



Communication

Modelling the Impact of Different COVID-19 Pandemic Waves on Real Estate Stock Returns and Their Volatility Using a GJR-GARCHX Approach: An International Perspective

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Abstract: This paper aims to investigate the impact of various COVID-19 pandemic waves on real estate stock returns and their volatility in developed (US, Australia), emerging (Turkey, Poland), and frontier (Morocco, Jordan) markets. A study using a GJR-GARCHX model revealed that the pandemic outbreak had a limited impact on real estate company stocks. The first pandemic wave only in the US caused a decline in stock returns. In turn, this was the case in Poland and Jordan during the second and third waves. Furthermore, in the aftermath of the pandemic development, an increase in the volatility of stock returns can be observed in the Polish financial market. However, this effect mainly applies to the period of the first disease wave.

Keywords: real estate; stock returns; volatility; GJR-GARCHX; COVID-19



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1. Introduction

The COVID-19 pandemic, one of the greatest humanitarian crises in recent years, also caused distortions in economic activity (Jindřichovská and Uğurlu 2021), leading to a recession in many countries. The emergence of the coronavirus had a significant impact on financial markets, as well. Namely, the COVID-19 pandemic lowered stock returns and increased their volatility (Baker et al. 2020). However, when considering the real estate sector, studies to date are inconclusive. For example, in the US, stocks of real estate companies drop significantly after the pandemic outbreak (Mazur et al. 2021). In contrast, in Australia and Turkey, the development of the pandemic did not result in changes in real estate stock returns (Öztürk et al. 2020; Narayan et al. 2021). This ambiguous impact may be the effect of the relatively high resilience of some parts of the real estate sector (e.g., the housing market) to the outbreak shock (Duca et al. 2021). In addition, the analysis so far clearly shows that the influence of the pandemic on real estate stock returns and their volatility differs between countries, which is likely to be related to country-specific financial market characteristics, as well as previous experiences of market participants to similar pandemics and other crises (Milcheva 2021).

The main objective of our study is to provide new evidence on the impact of various COVID-19 pandemic waves on real estate stock returns and their volatility. In order to accomplish this task, we use the GJR-GARCHX model, which, in addition to the capabilities of the standard GARCH model, allows to take into account the asymmetric impact of negative and positive shocks on volatility as well as offers the possibility of including extra covariates in both the mean and the volatility equations.

This study contributes to the current literature in several ways. First, unlike other available analyses, this research seeks to indicate whether the impact of pandemic evolution on real estate stock returns during its various waves was changing. Second, while most works focus on examining real estate stock returns in a single country, this study considers economies with different levels of development to understand the surveyed phenomenon from an international perspective. Specifically, this analysis looks at the financial markets in

the US, Australia, Turkey, Morocco, Jordan, and Poland, and to the best of our knowledge for the latter two countries this is the first study of its kind. Finally, the issues addressed in this paper are still very vital due to the inconclusive results of previous research and dynamically changing trends in financial markets worldwide.

2. Data and Software

The analysis covers the period from March 2020 to April 2021 and concerns developed (US, Australia), emerging (Poland, Turkey), and frontier (Morocco, Jordan) markets. As a proxy of pandemic development, we apply the percentage change in COVID-19 new daily cases. Furthermore, in order to assess to what extent, the different pandemic waves affected stock returns and their volatility, we split the period under study into two. The first includes the first coronavirus wave from March 2020 to September 2020 and the second period from October 2020 to April 2021, during which the second and third waves of the pandemic occurred (see Figure 1). The analysis also uses time series on returns of real estate stocks and country-specific major stock market indices, which serve as regressands and controls, respectively. All time series are stationary (test results available upon request) and have been collected from Investing (<https://www.investing.com>, accessed on 5 May 2021) and (Dong et al. 2020). Table 1 provides details of the country-specific data used for the analysis. Stata 14.1 software is used to perform all planned research tasks.

Table 1. Data description.

