International Journal of Economics, Commerce and Management
United Kingdom ISSN 2348 0386 Vol. 12, Issue 2, Feb 2024

https://ijecm.co.uk/

A GRANGER CAUSALITY ANALYSIS OF THE IMPACT OF COVID-19 ON CONSUMPTION PATTERNS WITH A FOCUS ON CYPRUS

C. Christodoulou-Volos
Department of Economics and Business, Neapolis University Pafos, Cyprus
c.volos@nup.ac.cy

Dikaios Tserkezos
Department of Economics and Business, Neapolis University Pafos, Cyprus

Abstract

This study examines the effects of the COVID-19 pandemic on both the economy and people's consumption habits, focusing specifically on Cyprus. It employs Granger causality analysis to compare sales fluctuations before and after the pandemic. By utilizing supermarket sales data, we gain insights into how the pandemic has influenced consumer behavior. Particularly, the study reveals that sales volumes from 2020 to 2021 significantly increased compared to the previous year, although they fluctuated as the pandemic situation evolved. This suggests that consumer purchasing patterns responded dynamically to the changing circumstances brought about by COVID-19. Furthermore, this research contributes to a broader understanding of the pandemic's impact on both the global economy and daily life. While this study specifically targets Cyprus, its findings can offer valuable insights for similar analyses in other regions. Understanding how economic variables respond to such crises is crucial for devising effective policy measures and ensuring the resilience of economies in the face of unexpected challenges.

Keywords: COVID-19 pandemic, Unit-root test, Granger causality

INTRODUCTION

The COVID-19 pandemic has been a global crisis of unparalleled magnitude, affecting not only public health but also the global economy. Understanding the multifaceted impact of the pandemic on consumption patterns and economic behavior is essential. It altered the way people consumed goods and services. Lockdowns, social distancing, and health concerns prompted a surge in online shopping.

According to a report by IBM (2021), there was a 20% growth in global e-commerce sales in 2020, driven by consumers' preference for contactless shopping. This shift in consumer behavior not only favored e-commerce giants but also led to a boom in local delivery services, highlighting the adaptability of businesses. On the other side, sectors heavily dependent on physical presence, such as hospitality, travel, and brick-and-mortar retail, faced immense challenges. Lockdowns and travel restrictions led to a sharp decline in demand, causing revenue losses and layoffs. Many of these businesses struggled to survive without government support. The pandemic exposed vulnerabilities in global supply chains. Disruptions in manufacturing and logistics led to shortages of essential goods like, causing price hikes. These disruptions rippled through various industries, impacting not only the availability of products but also their affordability.

Atkeson (2020) offers preliminary estimates of the economic impact of COVID-19 in the United States under various disease scenarios. This study serves as a foundational work for understanding the potential economic consequences of the pandemic and provides a framework for further analyses. Lin and Meissner (2020) examine the relationship between public health policies and their impact on the economy during the COVID-19 pandemic. Their work underscores the intricate causal links between public health interventions and economic outcomes. It raises questions about the trade-offs between public health and economic well-being, emphasizing the interplay between the two. Bavel et al. (2020) stress the significance of social and behavioral science in supporting the pandemic response. This research highlights the role of human behavior as a critical factor in the spread and mitigation of COVID-19, aligning with the concept of Granger causality, which explores the causal relationships between events and outcomes. Chetty et al. (2020) present real-time data on the impact of COVID-19 and stabilization policies on spending and employment. This research underscores the need to understand the causal links between policy responses and economic outcomes. It provides a comprehensive view of how government interventions influenced economic behavior during the pandemic. Cao et al. (2020) explore the empirical evidence of how an epidemic, in this case, COVID-19, impacts consumer behavior in China. The study demonstrates the practical application of Granger causality in

understanding the pandemic's influence on consumption patterns. It highlights the necessity of understanding the causal relationships between public health crises and consumer choices. Górka (2020) focuses on the impact of the COVID-19 pandemic on the consumption behavior of Polish households. This study provides insights into the direct consequences of the pandemic on consumer choices and spending patterns, contributing to the understanding of the micro-level impacts of the crisis.

The pandemic had a profound impact on the Cypriot economy. It resulted in a significant decline in the country's GDP and an increase in the unemployment rate. Along with, the imposition of travel bans in various countries dealt a severe blow to Cyprus's tourism industry, leading to a substantial decrease in national income. This double blow, involving the collapse of the tourism sector and the closure of many small enterprises, resulted in a sharp contraction of the GDP by -5.0% in the year 2020. However, there were signs of hope as the slow recovery of the tourism industry commenced in 2021. This revival in the tourism sector played a pivotal role in the overall economic recovery of Cyprus. Interestingly, this economic rebound was particularly favorable for local enterprises, such as supermarkets. In 2021, as policies eased and the tourism industry showed signs of resurgence, local supermarkets experienced a significant surge in sales volume. This nuanced response of different sectors of the Cypriot economy to the evolving pandemic conditions reflects the intricate interplay between external factors, government policies, and local businesses' adaptability.

