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Banking Sector Resilience to Major Crises

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Abstract The Covid-19 crisis, started as an endemic health crisis but it was rapidly transformed to a global pandemic. As expected, it did not leave the global economy unaffected. The prolonged interruption of the production activity and the relevant general lockdowns, led to a significant drop in production, consumption and employment. This rapid deterioration of the economic activity and the associated increase in the uncertainty for the day-after, led to a significant decline of major stock markets around the globe. Banking institutions are fighting their own battle to continue their operation uninterrupted during the pandemic. Their problem is twofold: from one hand to deal with the decline in economic activity and on the other to adapt to a new and externaly imposed model of distance-banking. In this paper, we examine the possible impact of the Covid-19 crisis on bank share prices worldwide. We also measure and compare the impact of the 2008 global financial crisis. In measuring the impact of these two crises on bank share prices, we used bank share indices from four alternative countries: Greece, Germany, the US, and China for the period 2004:1 – 2021:2. The macroeconomic variables used in this context are: exchange rates, country specific 10-year government bond interest rates, the industrial production index and inflation, all in monthly frequency. Based on the empirical results, bank shares appear, in general, resilient and unaffected by these two crises.

Keywords: *Covid-19, global financial crisis, banking institutions, bank shares, multiple regression*

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1. Introduction

The outbreak of the Covid-19 virus to pandemic proportions led many countries to impose economy-wide lockdowns and other restrictive measures in the effort to contain the infections and the resulting strain to national health systems. Apparently, all these measures, significantly affected economic activity and one would expect that this situation would be reflected in the stock markets as investors would expect profitability to fall. The banks, as a response to the pandemic, started adjusting their operations. This happened to ensure their survival and the continuation of their uninterrupted operation, which is inextricably linked to the economic activity of each country. In this respect, it is interesting to study the price evolution of bank shares worldwide and their correlation to the developments on the pandemic front.

Based on the literature, stock prices are influenced by both microeconomic and macroeconomic factors, such as money supply, interest rate changes, inflation, industrial production, exchange rates and the national economy's GDP [1]. Of course, many studies also focus on how the fundamental factors such as ROA (Return On Assets), EPS (Earnings Per Share), P/E (Price/Earnings ratio), leverage, and dividend yield [2] affect the evolution of stock prices. Stock markets also seem to be affected during periods of financial [3,4], political [5], and health [6,7] crises which lead to economic recessions.

In this paper we study the impact of a) the Covid-19 health crisis and b) the financial crisis of 2007, on the price evolution of bank shares. For this purpose, we collected stock market banking industry index prices from four countries worldwide, Greece, Germany, the United States and China for the period from 2004:1 to 2021:2 at a monthly frequency. Specifically, the bank stock indexes we study are the FTSE Banks (FTSEB) index for Greek banks, the DAX Banks (CXPB) index for German banks, the DJ Banks (DJUSBK) index for the US banks and the FTSE China A600 (FTXIN) index for Chinese banks.

2. Literature Review

Stock returns seem to be affected by both microeconomic and macroeconomic factors. Microeconomic factors that have been studied the most are the ones affecting the performance of a firm, such as ROA, EPS, P/E, leverage and dividend yield. Of the macroeconomic factors, the most studied have been the impact of money supply, interest rate changes, inflation, industrial production, exchange rates and GDP.

Tangjitprom [8] conducted a review of studies on the impact of macroeconomic factors on stock returns. The majority of the results showed a significant effect of

macroeconomic variables on stock returns in both the short and long term which, however, involves small fluctuations in returns. Ricci [9] studied the impact of ECB monetary policy announcements on the share price of major European banks. The results showed that banks were more sensitive to unconventional measures than interest rate decisions and that the same type of intervention may have a different impact depending on the stage of the crisis. Chhipa and Nabi [10] studied 4 intra-firm determinants of stock prices, EPS and ROA, dividend yield and asset growth by collecting financial data of 20 listed firms in the banking sector of Pakistan for the period 2010-2017. They found that out of the four determinants, EPS ratio was a significant variable with a positive correlation with stock price, while the other factors studied had no effect on stock price hence, they were not significant variables.

Ahmad et al. [11] conducted a review of empirical studies on the impact of macroeconomic factors on stock prices and came to mixed results and conclusions. Most studies showed evidence supporting the idea that there is a relationship between stock returns and macroeconomic variables from both short and long term perspectives. However, most of them show that only small fluctuations in stock returns can be explained by these macroeconomic variables. Barakat et al. [12] conducted a study to investigate the relationship between the stock market and macroeconomic factors (CPI, exchange rate, money supply, interest rate) in two emerging economies (Egypt and Tunisia) for the period from January 1998 to January 2014. It was found that the exchange rate and money supply have a greater impact on Egypt's stock market index than the consumer price index, while all three variables are statistically significant and have a positive correlation with the stock market index. The interest rate is significant and negatively affects the stock market index. Regarding the stock market index of Tunisia, it was found that consumer price index is statistically significant with a negative correlation with the changes in the stock market index and exchange rate with a positive correlation. The other variables were not found to be statistically significant. Khan J. and Khan I. [13] studied the impact of interest rate, CPI, money supply, exchange rate, industrial production index and exports on stock prices of Karachi (Pakistan) stock exchange through analysis of monthly data for the period from May 2005 to August 2016. The results showed that in the short run, only exchange rate is statistically significant with negative correlation with stock prices while other variables are not statistically significant. In the long run, money supply, exchange rate and interest rate were found to be statistically significant.

Stock markets seem to be affected and lead from short time losses to complete collapse during periods of economic recession caused by the outbreak of financial, political and health crisis. Bernhardt and Eckblad [4] in their report for the global financial crisis of 1987 refer to the final collapse of the global stock markets. The financial crisis, like the global depression of 1929, started with a strong upward trend in stock markets, which at the end of August 1987 had the characteristics of an asset bubble, as in 7 months the DJIA index showed gains of 44%. In mid-October of the same year the lack of investor’s confidence in combination with the depreciation of the dollar led to the destabilization of the markets which led to Black Monday on 19 October when the DJIA index decreased by 22.6%. Within hours a chain reaction followed which led to a collapse of global stock markets. The Japanese bubble, according to Okina et al. [14], which emerged in the mid-1980s with the increase in asset prices, the increase in money and credit supply and the expansion of economic activity, when it burst in the early 1990s dragged down stock markets. With the bursting of the bubble, asset prices fell, causing an increase of non-performing loans and distress in financial institutions and leading the economy to a prolonged recession. Stock prices for this period, according to the Nikkei225 index, reached their highest level at the end of 1989 before beginning their decline, reaching a 60% decline by August 1992 [15]. Chaudhury [3] studied the behavior of stock prices during the 2007 financial crisis by aggregating the daily returns of 31 large U.S. stocks, some equally weighted portfolios consisting of these stocks and the S&P 500 index for the period from 01/01/2007 to 12/31/2008. It was found that the expected average daily returns of the stocks under consideration fell to negative levels while the expected volatility increased by more than 200%. Adeyeye et al. [16] studied the impact of the global financial crisis on the emerging stock market in Nigeria. They studied the period from July 2004 to December 2014, which was divided into three time periods, pre-crisis, during the crisis and post-crisis. It was found that while during the pre-crisis period, stock prices were predictable, during and after the crisis, there was a collapse in stock prices, which during this period moved unpredictably. Kunt et al. [5], included in their study an examination of bank stock price trend from 45 countries worldwide in conjunction with around 400 announcements of liquidity support measures, prudential measures, borrower assistance and monetary policy measures between 2 February and 17 April 2020. According to Burdekin's study [7] the effects of the Spanish flu pandemic of 1918-1919 were obvious in the stock markets. The results of the study, among ten countries, showed that European and American stock markets reacted significantly, and negatively, in the increase in mortality rates observed during the two years of the Spanish flu. He et al. [6] studied the immediate and secondary effects of the Covid-19 pandemic on the stock exchanges of the People's Republic of China, Italy, South Korea, France, Spain, Germany, Japan and the US. The empirical results of the survey showed that the Covid-19 pandemic had a negative but short-term impact on the stock markets of the 8 countries while two-way secondary effects were found between Asian countries and European and American countries. At the same time, with the exception of China, for the period studied, it was observed that the Covid-19 crisis did not have a negative impact on the main stock market indices of these countries compared to the global S&P 1200 index. The results of this study initially showed that the banking sector was affected by the Covid-19 global health crisis by showing a significant decline in bank stock prices mainly in March during the studied period. Support measures by central banks and governments appeared to boost the banking sector with liquidity support and borrower support measures having the largest positive impact on bank stock prices, with

