crisis: strategic response of the Spanish cultural and creative firms. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(1), Article 39. <https://doi.org/10.3390/joitmc8010039>.
51. Petrucci, F., & Milanesi, M. (2022). It ain't over till it's over: exploring the post-failure phase of new ventures in business networks. *Journal of Business & Industrial Marketing*, 37(13), 64–76. <https://doi.org/10.1108/JBIM-12-2020-0537>.
52. Protogerou, A., Kontolaimou, A., & Caloghirou, Y. (2022). Creative industries and resilience in times of crisis: the role of firm and entrepreneurial team characteristics. *International Journal of Entrepreneurial Behavior & Research*, 28(4), 1075–1105. <https://doi.org/10.1108/IJEBr-09-2021-0701>.

53. Rababah, A., Al-Haddad, L., Sial, M. S., Chunmei, Z., & Cherian, J. (2020). Analyzing the effects of COVID-19 pandemic on the financial performance of Chinese listed companies. *Journal of Public Affairs*, 20(4), Article e2440. <https://doi.org/10.1002/pa.2440>.
54. Ryu, S., Xiang, Y., & Zhang, W. (2024). Digital transformation of traditional cultural and creative industry. In *Guide to Digital Innovation in the Cultural and Creative Industry*. SAGE Publications, Inc. <https://doi.org/10.4135/9781071910023.n4>.
55. Santoro, G., Bresciani, S., & Papa, A. (2020). Collaborative modes with cultural and creative industries and innovation performance: the moderating role of heterogeneous sources of knowledge and absorptive capacity. *Technovation*, 92, Article 102040. <https://doi.org/10.1016/j.technovation.2018.06.003>.
56. Schalck, C., & Yankol-Schalck, M. (2021). Predicting French SME failures: new evidence from machine learning techniques. *Applied Economics*, 53(51), 5948–5963. <https://doi.org/10.1080/00036846.2021.1934389>.
57. Shin, S. (2025). The impact of COVID-19 on cultural and arts activities: evidence from a large-scale micro-level survey in South Korea. *Journal of Cultural Economics*, 49(1), 193–229. <https://doi.org/10.1007/s10824-024-09501-5>.
58. Shpak, N., Podolchak, N., Karkovska, V., Sroka, W., & Horbal, N. (2022). The application of tools for assessing the financial security of enterprises. *Forum Scientiae Oeconomia*, 10(2), 29–44. https://doi.org/10.23762/FSO_VOL10_NO2_2.
59. Skocdopole, P., Skypalova, R., & Fitala, P. (2023). Sustainable Strategic Management: Foreign Capital Participation in the Post-COVID-19 Era. *Forum Scientiae Oeconomia*, 11(3), 189–207. https://doi.org/10.23762/FSO_VOL11_NO3_10.
60. Smrt, M., Hodinova, A., & Kuchar, R. (2025). Impact of COVID-19 on stock prices in the global video game market. *Forum Scientiae Oeconomia*, 13(1), 8–20. https://doi.org/10.23762/FSO_VOL13_NO1_1.
61. Snowball, J. D., & Gouws, A. (2023). The impact of COVID-19 on the cultural and creative industries: determinants of vulnerability and estimated recovery times. *Cultural Trends*, 32(3), 207–230. <https://doi.org/10.1080/09548963.2022.2073198>.
62. Song, H. J., Yeon, J., & Lee, S. (2021). Impact of the COVID-19 pandemic: evidence from the US restaurant industry. *International Journal of Hospitality Management*, 92, Article 102702. <https://doi.org/10.1016/j.ijhm.2020.102702>.
63. Stefanovic, N., Barjaktarovic, L., & Bataev, A. (2021). Digitainability and financial performance: evidence from the Serbian banking sector. *Sustainability*, 13(23), Article 13461. <https://doi.org/10.3390/su132313461>.
64. Ullah, S. (2023). Impact of COVID-19 pandemic on financial markets: a global perspective. *Journal of the Knowledge Economy*, 14(2), 982–1003. <https://doi.org/10.1007/s13132-022-00970-7>.
65. Vitálišová, K., Borseková, K., Vaňová, A., & Helie, T. (2021). Impacts of the COVID-19 pandemic on the policy of cultural and creative industries of Slovakia. *Scientific Papers of the University of Pardubice. Series D. Faculty of Economics and Administration*, 29(1). <https://doi.org/10.46585/sp29011241editorial.upce.cz/SciPap>.
66. Wall-Andrews, C., Walker, E., & Cukier, W. (2021). Support mechanisms for Canada's cultural and creative sectors during COVID-19. *Journal of Risk and Financial Management*, 14(12), Article 595. <https://doi.org/10.3390/jrfm14120595>.
67. Wang, Y., Witman, A. E., Cho, D. D., & Watson, E. D. (2022). Financial outcomes associated with the COVID-19 pandemic in California hospitals. *JAMA health forum*, 3(9), e223056–e223056. <https://doi.org/10.1001/jamahealthforum.2022.3056>.
68. Williams, K., Lester, L., & Seivwright, A. (2024). The invisible architecture of creative and cultural work: the relationship between miscategorization and sector wellbeing during COVID-19. *Creative Industries Journal*, 17(3), 400–418. <https://doi.org/10.1080/17510694.2022.2106091>.

69. Yang, S. S., Huang, J. W., & Li, W. H. (2024). Institutional investor stewardship and material sustainability information: evidence from Taiwan. *Pacific-Basin Finance Journal*, 85, 102382. <https://doi.org/10.1016/j.pacfin.2024.102382>.
70. Yue, A. (2022). Conjunctions of resilience and the Covid-19 crisis of the creative cultural industries. *International Journal of Cultural Studies*, 25(3-4), 349–368. <https://doi.org/10.1177/13678779221091293>.
71. Zhang, D., & Fang, Y. (2022). Are environmentally friendly firms more vulnerable during the COVID-19 pandemic?. *Journal of Cleaner Production*, 355, Article 131781. <https://doi.org/10.1016/j.jclepro.2022.131781>.
72. Zhang, R., Ji, H., Pang, Y., & Suo, L. (2022). The impact of COVID-19 on cultural industries: an empirical research based on stock market returns. *Frontiers in public health*, 10, Article 806045. <https://doi.org/10.3389/fpubh.2022.806045>.
73. Zhao, X., Shen, L., & Jiang, Z. (2024). The impact of the digital economy on creative industries development: empirical evidence based on the China. *PLoS ONE* 19(3), Article e0299232. <https://doi.org/10.1371/journal.pone.0299232>.
74. Zhou, G., Liu, L., & Luo, S. (2022). Sustainable development, ESG performance and company market value: mediating effect of financial performance. *Business Strategy and the Environment*, 31(7), 3371–3387. <https://doi.org/10.1002/bse.3089>.