This study primarily investigates the repercussions of COVID-19 on consumer behavior in Cyprus by analyzing fluctuations in supermarket sales before and after the pandemic. Specifically, by correlating changes in COVID-19 cases with sales data, we aim to ascertain whether sales underwent significant decreases during periods of high pandemic severity. Additionally, we seek to comprehend the broader economic implications of COVID-19 by comparing supermarket sales before and after the pandemic. Through the comprehensive analysis of data specific to Cyprus, we intend to gain deeper insights into how COVID-19 has influenced global economies and individuals' daily lives. Furthermore, we aim to explore the pandemic's effects on enterprise sales to better understand shifts in consumer perspectives during this challenging period. Ultimately, our data-driven analysis aims to confirm that COVID-19 indeed impacted supermarket sales, and, conversely, that sales exerted a certain influence on the rate of COVID-19 infections.

The rest of this paper is structured as follows. Section 2 presents data, methods and discusses the empirical results. Finally, Section 3 presents a summary and some concluding results.

RESEARCH METHODOLOGY

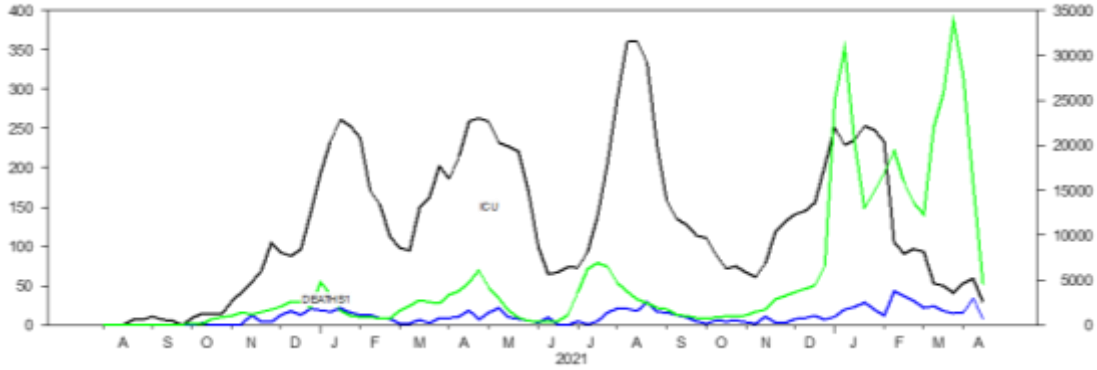
This study employs weekly data for the period from 2019 to 2022 to investigate the impact of the pandemic on supermarket sales. The variables selected are as follows: 1) Supermarket sales (Y); 2) The number of new COVID-19 cases (X_1); 3) COVID-19 deaths and intensive care unit (X_2); 4) the number of COVID-19 units of hospital (X_3). The COVID-19 variables are obtained from GitHub and the supermarket sales data have been provided by a local supermarket. In order to get accurate relationships between supermarket sales and COVID-19 variables, Granger causality approach was used.

EMPIRICAL RESULTS

COVID-19 Data

The values of all the COVID-19 variables are plotted in a time-series graph in Figure 1 to comprise all series to see how they move. Figure 1 shows the new cases, the number of ICUs and deaths over time and can be used to visually analyze whether there is any relationship among them.

Figure 1. COVID-19 Statistics: New Cases, Deaths, and Intensive Care Unit Admissions at a Hospital in Cyprus



Data source: World Health Organization. (2022). COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. GitHub. https://github.com/CSSEGISandData/COVID-19. Accessed on January 24, 2023.

Figure 1 indicates that the number of new cases from August to October 2020 is relatively small and the number of deaths and hospital wards is zero (0). However, the number of cases has gradually increased since September 2020. However, although the number of cases has increased slightly from August to mid-September, the number of ICUs and deaths was still 0. This might be because the COVID-19 virus infected by people at that time was a

degraded variant, with minor sequelae after infection and a low probability of death. From the middle of September 2020 to January 2021, the number of cases increased rapidly from 0 to nearly 23,000; The number of ICUs has also increased to a certain extent, but compared with the speed of new cases, the increase is not significant, but the highest value has reached nearly 6000; The death toll also increased, with a maximum of about 2,500. From January to March 2021, the number of cases began to decline, and the number of new cases fell to nearly 8,000 by March; After the gradual decline, the number of ICUs increased by a small margin to nearly 2,500 but decreased significantly compared the previous peak; The death rate showed a downward trend, approaching 0. From March to May, the number of cases began to increase again and fluctuated a little in the middle, but the primary trend was upward, and the number was similar to the peak value in January; The increased number of ICUs is nearly 1,000 higher than the highest value in January; The mortality rate fluctuates up and down, and the highest value during the period is lower than the highest value in January. However, from May to June, the growth rate of cases dropped rapidly, from 23,000 to about 6,000 in a month; The number of new cases in ICU and deaths was less than 1,000. From June to August, the number of new cases began to rise significantly, and the highest value exceeded the highest value in January and May, reaching nearly 31,000; The peak value of ICU is also higher than before, reaching about 7,000; Although the number of deaths has also shown an upward trend, it has not reached a new high. Compared with the numerical growth in the previous months, the death rate has been well controlled.