banks with less liquidity benefiting from liquidity support measures and larger banks experiencing increased returns on the announcement of borrower support measures. The impact of the Covid-19 health crisis was not the same across banks but varied depending on the size of each bank and the fiscal policy of the country concerned.

Based on the literature review we can conclude that microeconomic factors affect stock prices in different ways depending on the industry sector studied. On the other hand, macroeconomic factors seem to have a significant impact though they involve small fluctuations in stock prices. Reviewing periods in the past when events of an economic, political and health nature led to an economic downturn, we can see that in all cases stock prices have followed the downturn brought about by the crisis, either in the short or long term. In the context of this paper, we focus on the macroeconomic factors determining the price of bank shares and in particular we examined the effect of interest rates, exchange rate, industrial production index and inflation. Based on the literature, these factors are expected to have an effect on bank stock prices under normal conditions, so it is of great interest whether their effect is still valid in times of crises.

3. Data and Methodology

3.1. Data Collection

For this study we used the FTSE Banks (FTSEB) index for Greek banks, the DAX Banks (CXPB) index for German banks, the DJ Banks (DJUSBK) for the US and the A600 (FTXIN) index for China on monthly frequency for the period from 2004:1 to 2021:2. The period we studied covers a period before the 2007 financial crisis until the outbreak of the pandemic for a total of 204 observations. The selection of countries covers a diverse, in many aspects, range of economies, geographical areas and banking industries. We selected the US, a major industrialized country where the 2007 financial crisis originated from and China that continues to be the most important and fastest emerging economy among the world's developing markets[1] where the Covid-19 health crisis started. At the same time, we also selected two EU economies, Germany and Greece which represent the strongest and one of the weakest economies in the EU respectively.

The Greek bank index, FTSE Banks, includes the stocks of the National Bank of Greece, Piraeus Bank, Alpha Bank, Eurobank and Attica Bank[2]. The German bank index DAX Banks includes the shares of Deutsche Bank, Commerzbank, Aareal Bank and Deutsche Pfandbriefbank[3]. The DJ Banks US bank index includes shares of 60 US and Canadian banks, including JPMorgan Chase and Co, Bank of America, Citigroup, Royal Bank of Canada, and National Bank of Canada[4]. For the FTSE China A600 banking index, it was not possible to find its exact composition. The price data for the bank indices other than the Greek index were obtained from the database of investing.com[5]. For the Greek bank index, the data were obtained from the Bulletins of Conjunctural Indicators published on the Bank of Greece website. Due to the three recapitalizations of systemic banks that took place between 2013 and 2015 and the resolution measures imposed on banking institutions that led to bank mergers, for the purpose of normalizing the results, it was necessary to adjust all FTSEB prices to the base price of 5.000 points with a base date of December 31, 2005[6]. Regarding the macroeconomic factors that are expected to affect the prices of bank stocks, we used: the exchange rates of CNY/USD, EUR/USD and USD/EUR[7], the interest rate of the 10-year government bond of each country[8], the industrial production index[9] for each country and the inflation as measured through the CPI[10]. To examine the impact of the 2007 financial crisis and the Covid-19 health crisis on stock prices, two dummy variables corresponding to the crises were added. The dummy variable for the 2007 financial crisis (FIN) takes the value 0 for the years before the crisis (2004-2007), 0 for the years after the crisis (2010-2021) and 1 for the years of the crisis (2008-2009). The dummy variable for the Covid-19 pandemic health crisis (COV) takes the value 0 for the years preceding the crisis (2004-2019) and the value 1 for the last two years of the study when the crisis realized (2020-2021).

3.2. Descriptive Statistics

Before applying the regression model, we present the descriptive statistics of the data. These include the usual: mean, median, minimum and maximum values, standard deviation, variance, asymmetry and kurtosis. The statistics are presented in Table 1.

Examining the mean and median of the variables, we see that between the variables of Greece, there is a significant difference which is more obvious in the Greek bank index and in the 10-year government bond yield (with the only exception of the exchange rate). The Chinese and Greek bank indices show the largest standard deviation. China's bank index appears to have a consistent upward trend until mid-2008, typical of the country's emerging economy (Figure 1). The Greek 10-year government bond yield shows a large standard deviation with extreme values compared to the other countries

[1] IMF, World Economic Outlook Update, January 2021
[2] https://www.athexgroup.gr/el/index-composition/-/select-index/136
[3] https://www.marketscreener.com/quote/index/DAX-BANKS-442427/components
[4] https://www.marketscreener.com/quote/index/DJ-US-BANKS-449465/components

[5] https://www.investing.com/indices/cxpbx-historical-data, https://www.investing.com/indices/dj-banks-historical-data, https://www.investing.com/indices/ftse-china-banks-historical-data
[6] https://www.bankofgreece.gr/ekdoseis-ereyna/ekdoseis/anazhthsh-ekdosewn?dateRange=01/01/2004|21/04/2021&types=dd62428c-4077-4c7b-a246-fbb9bde53c3e
[7] https://www.investing.com/currencies/cny-usd-historical-data, https://www.investing.com/currencies/eur-usd-historical-data, https://www.investing.com/currencies/usd-eur-historical-data
[8] https://www.investing.com/rates-bonds/china-10-year-bond-yield-historical-data, https://www.investing.com/rates-bonds/germany-10-year-bond-yield-historical-data, https://www.investing.com/rates-bonds/greece-10-year-bond-yield-historical-data, https://www.investing.com/rates-bonds/u.s.-10-year-bond-yield-historical-data
[9] https://data.oecd.org/industry/industrial-production.htm, https://fred.stlouisfed.org/series/CHNPRINTO01IXPYM
[10] https://data.oecd.org/price/inflation-cpi.htm

(Figure 2). The asymmetry is positive for all bank indices, for the USD/EUR exchange rate, for government bond yields of all four countries and for the Greek and Chinese IPI. Industrial production in China has been on a stable trend since the global financial crisis, while Germany, the US and Greece have seen an increase in their industrial production index, after the financial crises of 2008 (Figure 3). The positive asymmetry of the USD/EUR exchange rate indicates an appreciation of the US dollar while the euro and the Chinese Yuan depreciated as shown in Figure 4. The CPI of all the countries studied showed negative asymmetry, indicating an increase in inflation in these countries after the financial crisis (Figure 5). The kurtosis is greater than 3 only for the Greek government bond yield, while for the other variables it is less than 3 or even negative.