Country	Dependent Variable				Control Variable	Period Analyzed	N
	Index	S	K	Shapiro–Wilk Test			
US	S&P 500 Real Estate returns	−1.45	12.90	$p < 0.01$	S&P 500 returns	2 March 2020–30 April 2021	295
Australia	S&P/ASX 200 Real Estate returns	−1.52	10.31	$p < 0.01$	S&P/ASX 200 returns	2 March 2020–30 April 2021	293
Poland	WIG Real Estate returns	−0.65	4.25	$p < 0.01$	WIG returns	9 March 2020–30 April 2021	288
Turkey	BIST Real Estate Invest Trusts returns	−0.73	3.40	$p < 0.01$	BIST 100 returns	16 March 2020–30 April 2021	284
Morocco	Real Estate (IMMOB) returns	−0.32	2.35	$p < 0.01$	FTSE CSE Morocco 15 returns	11 March 2020–30 April 2021	285
Jordan	Real Estate (AMREX) returns	0.26	0.70	$p > 0.10$	Amman SE All Share returns	10 May 2020–29 April 2021	237

Note: S means skewness, K means kurtosis.

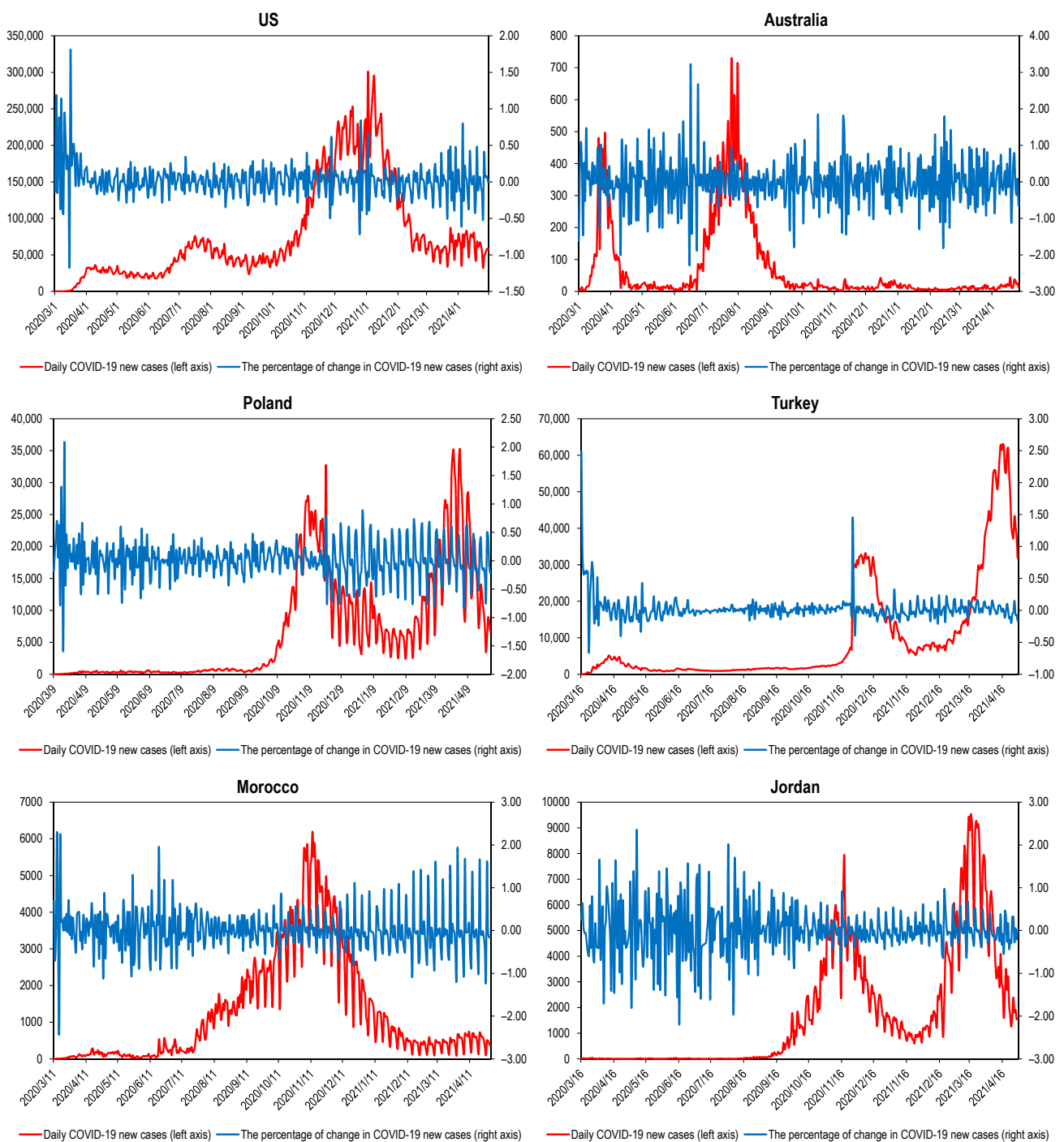


Figure 1. The development of COVID-19 in the studied countries.