Although the number of new cases and ICUs is higher than before, the death rate has not subsequently exceeded the previous peak value. From August to November, the number of new cases began to decline, with the lowest value of nearly 5,000, which was lower than the lowest value in June; the number of ICUs showed a downward trend, and the number of deaths was close to zero. The number of new cases increased from November to mid-January and fluctuated slightly in December, but the highest value was about 22,000 less than the previous value; The number of ICUs has exceeded the previous peak and reached 31,000; The death toll did not exceed the previous highest value. From the middle of January to April 2022, the number of new cases decreased slowly. Although there was a slight fluctuation, the overall trend was downward; The number of ICUs again exceeded the previous peak in mid-March, and the number of ICUs was about 34,000; The death toll broke the previous record in February and reached about 4,000, with a slight fluctuation, but the overall trend was stable.

Figure 1 also shows that the highest number of new cases occurred in 2021 January, May, August 2021, and January of 2022. The fluctuation range of new cases is extensive, the highest value is 31,000, and the lowest value is 0; The maximum number of ICUs is 34,000, and

the minimum number is 0; The highest mortality rate was 4,000, and the lowest was 0. Although the number of new cases fluctuated significantly before January 2022, the number of ICUs and deaths did not exceed the number of new cases. The overall fluctuation was close to the fluctuation of new cases. The number of ICUs and deaths increased with the increase of new cases. However, in January 2022, the number of ICUs was even higher than 11000 new cases. Although the number of ICUs increased significantly, the number of deaths did not exceed the previous peak, which means that there is an effective treatment for COVID-19, which will enter the ICU but will not cause many deaths. In March 2022, when the number of new cases showed a downward trend, ICUs increased sharply and exceeded the highest value in January, reaching 34,000. However, the mortality rate remained stable, with a slight fluctuation, but it did not increase with the number of ICUs in general.

The increase in COVID-19 cases in 2021 may be related to the opening flights in Cyprus. According to the situation of the tourism industry in 2021 published by Cyprus mail, the income of the tourism industry in Cyprus in 2021 is 1.45 billion euros, which has a significant increase compared with 2020 (Kyriacos N, 2023). The opening of the tourism industry is also the reason for the fluctuation in the number of new cases in 2021. June to August 2021 is the summer holiday period; it is also the peak of the number of tourists in Cyprus, so the number of new cases has also increased to a peak. With the beginning of school and the end of the tourist season, the number of new cases has also begun to decline. The reason that affects the ICU and the death toll in 2021 may be due to the vaccine. In 2021, Cyprus began using many vaccines and tried to increase the number of people vaccinated by some measures. For example, the certificate of vaccination completion is required to enter the supermarket or the rapid test certificate within 72-24 hours.

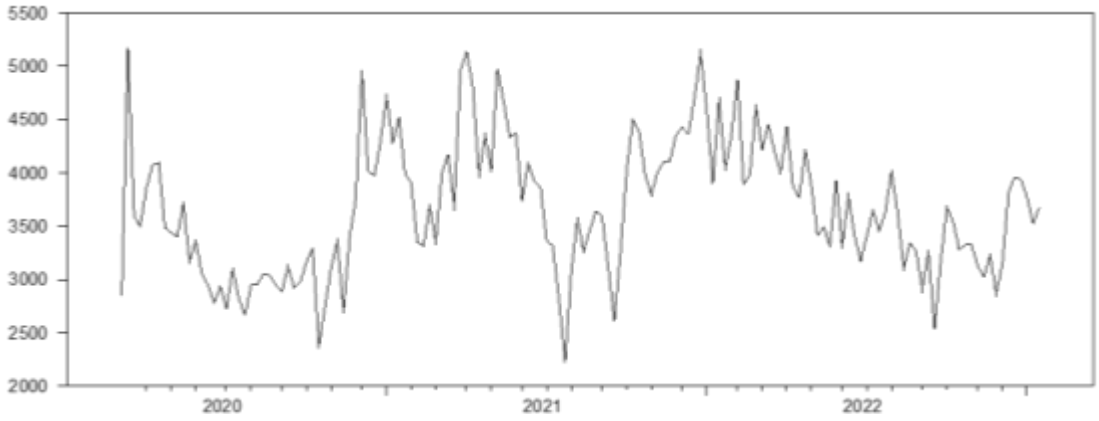
Compared with the time-effective rapid test certificate, the vaccine certificate is more straightforward, so more and more people are convenient, selecting to remove the vaccine. The vaccine can effectively reduce the harm of COVID-19 to the human body. Although there is still a certain probability of COVID-19 infection, it dramatically reduces the probability of death. Through the comparison between the number of deaths in ICUs in 2021 and the number of deaths, it can be found that the number of deaths is generally not higher than the number of ICUs, and the number of ICUs is far lower than the number of new cases. Nevertheless, in November 2021, a new COVID-19 variant virus, Omicron (Ecdc, 2023), was found in South Africa. This variant has high transmissibility and severity and significantly impacts immunity. This also led to an increase in the number of new cases and deaths in ICUs from November 2021 to April 2022, although the number of new cases is lower than the peak of tourism; among

them, the ICU value has increased significantly for two consecutive times, even higher than the number of new cases.