Table 1. Descriptive statistics of variables

		Summary Statistics, using the observations 2004:01 - 2021:01 for the variables (205 valid observations)							
		Mean	Median	Minimum	Maximum	Std. Dev.	C.V.	Skewness	Ex. kurtosis
Bank index	FTSEB	1779.9	236.31	1.1805	7751.1	2300.8	1.2926	1.0595	-0.25011
	CXPB	239.93	178.20	50.980	702.57	165.84	0.69121	1.0942	0.12615
	DJUSBK	358.21	337.62	111.25	573.71	120.08	0.33523	-0.019224	-1.2526
	FTXIN	10307.	10201.0	2760.7	20617.	4002.0	0.38828	-0.25377	-0.71807
Exchange rate	EUR/USD	1.2615	1.2637	1.0516	1.5774	0.12311	0.097595	0.33521	-0.57502
	USD/EUR	0.80006	0.79150	0.63410	0.95070	0.076878	0.096090	0.011149	-0.89737
	CNY/USD	0.14574	0.14660	0.12080	0.16520	0.013173	0.090388	-0.60241	-0.71855
10 Year Government Bond rate	GB GR	7.5239	5.2970	0.62800	36.591	6.2814	0.83487	2.3271	6.2504
	GB DEU	1.9322	1.7300	-0.70300	4.6280	1.6406	0.84907	0.024962	-1.4680
	GB USA	2.8863	2.6860	0.53300	5.1450	1.1322	0.39227	0.15453	-0.84131
	GB CHN	3.5958	3.5500	2.5100	4.9510	0.52065	0.14479	0.47675	-0.48191
Industrial Production Index	IPI GR	113.53	109.40	93.10	144.00	14.842	0.13073	0.52662	-1.1369
	IPI DEU	95.287	97.600	71.50	108.60	7.7262	0.081084	-0.71905	-0.32763
	IPI USA	97.299	98.000	83.60	106.20	5.0543	0.051947	-0.55780	-0.032898
	IPI CHN	110.70	109.60	86.50	123.20	5.0205	0.045351	-0.21082	1.2245
Consumer Price Index	CPI GR	96.732	99.800	79.90	105.50	6.7571	0.069854	-0.95366	-0.32444
	CPI DEU	96.146	97.100	84.10	106.60	6.4827	0.067426	-0.17983	-1.1163
	CPI USA	95.696	97.000	78.10	110.40	8.6658	0.090556	-0.19847	-0.94947
	CPI CHN	92.766	94.300	73.30	113.70	11.820	0.12741	-0.11541	-1.2156

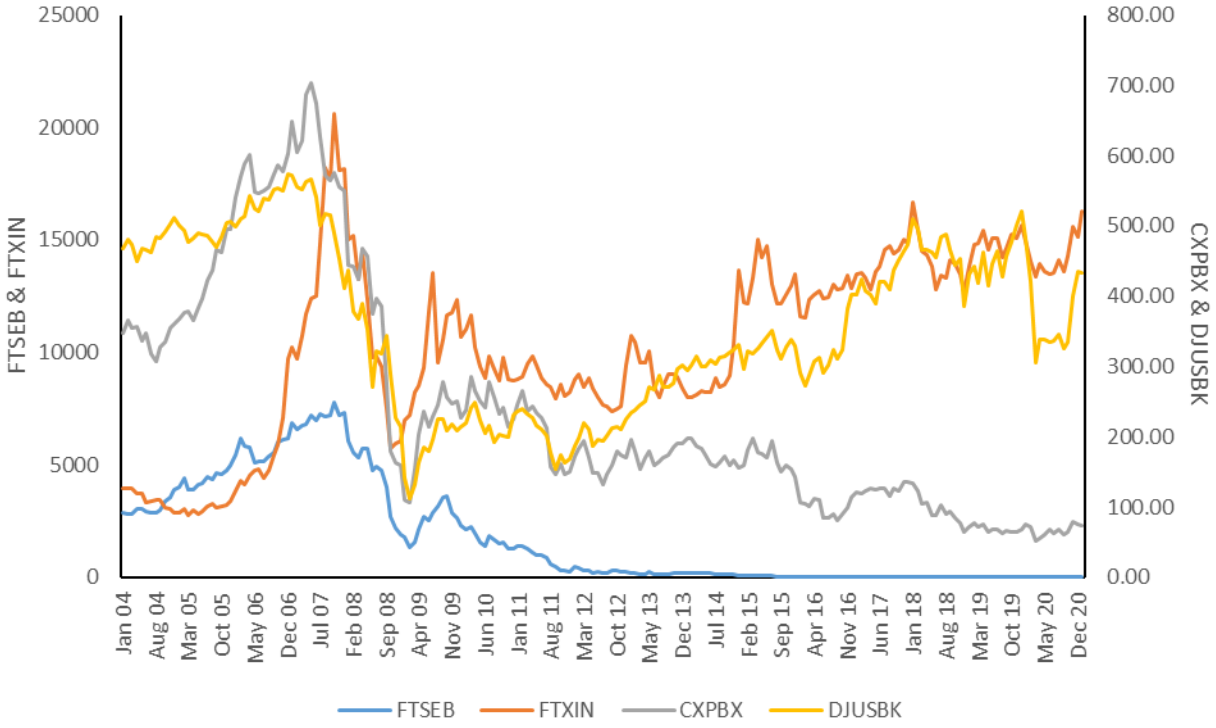

Figure 1. Trend of FTSEB, FTXIN for the period 2004:1-2021:2.