3. Methodology

It is widely accepted in the academic literature to model stock returns and their volatility using the generalized autoregressive conditional heteroskedasticity (GARCH) model, which does not assume linearity, independence, and constant conditional variance. This model consists of two equations, namely a mean and a conditional variance equation. Based on the above model, the GARCHX approach was developed to allow for additional covariates in both equations.

Our starting point for estimating a GARCH-based model is an ARMA(p, q) returns process to calculate uncorrelated errors (see, for example, Apergis and Apergis 2020). Next, we use the GJR-GARCH(1,1) approach developed by (Glosten et al. 1993) to account

for the potential asymmetric impact of various economic shocks on volatility. Finally, including additional covariates describing the pandemic, our model under Stata software parametrization of GJR-GARCHX looks as follows:

$$r_t = \varphi + \sum_{i=1}^p \phi_i r_{t-i} + \sum_{j=1}^q \theta_j \varepsilon_{t-j} + \vartheta \text{Control} + \delta_1 \text{COVID19} + \delta_2 \text{CWave23} + \delta_3 \text{COVID19} \times \text{CWave23} + \varepsilon_t \quad (1)$$

$$h_t = \beta \varepsilon_{t-1}^2 + \rho I(\varepsilon_{t-1} > 0) \varepsilon_{t-1}^2 + \gamma h_{t-1} + \exp(\alpha + \mu_1 \text{COVID19} + \mu_2 \text{CWave23} + \mu_3 \text{COVID19} \times \text{CWave23}) \quad (2)$$

where $I(\varepsilon_{t-1} > 0)$ is an indicator function, which is equal to 1 if $\varepsilon_{t-1} > 0$, and 0 otherwise, $\varepsilon_t = \sqrt{h_t} e_t$ with $e_t \sim iid(\text{GED or } N)$. Moreover, the above model should meet the restriction that $\beta + \gamma + \frac{1}{2}\rho < 1$, which indicates that conditional volatility is stationary. Due to the fact that real estate stock returns are characterized by high kurtosis (except for the Jordan data) and low skewness (see Table 1), we employ a GJR-GARCHX model with a symmetric generalized error distribution (GED). The exception here is the model for Jordan, in which a normal distribution for the disturbances is assumed. These assumptions are supported by the Shapiro-Wilk test results shown in Table 1.

In our GJR-GARCHX(1,1) model, the COVID19 variable represents the percentage change in the number of new cases and is intended to capture the impact of the pandemic development during its first wave on stock returns and their volatility. In contrast, the CWave23 covariate is a dummy variable taking the value 1 for observations from October 2020 to April 2021, i.e., occurring during the second and third pandemic waves. Finally, by including the COVID19 \times CWave23 interaction variable, it is possible to test whether the pandemic impact on stock returns and their volatility varied during its successive waves.

Stata uses the method of maximum likelihood (ML) estimation to determine the parameters of the GJR-GARCHX model. Specifically, Stata employs a mixed algorithm to maximize the log-likelihood function, i.e., the first five iterations are performed applying the Berndt-Hall-Hall-Hausman algorithm and the next 10 iterations utilize the Broyden-Fletcher-Goldfarb-Shanno algorithm, after which the process is repeated (Charles and Darné 2019). As noted by (Lombardi and Gallo 2002), this type of approach can improve the model performance in terms of root mean square error.

4. Results and Discussion

The estimation results of the GJR-GARCHX models are presented in Table 2. First, the obtained coefficients satisfy the required condition, i.e., $\beta + \gamma + \frac{1}{2}\rho < 1$ indicating the stationarity of the conditional volatility. Second, the ARCH effect does not characterize Jordan's data. Therefore, only the mean equation was estimated for this country. Third, among all models, the control variable is positively correlated with the dependent variable.