Supermarket's Sales

Figure 2 plots the supermarket sales data, and it shows that they are fluctuating over the period of the pandemic. COVID-19 broke out at the end of 2019, and sales fell sharply from October to December 2019. In 2020, the sales fluctuated wildly, but the overall trend was upward. From December 2020 to February 2021, there was a sharp decline and a peak in sales in July. There was some subsequent fluctuation, but the overall trend was downward until December. From January to July 2022, the sales increased slowly but did not reach the previous peak.

Figure 2. Monthly Sales Trend for Local Supermarket (2021-2022)



Data source: Local Supermarket (sales data provided with consent)

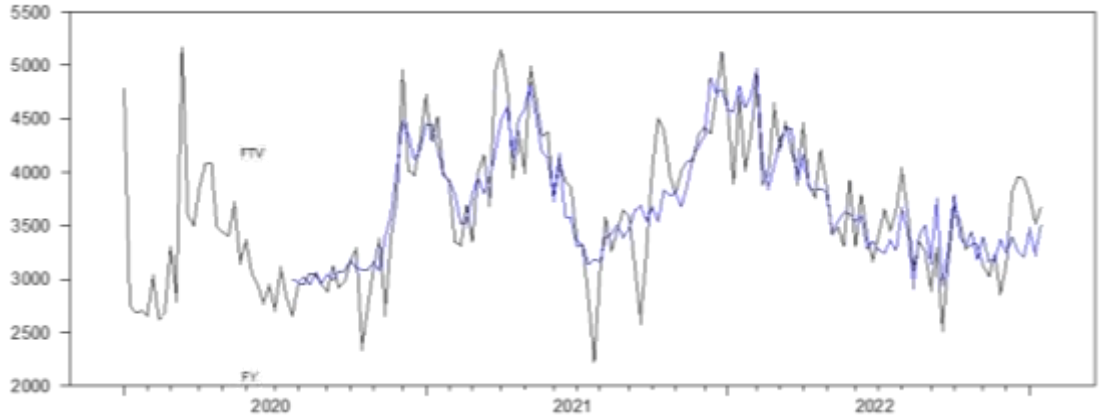
From October 2019 to April 2020, the sales of supermarkets reached a peak before the outbreak of the epidemic. However, after the epidemic outbreak, sales fell rapidly because, after the outbreak of COVID, the government began to implement blockade measures to reduce the transmission rate and ensure people's health. From April 2020 to 2021, under the condition that people have enough experience to deal with the blockade measures, the sales of supermarkets began to rise continuously. Because of the blockade measures, people's access to fresh food and time was limited, so people began to buy enough daily necessities at once to reduce the number of trips. People could not determine when the blockade policy would be changed, So the safest way was to buy more daily necessities and food to ensure life during the isolation period. From June to August 2020, people need to buy more supplies due to the start of summer vacation and the arrival of summer. Although the country was still implementing a travel

ban in 2020, the sales of supermarkets are still very considerable. From the middle of November 2020 to February 2021, the sales volume decreased rapidly but rose rapidly in March, then decreased briefly and rapidly in April, and then increased significantly. Because in 2021, Cyprus opened flights and cancelled too many requirements for entry, the sales of supermarkets have been rising from February to July 2021 and even reached a peak of 5200 in July, from July to September due to the end of the students' start of school and the tourism season, the sales decreased slowly, and the sales remained in a downward trend until 2022. The slow decline in sales may be because people have bought enough food and daily necessities before, and because of the opening of Cyprus policy, people are no longer restricted by too much time and conditions (security code or rapid detection results within 72h) when shopping, which also leads to people not needing to buy too much food and supplies at one time. From January to February 2022, the sales of supermarkets increased slightly. Then from February to the middle of March, the sales continued to show a downward trend until there was a rapid rise from the middle of March to April and then continued to show a downward trend. Supermarket sales will be affected by many factors and lead to fluctuations to varying degrees.

Actual and Predicted Sales

Figure 3 shows that there exists a large gap between the sales forecast and the actual situation. Especially in February and April of 2021, the sales volume reached the lowest value twice. Because the Cyprus government had gradually opened its policy since 2021, people reduced their consumption when they have a certain amount of goods, so the sales volume in the months since 2021 has reached two lowest records.

Figure 3. Sales Comparison: Actual vs. Projected



Data source: Local Supermarket (sales data provided with consent)

However, the two lowest values were in February and April 2021, which may be due to the increase in the number of new cases in that period. During those periods, the number of new cases was too large, and people chose to reduce the frequency of shopping to ensure their own safety. After April, the predicted sales volume at the highest and lowest values were significantly different from the actual sales index. However, in addition to these sharp fluctuations, the rest of the values are partially coincident and consistent, both rising and falling, with the same results but different fluctuations in the intermediate values.