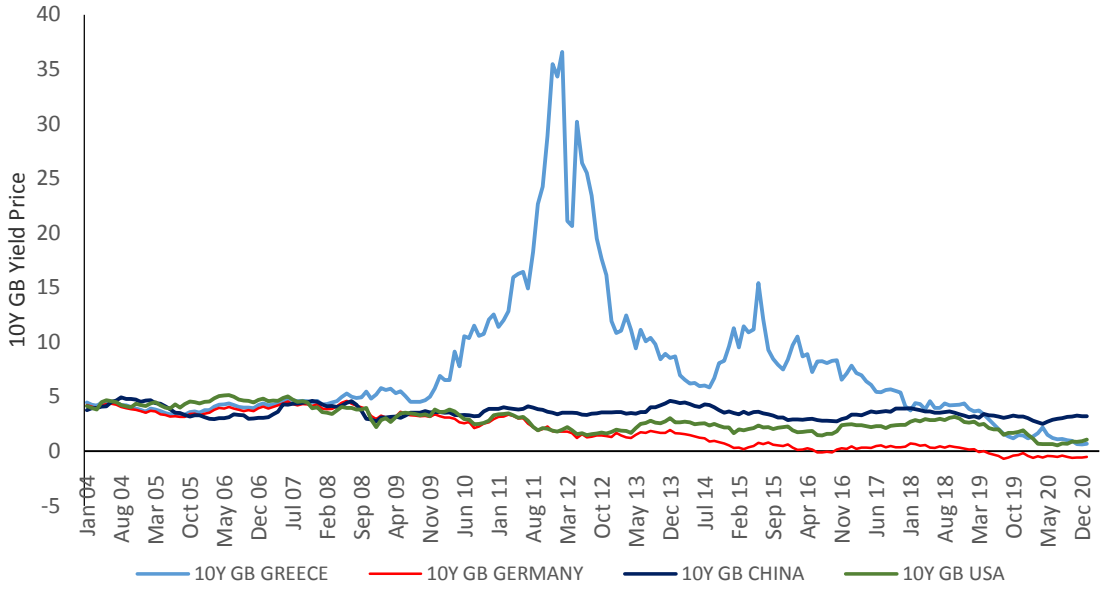

Figure 2. Yield of the 10-year government bond of Greece, Germany, China and USA for the period 2004: 1-2021: 2

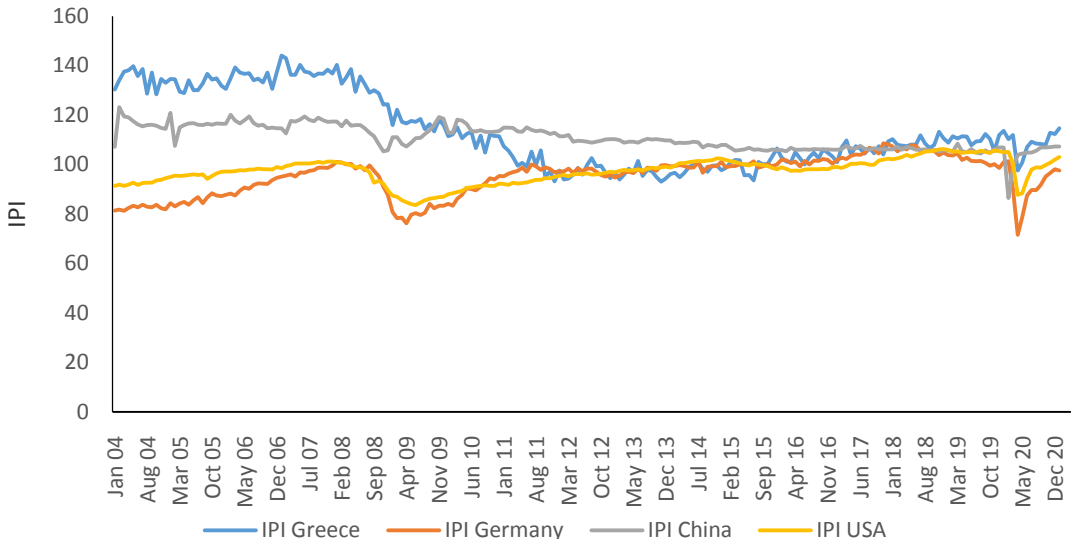

Figure 3. IPI trend of Greece, Germany, China and USA for the period 2004:1-2021:2

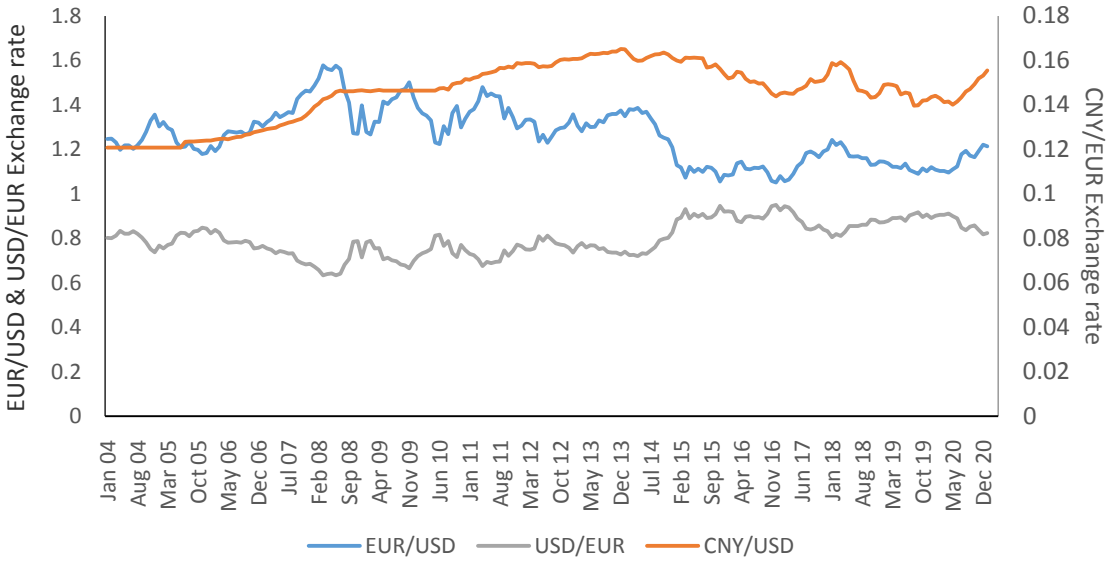

Figure 4. EUR/USD, CNY/USD and USD/EUR exchange rate trend for the period 2004:1-2021:2