The results reveal that the pandemic development during its first wave negatively affects the stock returns only in the US, while in Poland and Jordan during the second and third waves. In the remaining countries, there is no significant impact of the pandemic on the level of real estate stock returns. The above estimates are in full agreement with other studies analysing real estate stock returns in the US (Thorbecke 2020), Australia (Huynh et al. 2021), and Turkey (Öztürk et al. 2020). On the other hand, the results we obtained in the context of the financial market in Morocco contradict those presented by (Khalil 2021; Janndi and Moussamir 2021). These authors found that the pandemic negatively affected the real estate stock indices in Morocco.

Table 2. Estimates of GJR-GARCH models.

Variable	US	Australia	Poland	Turkey	Morocco	Jordan
Mean equation						
Constant	0.000144	−0.000108	−0.001248	0.001766	0.001815	0.000765
Control	1.031600 ***	1.112680 ***	0.512053 **	1.034670 ***	0.951915 ***	0.270696 ***
COVID19	−0.015908 ***	−0.000398	0.002723	0.004504	0.001545	0.000430
CWave23	0.000260	−0.000237	0.002930 **	−0.002585	0.001285	−0.000099
COVID19 × CWave23	0.009304	0.001947	−0.007845 **	0.000040	−0.001064	−0.003241 *
Diagnostics						
<i>q</i>	2	3	2	3	2	1
<i>p</i>	3	3	2	2	1	0
Joint significance †	<i>p</i> < 0.01	<i>p</i> > 0.10	<i>p</i> < 0.05	<i>p</i> > 0.10	<i>p</i> > 0.10	<i>p</i> > 0.10
ARCH effect	<i>p</i> < 0.01	<i>p</i> < 0.01	<i>p</i> < 0.01	<i>p</i> < 0.05	<i>p</i> < 0.01	<i>p</i> > 0.10
Conditional volatility equation						
Constant	−9.544025 ***	−11.174630 ***	−10.019260 ***	−12.093360 ***	−8.776888 ***	NA
COVID19	0.999685	1.020167	2.187499 ***	0.793015	0.007589	NA
CWave23	−0.410830	−0.741840	−0.256941	0.884779*	−0.473977 **	NA
COVID19 × CWave23	−4.289059 *	−2.223724	−2.434554 *	−0.408110	0.172183	NA
β	0.072690	0.212285 **	0.100403	−0.054744	0.156881	NA
ρ	0.159656	−0.064464	0.044493	0.209003 **	0.351020	NA
γ	0.278839	0.732480 ***	0.428604 ***	0.878622 ***	0.080777	NA
Diagnostics						
Joint significance †	<i>p</i> < 0.05	<i>p</i> > 0.10	<i>p</i> < 0.01	<i>p</i> < 0.10	<i>p</i> > 0.10	NA
Joint significance ‡	<i>p</i> < 0.05	<i>p</i> < 0.01	<i>p</i> < 0.01	<i>p</i> < 0.01	<i>p</i> < 0.10	NA
GED shape parameter	2.003883	1.723155	1.530436	1.633107	1.571219	NA
$\beta + \gamma + \frac{1}{2}\rho$	0.431358	0.912532	0.551254	0.928379	0.413168	NA
Log-likelihood	945.4581	905.1113	917.9927	867.1617	820.9228	NA
N	295	293	288	284	285	237

Note: NA means not applicable. Significant at * 0.10; ** 0.05; *** 0.01 level. † The test was executed for parameters generated for COVID19, CWave23, and COVID19 × CWave23 covariates. ‡ The test was executed for parameters β , ρ , and γ .

Analysing the estimated parameters for the conditional volatility equation, one may notice that they are similar to those generated for the mean equation. In particular, there is some evidence that in the period immediately after the epidemic outbreak, the development of the disease caused a rise in the volatility of real estate stock returns only in Poland. These results are consistent with the research done by (Buszko et al. 2021), who, using simple measures based on the standard deviation, observed an increase in the volatility of the WIG Real Estate index listed on the Warsaw Stock Exchange during the first wave of the pandemic. In turn, in subsequent waves in Poland, one can see a significant reduction of the pandemic impact on the volatility of stock returns, similar to what happened in the US.

Examining the results presented in Table 2, it should also be noted that in most countries the impact of positive and negative shocks on volatility is quite similar. Only in Turkey it is clear that an unexpected increase in real estate stock returns has the destabilizing effect leading to elevated conditional variance (Figure 2).