It can also be seen that the predicted and the actual values are the same except for the apparent difference between the lowest value and the highest value several times. It can be seen from the figure that although there was a sharp fluctuation from June to December 2020, most of the figures were in an upward trend. This period is the sales volume from half a year after the outbreak of the pandemic to one year, which also means that people are still in the state of blockade measures during this period, and the tourism industry is in a downturn. The sales volume is due to people's demand for daily necessities and people's restrictions on buying necessities and food. As a result, there will be a significant gap in people's consumption after 1-2 months.

The expansion of the travel ban has led to the recovery of Cyprus's tourism industry and increased supermarket sales. In 2021, the national opening policy, people have some experience in the blockade measures, so the increase in sales is much smaller than that in 2020. The predicted data fluctuates less, while the actual data fluctuates more. It may be because some policies have been introduced, but people still need to wear masks and show their health code or the rapid detection results within 72h when shopping. Hence, people's shopping habit is buying more food and daily necessities at once. However, people can shop more reasonably through the experience accumulated in 2020. Because there is no time limit for going out, people only need to buy a little food and daily necessities at one time. The recovery of the tourism industry has led to the fact that the monthly sales volume from May to October fluctuates wildly, but it is in an upward trend. From the predicted value, the sales volume from May to October has a high degree of overlap, but there is still a significant gap in the degree of fluctuation. During this period, the degree of bullying in sales volume is like that in 2020. However, due to the opening of the tourism industry, the increase in the number of people coming to Cyprus had led to a slight fluctuation in sales compared with 2020.

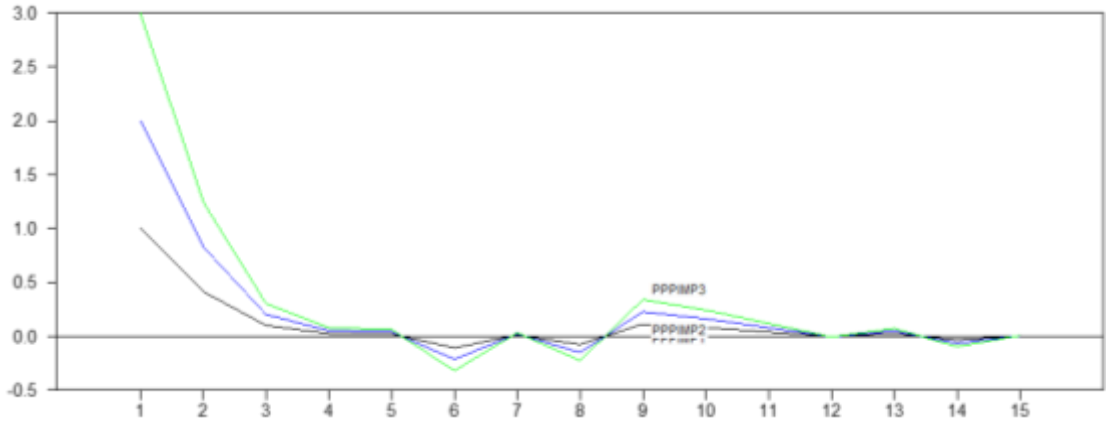
In February 2021, the fluctuation of the predicted value and the trend of the actual sales were basically the same except for the fluctuation range. The time when the predicted sales declined was basically the same as the time when the actual sales declined. After February 2021, it is evident that the fluctuation gap between the predicted value and the actual sales

volume has increased. Although the trend is still upward, the fluctuation of the predicted value is less than the fluctuation of the actual sales volume until June 2021. Looking at the number of new cases in that period, it can be seen that with the number of new cases, ICUs and mortality decreasing, supermarkets' sales had significantly increased.

Effects of COVID-19 on Consumption

In Figure 4, the profound influence of COVID-19 on consumption becomes evident through three key factors: the escalation in new cases, the increase in fatalities, and the rise in ICU admissions. Strikingly, the data depicted in fig. 4 underscores that these three factors correlate positively with consumption patterns. This observation implies that as COVID-19 surges, triggering more cases, deaths, and critical care admissions, there is a parallel increase in consumer behavior, potentially impacting supermarket sales. The findings highlight the interconnectedness of public health crises and economic dynamics, emphasizing the importance of adaptability and resilience in various sectors, including the retail industry, during such challenging times.