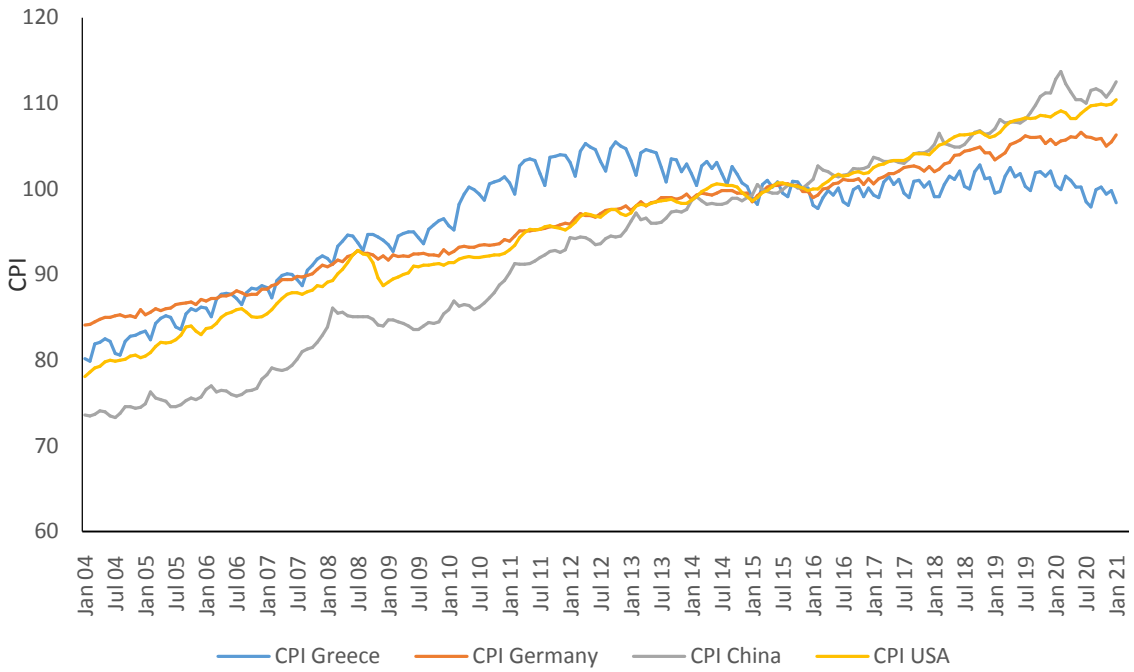

Figure 5. Greek, German, Chinese and US CPI trend for the period 2004:1-2021:2

3.3. Unit Root Tests

We used both the ADF and the KPSS unit root tests to examine the stationarity of the data. The stationarity test was carried out on the logarithms of the variables except for the ten-year government bond interest rates. We employed both tests as in the ADF test the null hypothesis is that the data are non-stationary, while in the KPSS the null hypothesis is that the data are stationary. Depending on the test results, the variables were classified as either stationary (I_0) or non-stationary (I_1)[11].

From the stationarity test results we concluded that for all countries the variables tested are non-stationary at a 5% level of significance. For the conversion of the variables to stationary, we used the first differences of their logarithms, except for the variables of the ten-year government bond interest rates for which we used their first differences. To verify the stationarity of the above variables, ADF and KPSS tests were carried out again[12] on their first differences. From these stationarity tests we concluded that for all countries, the variables tested are stationary at a 5% level of significance.

4. Empirical Results

The relation between the variation of the selected determinants and the impact of the two examined crises on the bank stock price indices was studied by applying multiple regression analysis.

The modified stationary variables used in the multiple regression model express the percentage changes in the values of the original variables. We used the following equation (1):

$$dlogBKINDX_t = a + b_1\left(dlogCUR_t\right) + b_2\left(dGB_t\right) + b_3\left(dlogIPI_t\right) + b_4\left(dlogCPI_t\right) + FIN + COV + e_t \quad (1)$$

where

- $dlogBKINDX_t$ is the dependent variable of the percentage changes of the bank stock index prices under consideration, and it is *dlogFTSEB* for the Greek bank index, *dlogCXPB* for the German bank index, *dlogDJUSBK* for the US bank index and *dlogFTXIN* for the Chinese bank index, a is the constant term of the equation, and b_1, b_2, b_3, and b_4 are the coefficients of the independent variables,
- $dlogCUR_t$ are the percentage changes of the exchange rates selected for each country, i.e. *dlog(EUR/USD)* for Greece and Germany, *dlog(USD/EUR)* for the US and *dlog(CNY/USD)* for China,
- dGB_t are the percentage changes (first diferrences) of the government bond yields of each of the countries under consideration,
- $dlogIPI_t$ are percentage changes of each country's industrial production index prices,
- $dlogCPI_t$ are the percentage changes of each country's CPI prices,
- *FIN* is the dummy variable for the 2007 financial crisis and takes the value 1 for the first years after the crisis (2008-2009) and the value 0 elsewhere
- *COV* is the dummy variable for the Covid-19 pandemic health crisis and takes the value 1 for the years of the crisis (2020-2021) and the value 0 elsewhere.
- e_t is the error term or residual of the equation.

To increase the explanatory power of the regression model and to also address possible issues of autocorrelation and timeseries short dynamics, we also added the corresponding lagged instances of the original

[11] The results are presented in the Appendix, Tables 9-12.
[12] The results are presented in the Appendix, Tables 13-16.

variables. For the dependent variable of the bank index and the independent variables, lags from 1 to 3 are used. Thus, the final form of the regression equation estimated is as follows:

$$\begin{aligned}&\text{dlogBKINDX\_t}\\&=\text{a}+\text{b\_1}\left(\text{dlogCUR\_t}\right)+\text{b\_2}\left(\text{dlogCUR\_}\left(\text{t}-1\right)\right)\\&+\text{b\_3}\left(\text{dlogCUR\_}\left(\text{t}-2\right)\right)\\&+\text{b\_4}\left(\text{dlogCUR\_}\left(\text{t}-3\right)\right)\\&+\text{b\_5}\left(\text{dGB\_t}\right)+\text{b\_6}\left(\text{dGB\_}\left(\text{t}-1\right)\right)\\&+\text{b\_7}\left(\text{dGB\_}\left(\text{t}-2\right)\right)+\text{b\_8}\left(\text{dGB\_}\left(\text{t}-3\right)\right)\\&+\text{b\_9}\left(\text{dlogIPI\_t}\right)+\text{b\_10}\left(\text{dlogIPI\_}\left(\text{t}-1\right)\right)\\&+\text{b\_11}\left(\text{dlogIPI\_}\left(\text{t}-2\right)\right)\\&+\text{b\_12}\left(\text{dlogIPI\_}\left(\text{t}-3\right)\right)\\&+\text{b\_13}\left(\text{dlogCPI\_t}\right)+\text{b\_14}\left(\text{dlogCPI\_}\left(\text{t}-1\right)\right)\\&+\text{b\_15}\left(\text{dlogCPI\_}\left(\text{t}-2\right)\right)\\&+\text{b\_16}\left(\text{dlogCPI\_}\left(\text{t}-3\right)\right)\\&+\text{b\_17}\left(\text{dlogBKINDX\_}\left(\text{t}-1\right)\right)\\&+\text{b\_18}\left(\text{dlogBKINDX\_}\left(\text{t}-2\right)\right)\\&+\text{b\_19}\left(\text{dlogBKINDX\_}\left(\text{t}-3\right)\right)\\&+\text{FIN}+\text{COV}+\text{e\_t}\end{aligned}\qquad(2)$$

The regression of the above equation was initially performed using O.L.S. (Ordinary Least Squares). Applying the O.L.S. and White's test we noticed the effect of heteroskedasticity in the residuals of the equation for each country studied. The results of heteroskedasticity tests for the data of the 4 countries are presented in Table 2 – Table 3 below.

Table 2. White's test results

	t - statistic	p - value
Greece	79,861066	0,000183
Germany	96,561006	0,000001
U.S.A.	104,114810	0
China	54,16054	0,059403

Table 3. Breusch-Pagan test και Koenker test results for China data

	t - statistic	p - value
Breusch-Pagan test	97,481060	0
Koenker test	51,401529	0,000232

For the data of Greece, Germany and the U.S., the heteroskedasticity was strong, while for China the null hypothesis of no heteroskedasticity was marginally not rejected at the 95% confidence level. Therefore, for China, heteroskedasticity was tested by both the Breusch-Pagan test and the Koenker test, the result of which showed heteroskedasticity of the disturbance term for China as well. Thus, the regression with heteroskedasticity corrected model was applied for the data of all the countries studied. This model uses the Weighted Least Squares (WLS) method when applying the regression to achieve the homoskedasticity of the disturbance terms [17].

We measure the significance of the coefficients estimated using a significance level (*p*-value) of 5%. The sign of the coefficients of the independent variables determined the positive (+ sign) or negative (- sign) effect of each independent variable on the price of the banking indicators, while the value of the coefficients determined the magnitude of the change in the price of the bank indices caused by a one-unit change in each independent variable.

4.1. Regression Analysis Results

The regression analysis results for Greece are presented in the table below (Table 4).

Observing the *R*-squared which has a value of 0.418, we conclude that 41.88% of the changes in the returns of the Greek bank stock index are affected by the changes in the determinants we used. The joint significance of all regressors in the above estimated equation was tested using the *F*-test and its value is 6.144 with a *p*-value= 1.26e-12. Thus, we have evidence that the specified equation is strongly significant even at the 1% significance level. Moreover, no autocorrelation appears in the residuals.

Regarding the determinants of the change in the price of the Greek bank stock index, we observed, based on the *t*-ratio values and the corresponding *p*-value that all the variables appear statistically significant at time *t* and some of them appear statistically significant with a time lag. In particular, the percentage change in the exchange rate and in the yield of the 10-year government bond are statistically significant at time *t* and at time *t*-1 at a 1% significance level. The relation between the percentage change in the EUR/USD exchange rate and the percentage changes in the price of the Greek bank stock index is positive at all intervals. This implies that the changes in the Greek bank stock index returns are influenced by the percentage changes in the exchange rate and the 10-year government bond yield and by their corresponding changes at earlier times. Percentage changes in the IPI are also found to be statistically significant at time *t* and the 5% level of significance, while percentage changes in the CPI are statistically significant at 1% level of significance at time *t*-2 and at 5% level of significance at time *t* and *t*-1. We also observed that the percentage changes of the bank stock market index itself with 3 lags appears statistically significant at the 10% significance level.

Regarding the main issue and the dummy variables of the two crises, both seem to have a negative relation with the percentage changes in the price of the Greek bank stock index, but only the variable of the 2007 global financial crisis appears statistically significant with a *t*-ratio of -2.136 and *p*-value = 0.034.

The regression analysis results for Germany are presented in Table 5.

Table 4. Regression analysis with correction for heteroskedasticity in Greek data

Model 1: Model 1: Heteroskedasticity-corrected, using observations 2004:05-2021:01 (T = 201). Dependent variable: d_l_FTSEB

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.016	0.011	−1.416	0.158	
d_l_EURUSD	1.150	0.398	2.890	0.004	***
d_l_EURUSD_1	0.990	0.328	3.022	0.003	***
d_l_EURUSD_2	−0.359	0.356	−1.010	0.314	
d_l_EURUSD_3	-0.643	0.393	−1.635	0.104	
d_GB	−0.047	0.008	−5.557	9.83e-08	***
d_GB_1	0.022	0.008	2.645	0.009	***
d_GB_2	0.0002	0.006	0.037	0.970	
d_GB_3	0.006	0.007	0.747	0.456	
d_l_IPI	0.616	0.299	2.058	0.041	**
d_l_IPI_1	0.195	0.343	0.569	0.570	
d_l_IPI_2	-0.538	0.350	−1.537	0.126	
d_l_IPI_3	−0.211	0.348	−0.608	0.544	
d_l_CPI	1.839	0.850	2.163	0.032	**
d_l_CPI_1	2.433	0.945	2.575	0.011	**
d_l_CPI_2	2.737	0.847	3.233	0.001	***
d_l_CPI_3	−0.057	0.760	−0.007	0.940	
FIN	−0.048	0.023	−2.136	0.034	**
COV	−0.009	0.036	−0.245	0.456	
d_l_FTSEB_1	−0.017	0.050	−0.335	0.738	
d_l_FTSEB_2	−0.029	0.061	−0.425	0.671	
d_l_FTSEB_3	0.113	0.060	1.872	0.063	*

Statistics based on the weighted data:			
Sum squared resid	681.196	S.E. of regression	1.951
R-squared	0.419	Adjusted R-squared	0.351
F(21, 179)	6.144	P-value(F)	1.26e-12
Log-likelihood	-407.871	Akaike criterion	859.743
Schwarz criterion	932.415	Hannan-Quinn	889.149
rho	-0.020	Durbin's h	-0.412

Statistics based on the original data:			
Mean dependent var	−0.036	S.D. dependent var	0.216
Sum squared resid	8.443	S.E. of regression	0.217

Excluding the constant, p-value was highest for variable 21 (d_GB_2)

Table 5. Regression analysis with correction for heteroskedasticity in German data

Model 4: Heteroskedasticity-corrected, using observations 2004:05-2021:01 (T = 201). Dependent variable: d_l_CXPBX

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.002	0.007	−0.314	0.753	
d_l_EURUSD	0.262	0.214	1.224	0.223	
d_l_EURUSD_1	0.090	0.189	0.479	0.632	
d_l_EURUSD_2	−0.391	0.221	−1.775	0.078	*
d_l_EURUSD_3	−0.101	0.205	−0.492	0.623	
d_GB	0.195	0.026	7.609	1.52e-012	***
d_GB_1	−0.055	0.034	−1.622	0.107	
d_GB_2	0.019	0.029	0.670	0.504	
d_GB_3	−0.025	0.033	−0.766	0.445	
d_l_IPI	0.032	0.343	0.095	0.925	
d_l_IPI_1	−0.556	0.323	−1.721	0.087	*
d_l_IPI_2	0.310	0.286	1.082	0.281	
d_l_IPI_3	−0.509	0.279	−1.825	0.070	*
d_l_CPI	−0.422	1.442	−0.292	0.770	
d_l_CPI_1	0.040	1.358	0.0292	0.977	
d_l_CPI_2	3.581	1.547	2.315	0.022	**
d_l_CPI_3	−3.372	1.288	−2.618	0.010	***
FIN	0.001	0.013	0.091	0.928	
COV	0.046	0.039	1.191	0.235	
d_l_CXPBX_1	0.050	0.048	1.044	0.298	
d_l_CXPBX_2	−0.079	0.057	−1.387	0.167	
d_l_CXPBX_3	−0.002	0.064	−0.026	0.979	

Statistics based on the weighted data:			
Sum squared resid	685.017	S.E. of regression	1.957
R-squared	0.425	Adjusted R-squared	0.357
F(21, 179)	6.294	P-value(F)	5.77e-13
Log-likelihood	−408.434	Akaike criterion	860.867
Schwarz criterion	933.540	Hannan-Quinn	890.274
rho	0.081	Durbin's h	1.561

Statistics based on the original data:			
Mean dependent var	−0.008	S.D. dependent var	0.105267
Sum squared resid	1.896716	S.E. of regression	0.102938

Excluding the constant, p-value was highest for variable 31 (d_l_CXPBX_3)

From the R-squared we infer that 42.47% of the changes in the returns of the German bank stock index were affected by changes in the determinants we used in the period under consideration. From the statistics of the regression analysis, we concluded that even at the 1% significance level the equation we studied is strongly significant, with an *F*-test value = 6.29 and *p*-value = 5.77e-13. We observed no autocorrelation in the residuals. Observing the *t*-ratio values and the *p*-value of the determinants of the change in the price of the German bank stock index returns we concluded that the percentage changes in the exchange rate at time *t*-2 and at a significance level of 10% and the percentage change in the 10-year government bond yield at time *t* and a significance level of 1% appear to be statistically significant. The IPI shows statistical significance at time *t*-1 and *t*-3 and at a 10% significance level, while the CPI at time *t*-2 at a 5% significance level and at time *t*-3 at a 1% significance level.