Figure 4. Effects of the COVID-19 Pandemic on Consumption Patterns



Unit Root (Stationarity) Test

The Augmented Dickey-Fuller (ADF, 1979) test is a widely used method for examining the presence of unit roots in time series models. The results of the ADF test, based on equations (1) and (2), indicate that all variables under investigation are not stationary in their original form but exhibit integrated order one, I(1), when examined in their first differences. These two standard regression equations are employed for conducting the ADF unit root test within the context of an autoregressive (AR) process.

$$\Delta Y_t = \alpha + \lambda Y_{t-1} + \sum_{i=1}^{P} \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \alpha + \delta t + \lambda Y_{t-1} + \sum_{i=1}^{P} \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (2)$$

Where, Δ represents the first difference operator, and parameters α, λ, β, t (time trend), and α (constant) are estimated. The error term (ε_t) is characterized as a white noise disturbance term, and the ΔYt-i term accommodates autocorrelation while ensuring the εt term remains white noise. The null hypothesis, denoting the presence of a unit root in Yt, is H0 for eq. 1 (eq. 2), indicating that λ=0, α=0 (λ=0, δ=0). The critical value for each ADF equation is unique and determined by the size of the sample.

Table 1. The ADF Unit Root Test

	Level (Lag)	**1st. Dif. (Lag)**
Y	1.81 (0)	-8.05* (0)
X_1	-3.02 (0)	-9.77* (0)
	-1.06 (0)	9.83* (0)
X_2	-3.02 (0)	-9.77* (0)
	-1.06 (0)	-9.83* (0)
X_3	-1.16 (1)	-10.46* (0)
	-1.54 (1)	-10.33* (0)

Note: Critical table values for 1% and 5% are -4.11 (-3.54) and -3.48 (-2.91), (Mackinnon, 1991).
* denotes rejection of the null hypothesis of unit root at 1%.

In the level data, the absolute ADF statistic is smaller than the critical values specified in Table 2. Consequently, the variables in their original levels exhibit non-stationarity, indicating the presence of a unit root. However, the results of the ADF unit root test reveal a different story for the data in its first difference form. In this case, the t-values surpass the critical values, leading us to reject the null hypothesis. This implies that all the variables have become integrated of order one, denoted as [I(1)]. Given that all four series in their first difference form are stationary and have no unit roots, it becomes necessary to proceed with a pairwise Granger causality test on this transformed data.

Granger Causality

Granger (1969) proposed a method for testing causality by analyzing how each variable in a model relates to its own past values and those of other variables, as described in equations (3) and (4). There are several approaches to implement Granger causality tests. In this research, a bivariate linear autoregressive model involving two variables, Y and X, is employed.

$$Y_t = \varphi_0 + \sum_{i=1}^{P} \delta_i Y_{t-i} + \sum_{j=1}^{P} a_i X_{t-j} + u_{1t} \quad (3)$$

$$X_t = \gamma_0 + \sum_{i=1}^{q} \chi_i X_{t-i} + \sum_{j=1}^{q} \beta_i Y_{t-j} + u_{2t} \quad (4)$$

Where, p and q represent the maximum number of lagged observations included in the model, and u_1 and u_2 denote the residuals for each time series. If the variance of u_1 (or u_2) decreases due to the inclusion of the Y (or X) terms in equation 3 (or 4), it indicates that X (or Y) Granger causes Y (or X). This concept is rooted in Granger causality, a statistical hypothesis test used to evaluate causal relationships between time series data.

Based on the estimated Ordinary Least Squares (OLS) coefficients for equations (1) and (2), four different alternative hypotheses (H_1) are formulated:

i. $\alpha_j \neq 0$, $\beta_j = 0$ (j=1, 2, …, n) indicates causality running from X to Y, implying that X enhances Y's prediction, but not vice versa.
ii. $\beta_j \neq 0$, $\alpha_j = 0$ (j=1, 2, …, n) suggests causality from Y to X.
iii. $\alpha_j \neq 0$ and $\beta_j \neq 0$, indicating bidirectional Granger causality from X to Y and vice versa.
iv. $\alpha_j = 0$ and $\beta_j = 0$, implying no causality between Y and X.

The Granger causality test's effectiveness is influenced by the number of lags. Researchers determine the optimal lag length, denoted as k, to ensure the estimated model is free from autocorrelation and heteroscedasticity, often employing tests like the Lagrange Multiplier test (LM) and Breusch-Pagan-Godfrey test (BPG). The results of the Granger causality test for equations (3) and (4) are presented in Table 2, where the H_0 hypothesis, representing the absence of causality, is tested along a row.

Table 2. The Results of Granger Causality Test

	Model	F statistic (p-value)	Sign and way of causality	LM p-value	BPG p-value
1	$Y=f(Y(1), X_1(1))$	10.129 (0.001)*	+ $X_1 \rightarrow Y$ [0.079]*	0.524	0.322
2	$X_1=f(X_1(1), Y(1))$	0.217 (0.643)	No	0.123	0.774
3	$Y=f(Y(4), X_3(4))$	0.255 (0.901)	No	0.568	0.581
4	$X_3=f(X_3(4), Y(4))$	2.103 (0.091)***	+ $Y \rightarrow X_3$ [2.576]	0.223	0.302
5	$Y=f(Y(4), X_2(4))$	2.244 (0.084)***	$X_2 \rightarrow Y$ [0.139]**	0.751	0.604
6	$X_2=f(X_2(4), Y(4))$	0.723 (0.584)	No	0.342	0.713

Note: *, ** and *** denote significant 1, 5 and 10 % level.