Regarding the dummy variables of the two crises, neither the variable of the 2007 global financial crisis nor the Covid-19 health crisis appear statistically significant for the period studied.

The regression analysis results for the US are presented in Table 6.

The value of the *R*-squared led us to conclude that 44.364% of the changes in the returns of the U.S. bank stock index are explained by changes in the determinants studied. The regression analysis statistics, *F*-test = 6.79 with *p*-value = 4.36e-14, showed that even at the 1% significance level the equation we analyzed is strongly significant. The residuals did not show evidence of autocorrelation.

Based on the *t*-ratios and the *p*-values, we concluded that the percentage changes in the USD/EUR exchange rate, the CPI and the 10-year government bond yield were statistically significant for the period under consideration at time *t* and at a 1% significance level. The IPI does not show statistical significance while the CPI is statistically significant at time *t*-1 and *t*-2 at 5% level of significance and at time *t*-3 at 10% level of significance.

Regarding the dummy variables of the two crises, only the variable of the 2007 global financial crisis appears statistically significant at the 10% level of significance.

The regression analysis results for China data are presented in Table 7.

Table 6. Regression analysis with correction for heteroskedasticity in US data

Model 2: Heteroskedasticity-corrected, using observations 2004:05-2021:01 (T = 201). Dependent variable: d_l_DJUSBK

	Coefficient	Std. Error	t-ratio	p-value	
const	0.011	0.0056	1.990	0.048	**
d_l_USDEUR	−0.463	0.141	−3.271	0.001	***
d_l_USDEUR_1	0.176	0.126	1.402	0.162	
d_l_USDEUR_2	0.0166	0.148	0.112	0.911	
d_l_USDEUR_3	0.057	0.131	0.434	0.664	
d_GB	0.159	0.018	8.702	<0.0001	***
d_GB_1	0.023	0.017	1.372	0.172	
d_GB_2	−0.006	0.019	−0.322	0.747	
d_GB_3	0.009	0.017	0.521	0.603	
d_l_IPI	0.269	0.559	0.481	0.631	
d_l_IPI_1	0.276	0.285	0.969	0.334	
d_l_IPI_2	0.112	0.438	0.255	0.799	
d_l_IPI_3	−0.268	0.334	−0.802	0.424	
d_l_CPI	0.183	1.164	0.157	0.875	
d_l_CPI_1	−2.912	1.311	−2.221	0.027	**
d_l_CPI_2	3.114	1.367	2.278	0.024	**
d_l_CPI_3	−2.125	1.087	−1.954	0.052	*
FIN	−0.019	0.011	−1.700	0.091	*
COV	−0.0005	0.014	−0.036	0.972	
d_l_DJUSBK_1	−0.032	0.063	−0.511	0.610	
d_l_DJUSBK_2	−0.020	0.064	−0.307	0.759	
d_l_DJUSBK_3	−0.102	0.062	−1.649	0.101	

Statistics based on the weighted data:			
Sum squared resid	595.263	S.E. of regression	1.824
R-squared	0.444	Adjusted R-squared	0.378
F(21, 179)	6.796	P-value(F)	4.36e-14
Log-likelihood	−394.319	Akaike criterion	832.639
Schwarz criterion	905.311	Hannan-Quinn	862.045
rho	0.049	Durbin's h	1.499
Statistics based on the original data:			
Mean dependent var	−0.0002	S.D. dependent var	0.08
Sum squared resid	1.017	S.E. of regression	0.075

Excluding the constant, p-value was highest for variable 7 (COV)

Table 7. Regression analysis with correction for heteroskedasticity in China data

Model 2: Heteroskedasticity-corrected, using observations 2004:05-2021:01 (T = 201)
Dependent variable: d_l_FTXIN

	Coefficient	Std. Error	t-ratio	p-value	
const	0.008	0.0051	1.500	0.135	
d_l_CNYUSD	1.083	0.477	2.269	0.024	**
d_l_CNYUSD_1	0.346	0.411	0.842	0.401	
d_l_CNYUSD_2	−0.622	0.429	−1.447	0.149	
d_l_CNYUSD_3	−0.196	0.371	−0.527	0.599	
d_GB	0.043	0.029	1.463	0.145	
d_GB_1	−0.046	0.029	−1.588	0.114	
d_GB_2	−0.014	0.030	−0.475	0.635	
d_GB_3	−0.001	0.031	−0.048	0.961	
d_l_IPI	−0.017	0.268	−0.062	0.950	
d_l_IPI_1	0.096	0.175	0.549	0.584	
d_l_IPI_2	−0.258	0.179	−1.437	0.152	
d_l_IPI_3	0.069	0.135	0.511	0.610	
d_l_CPI	1.636	0.735	2.226	0.027	**
d_l_CPI_1	−1.087	0.809	−1.345	0.180	
d_l_CPI_2	0.368	0.859	0.428	0.669	
d_l_CPI_3	−0.069	0.904	−0.076	0.939	
FIN	−0.029	0.023	−1.279	0.203	
COV	−0.003	0.014	−0.236	0.814	
d_l_FTXIN_1	0.044	0.069	0.629	0.530	
d_l_FTXIN_2	−0.072	0.060	−1.190	0.236	
d_l_FTXIN_3	0.0316	0.068	0.461	0.645	

Statistics based on the weighted data:			
Sum squared resid	620.871	S.E. of regression	1.862
R-squared	0.471	Adjusted R-squared	0.409
F(21, 179)	7.583	P-value(F)	8.55e-16
Log-likelihood	−398.552	Akaike criterion	841.105
Schwarz criterion	913.777	Hannan-Quinn	870.511
rho	0.101	Durbin's h	8.639
Statistics based on the original data:			
Mean dependent var	0.007	S.D. dependent var	0.087
Sum squared resid	1.345	S.E. of regression	0.087

From the *R*-squared value we conclude that the percentage changes of the determinants we studied affect the percentage changes of China's bank stock index by 47.1%. The *F*-test, equals to 7.583 with a p-value of 8.55e-16, provides evidence that the set of the regressors is strongly significant even at the 1% level of significance. By observing the *t*-ratio values and the *p*-values, we conclude that for the period under consideration, the percentage change in the exchange rate and the CPI were statistically significant at time t and 5% significance level.

The dummy variables of the two crises, showed that neither the 2007 global financial crisis nor the Covid-19 health crisis are statistically significant.

4.2. Summary of the Empirical Results

Summarizing the results of our empirical study on the effect of the two crises examined on the prices of the bank stock indices we employed in this paper and by observing the *p*-value of the variables of the two crises (Table 8) we conclude that only the 2007 financial crisis affected the prices of bank stocks in Greece at a 5% level of significance and in the U.S. at a 10% level of significance, while the Covid-19 crisis did not show any statistical significance for these countries. Regarding the bank stock prices of Germany and China, neither of the two crises we examined appears statistically significant.