The F-statistic serves as a tool for examining the null hypothesis (H_0) that there is no collectively significant influence from past independent variable values on the present state of

the dependent variable. In models 1, 4, and 5, all F-statistics yield highly significant p-values (less than 10%), leading us to reject the null hypothesis. In Table 3, the F-statistic values indicate that both X_1 and X_2 Granger causally influence Y, while Y Granger causes X_3. However, there's no substantiated evidence of reverse causality. It appears that X_1 and X_2 values play a predictive role in determining Y. The causal link from new cases (X_1) to sales (Y) seems notably robust, as the null hypothesis of no causality can be confidently rejected at the 1% significance level. Additionally, the p-values for the LM test for autocorrelation and the BPG test for heteroscedasticity in the linear regression equations consistently indicate the absence of autocorrelation and heteroscedasticity issues across all models. To summarize the direction and significance of causality, refer to the third column of Table 3. The Wald F test results reveal that the cumulative lag coefficients of independent causal variables leading to a causal effect in models 1, 4, and 5 are 0.079* for X_1, 2.576* for Y, and 0.139** for X_2, indicating positive causality at the 1%, 1%, and 5% significance levels in all three equations, respectively.

CONCLUSIONS AND FINAL REMARKS

The results of the ADF unit root test for the data in its first difference form reveal that the t-values surpass the critical values, leading us to reject the null hypothesis. This implies that all the variables are I(1). Given that all four series in their first difference form are stationary and have no unit roots, a pairwise Granger causality test was applied on the transformed data, the F-statistic values indicate that both X_1 and X_2 Granger causally influence Y, while Y Granger causes X_3. However, there's no substantiated evidence of reverse causality. It appears that new cases and ICU values play a predictive role in determining sales. The causal link from new cases to sales seems robust, as the null hypothesis of no causality can be confidently rejected at the 1% significance level.

In addition, based on a detailed analysis of subscription results, we see that from 10/2020-12/2020, the purchase cycle of sales is fixed, fluctuating, rising, or falling every ten days. As December approaches Christmas, overall sales continue to decline. The number of new cases increased continuously from October to December, but the increase was insignificant due to travel ban restrictions and home quarantine. The number of new cases in the next stage after each sales increase will show an upward trend, which also means that the number of new cases will appear 10-15 days after each sales increase; At the same time, about 10-15 days after each increase in new cases, the sales decreased due to the increase in the procurement cycle and new cases. The main change is that from 2021, the change cycle of sales will change according to the month, the travel season, and the school holiday time. For example, in July and August, sales will continuously increase. This is because these two months are affected by the

travel season and holidays. After the sales rise in this period, the cycle will start again with this increase as a new cycle. The time is about the same, and it is still a fluctuation of 10-15 days.

During this period, the number of new cases in Cyprus was in line with the increase in mortality and ICU. With the increase of new cases, the value of mortality and ICU also increased. Although the popularity of vaccines and the opening of the tourism industry in 2021 will not have much impact on sales, it will have a more significant impact on the value of ICUs. The fluctuation of ICU value is more significant than that of new cases, and when the number of new cases starts to decline in 2022, the ICU value is not consistent with the parallel value of new cases. When the number of new cases dropped, the value of ICU was rising in a straight line, even breaking the peak value, reaching 34000, higher than the peak value of the number of new cases. However, although the death rate fluctuated slightly, it did not increase significantly. This also means that although the number of new cases is increasing and the frequency of ICU is increasing, the mortality rate is still fluctuating at the previous standard line.

Furthermore, after the end of the tourism season, due to the reduction of consumer groups, there will be two consecutive sales declines, which will also cause the standard procurement cycle to be disrupted and start a new cycle. In addition, it can be found that the number of new cases has increased significantly during the tourism season, which still has a specific impact on sales. However, the impact on sales is negligible due to the popularity of vaccines in 2021 and the increase in consumer population density caused by the tourism season.

Moreover, there is an upward trend of new cases from the middle of September 2020 to the middle of January 2021. This is because, close to the Christmas holiday, people have more contact than before, and the infection rate also increased by purchasing the supplies needed for Christmas. Then, from the middle of January to the middle of March, the overall trend was downward because the increase in the number of new cases in the past caused some consumers to become positively infected. However, they cannot be positive again for a period of three to six months after recovery. Because of the large number of new cases in the past, people tried to reduce the number of trips to lower the infection rate, so the number of new cases in that period showed a downward trend. From the middle of March to May 2021, the number of new cases began to increase again, which means that after people found that the number of cases decreased in the first two months, they believed that COVID-19 was under effective control, so they followed the standard procurement cycle, but led to the increase of new cases. From May to the middle of June 2021, the number of new cases once dropped significantly; From mid-June to mid-August 2021, the tourist season began, so the number of new cases reached its peak; From mid-August to mid-October 2021, the number of new cases