Table 8. Statistical significance of 2007 crisis (FIN) and Covid-19 crisis (COV) variables

	Statistical significance of crisis variables in bank stock market indices			
Crisis variables	p-value Greece	p-value Germany	p-value U.S.A	p-value China
FIN	0.0340**	0.9277	0.0909*	0.2027
COV	0.4559	0.2351	0.9715	0.8140

5. Conclusion

According to the literature, economic, political and health crises in the past led to an economic downturn which was followed by a long or short term downturn in stock prices. The Covid-19 health crisis did not leave the world economy unaffected. The rapid deterioration of economic activity led the banking sector to a battle for the continuation of their operation uninterrupted in the midst of the pandemic. As bank operations are inextricably

linked to the economic activity of each country, an examination of the possible impact of the Covid-19 crisis on bank share prices worldwide is of interest.

This paper studies the impact of the Covid-19 health crisis and the financial crisis of 2007, on the price evolution of bank shares worldwide. For this study, we collected stock market banking industry index prices from four countries worldwide, Greece, Germany, the United States and China for the period from 2004:1 to 2021:2 at a monthly frequency. The bank stock indexes studied are the FTSE Banks (FTSEB), the DAX Banks (CXPB), the DJ Banks (DJUSBK) and the FTSE China A600 (FTXIN). Regarding the factors that are expected to affect the prices of bank stocks, the macroeconomic variables used in this context are: exchange rates, each country's 10-year government bond yield, the industrial production index and inflation. For the examination of the impact of the 2007 financial crisis and the Covid-19 health crisis on stock prices, two dummy variables were used, the dummy variable for the 2007 financial crisis (FIN) and the dummy variable for the Covid-19 pandemic health crisis (COV).

Observing the results of our study, we conclude that the changes in the prices of the bank stock indices examined are only slightly affected by changes in some of the determinants selected. The direction in which each factor changes the prices of these indices varies from country to country. Changes in the CPI and the exchange rate appear to have the greatest impact, while changes in the industrial production index have had a lesser impact on changes of the prices of the bank stock indices. At the same time, the study of the impact of the two crises led us to conclude that the 2007 financial crisis had a small impact on changes in the Greek and the US bank stock indices while the health crisis of the Covid-19 pandemic does not seem to affect bank stock indices' prices in any country.

Thus, it appears that the experience of the global financial crisis and the post-crisis market environment and the implemented changes in the regulatory frameworks had a strong impact on the banking sector globally. In response to their new operational role, banks have reassessed and adapted their business strategies and models. Having survived the financial crisis of 2007, banks were better shielded against the threat of the new crisis, the outbreak of the Covid-19 pandemic. The measures taken by central banks and governments during the 2007 financial crisis seem to have paid off, and banks are now more resilient. In any case, the message is an optimistic one as banks have so far proved ready to face a new crisis and have not lost the confidence of the investing public.

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Appendix

Table 9. ADF – KPSS test - Greek data

Variables	ADF TEST		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
logFTSEB	0,9539	0,241	P-value < .01	P-value <.01	I_1
logEURUSD	0,2804	0,2759	P-value < .01	P-value < .01	I_1
GB	0,2871	0,6061	p-value 0.027	P-value < .01	I_1
logIPI	0,5023	0,9646	P-value < .01	P-value < .01	I_1
logCPI	0,2926	0,9148	P-value < .01	P-value < .01	I_1

Table 10. ADF – KPSS test - German data

Variables	ADF test		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
logCXPBX	0,8085	0,06912	P-value < .01	P-value > .10	I_1
logEURUSD	0.2804	0.2759	P-value < .01	P-value < .01	I_1
GB	0,839	0,2325	P-value < .01	P-value < .01	I_1
logIPI	0,1038	0,2335	P-value < .01	Interpolated p-value 0.028	I_1
logCPI	0,5665	0,5198	P-value < .01	P-value < .01	I_1

Table 11. ADF – KPSS test - US data

Variables	ADF TEST		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
logDJUSBK	0,3654	0,7122	P-value < .01	P-value < .01	I_1
logUSDEUR	0,2797	0,2759	P-value < .01	P-value < .01	I_1
GB	0,6392	0,2127	P-value < .01	P-value < .01	I_1
logIPI	0,2976	0,4405	P-value < .01	P-value < .01	I_1
logCPI	0,1712	0,206	P-value < .01	P-value < .01	I_1

Table 12. ADF – KPSS test - China data

Variables	ADF TEST		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
logFTXIN	0,2003	0,1577	P-value < .01	P-value < .01	I_1
logCNYUSD	0,3638	0,8294	P-value < .01	P-value < .01	I_1
GB	9,042e-005	0,0001919	P-value < .01	P-value > .10	I_1
logIPI	0,2387	5,202e-013	P-value < .01	P-value > .10	I_1
logCPI	0,7106	0,1870	P-value < .01	P-value < .01	I_1

Table 13. ADF – KPSS test of first differences - Greek data.

Variables	ADF TEST		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
dlogFTSEB	6.877e-009	5.219e-008	P-value > .10	P-value > .10	I_0
dlogEURUSD	2.118e-006	2.201e-005	P-value > .10	P-value > .10	I_0
dGB	0.000216	0.001169	P-value > .10	P-value > .10	I_0
dlogIPI	0.04165	0.07942	P-value > .10	P-value > .10	I_0
dlogCPI	0.2972	0.2785	P-value < .01	P-value > .10	I_0

Table 14. ADF – KPSS test of first differences - German data

Variables	ADF TEST		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
dlogCXPBX	3.728e-021	3.22e-022	P-value > .10	P-value > .10	I_0
dlogEURUSD	5.508e-018	3.424e-018	P-value > .10	P-value > .10	I_0
dGB	3.176e-010	2.724e-009	P-value > .10	P-value > .10	I_0
dlogIPI	2.177e-024	1.315e-026	P-value > .10	P-value > .10	I_0
dlogCPI	0.02525	0.06113	P-value > .10	P-value > .10	I_0

Table 15. ADF – KPSS test of first differences - US data

Variables	ADF TEST		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
dlogDJUSBK	4.541e-021	1.389e-020	P-value > .10	P-value > .10	I_0
dlogUSDEUR	2.152e-006	2.234e-005	P-value > .10	P-value > .10	I_0
dGB	1.604e-022	4.182e-022	P-value > .10	P-value > .10	I_0
dlogIPI	6.388e-022	3.65e-023	P-value > .10	P-value > .10	I_0
dlogCPI	1.1e-010	9.778e-011	P-value > .10	P-value > .10	I_0

Table 16. ADF – KPSS test of first differences - China data

Variables	ADF TEST		KPSS test		Decision
	with constant **p - value**	with constant and trend **p - value**	without trend	with trend	
dlogFTXIN	3.309e-021	1.174e-020	P-value > .10	P-value > .10	I_0
dlogCNYUSD	6.198e-016	3.44e-015	P-value > .10	P-value > .10	I_0
dGB	4.66e-011	3.414e-010	P-value > .10	P-value > .10	I_0
dlogIPI	7.188e-028	2.029e-031	P-value > .10	P-value > .10	I_0
dlogCPI	0.00495	0.01862	P-value > .10	P-value > .10	I_0