began to decline significantly; From mid-October 2021 to January 2022, the number of new cases rose again. These indicate that the number of new cases will fluctuate after every 2-3 months, with a 2–3-month increase followed by a 2-3 month decrease. This also shows that people attempted to reduce the infection rate to ensure their health after finding that new cases had increased for a period. At the same time, the sales volume of supermarkets and the number of new cases interact with each other. As previously mentioned, in the next stage of sales increase, the number of new cases started to rise; The increase in the number of new cases led to a decline in supermarket sales in the next stage. The decline in supermarket sales is not only due to the purchase of daily necessities 10-15 days ago but also the increase in the number of new cases, which led consumers to try to reduce the risk of infection to ensure their health and safety. Therefore, the sales volume and the number of new cases interact. Because the fluctuation of the number of new cases of COVID-19 was similar to the number of deaths and ICUs before January 2022, it can be proved that the changes in the three data led to the fluctuation of supermarket sales. Although the three data have a negative impact on consumption, the positive impact is still huge. Thus, the sales volume and the number of new cases interact with each other. While observing the number of new cases, since the increase in ICU and mortality is similar, it can be inferred that COVID-19 will affect supermarket sales.

Additionally, to new cases that can affect supermarket sales, new cases will also affect ICU and mortality. If more people are infected with COVID-19, the number of people infected with COVID-19 can increase, thus increasing the ICU and mortality rate. At the same time, the rise in ICU and mortality led to a decline in supermarket sales, thus reducing the number of new cases. Therefore, the number of new cases, ICU and mortality can affect the sales of supermarkets. Because people infected with the COVID-19 virus cannot be infected for a second time in a short time, which is why even though the number of new cases has increased, the death rate has not exceeded 5000. Although the ICU has increased to a certain extent, the increase is slight compared with the number of new cases. In addition, the sales volume from June to August 2021 is observed, although it is generally decreasing; however, compared with the sales volume from June to August 2020, it increased.

This empirical study faces several limitations that should be taken into account when interpreting its findings. Firstly, the analysis heavily relies on the availability and accuracy of COVID-19 data, encompassing new cases, ICU values, mortality rates, and sales data. Any limitations in the accuracy or completeness of these datasets could impact the reliability of the study’s conclusions. Moreover, the study covers the period from 2019 to 2022, introducing temporal constraints, and the impact of COVID-19 on consumption patterns might vary over time, limiting the generalizability of the findings. The discussion of external factors, such as

travel restrictions and home quarantine, is acknowledged, but there may be additional variables influencing consumption that were not considered, introducing uncertainties. Furthermore, the study's applicability is limited to the context of Cyprus, and caution is warranted when attempting to generalize the results to other regions due to potential variations in responses to the COVID-19 pandemic. The paper's utilization of Granger causality tests for establishing relationships between variables introduces assumptions that should be considered, as these tests are based on statistical associations and do not necessarily imply causation. The methodology for determining sales cycles lacks explicit detailing, potentially introducing subjectivity and bias. Additionally, the study's narrow focus on the impact of COVID-19 on supermarket sales may not fully capture all the factors influencing consumer behavior during a pandemic. The evolving dynamics of the COVID-19 pandemic, including changing public perceptions, government policies, and vaccine availability, may have influenced the observed consumption patterns. The assumption of stationarity, based on the results of the ADF unit root test, may not universally hold true, and sensitivity to this assumption should be acknowledged. Lastly, the paper provides only a brief mention of the impact of vaccination campaigns and public attitudes toward vaccination on consumption patterns, necessitating further exploration for a more comprehensive understanding. Future research should address these limitations to enhance the depth and breadth of insights into the relationship between COVID-19 dynamics and consumption patterns.

REFERENCES

Atkeson, A. (2020). What Will Be the Economic Impact of COVID-19 in the US? Rough Estimates of Disease Scenarios. National Bureau of Economic Research. WORKING PAPER 26867. DOI 10.3386/w26867

Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., and Drury, J. (2020). Using social and behavioural science to support COVID-19 pandemic response. Nature Human Behaviour, 4(5), 460-471. https://doi.org/10.1038/s41562-020-0884-z

Chetty, R., Friedman, J. N., Hendren, N., Stepner, M., and The Opportunity Insights Team (2023). The Economic Impacts of COVID-19: Evidence from a New Public Database Built Using Private Sector Data. National Bureau of Economic Research. Working Paper 27431. DOI 10.3386/w27431

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366a), 427-431.

Górka, P. (2022). The impact of the COVID-19 pandemic on the consumption of Polish households. Sustainability, 14(19), 11821. https://doi.org/10.3390/su141911821

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods, Econometrica, 37 (3) 424-38.

IBM. (2021). The Impact of COVID-19 on Consumer Shopping Behavior. https://www.ibm.com/topics

Lin, C., and Meissner, C. M. (2020). Health vs. wealth? Public health policies and the economy during Covid-19. NBER Working Paper No. 2709.

Zhou L., Linchuang Z., Xiaoxin L., and Zhenhui L. (2022). The Impact of the COVID-19 Pandemic on Consumer Behavior—Evidence From China's Stock Market, Front Public Health, 10: 865470. 10.3389/fpubh.2022.865470