The significant influence of the COVID-19 pandemic on real estate stock returns, particularly in the US and Poland, can be explained for several reasons. In the US context, it should be noted that the current crisis shows some similarities to the one in 2007–2008, which caused significant declines in US stock markets. For example, in March 2020, the spread between the yield on corporate bonds and 10-year US treasury bonds was wider than during the financial crisis that started 14 years ago. Moreover, especially during the first wave, the mortgage market froze, and banks started to increase credit requirements. In the case of Poland, the substantial impact of the pandemic on stock returns during its second and third waves may be due to the fact that the government introduced very far-reaching restrictions in this period (Tomal and Marona 2021). At the same time, however, the impact strength of the pandemic on the volatility of stock returns in Poland decreased, which indicate that market participants in the wake of the increased incidence of the disease tried to limit their actions in the stock market compared to the period of the first wave.

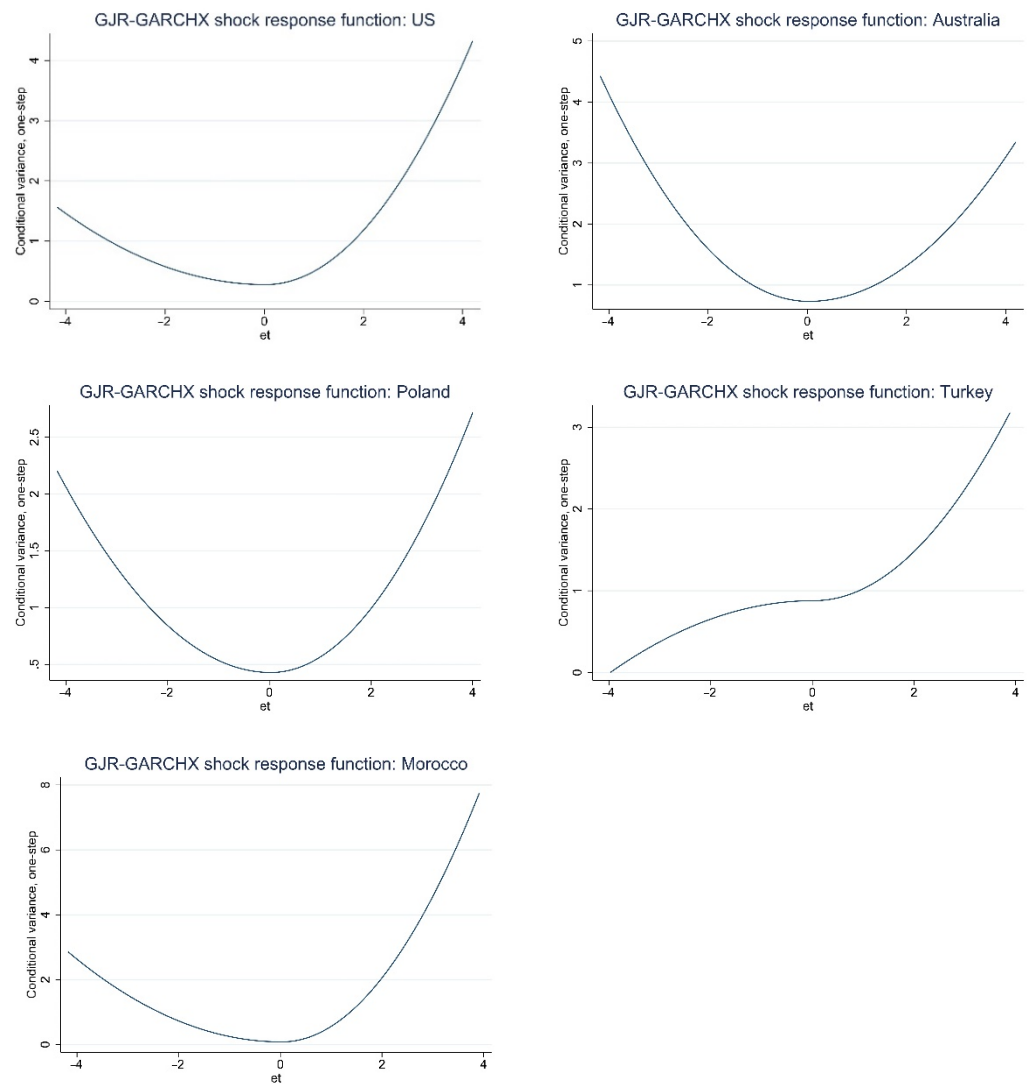


Figure 2. GJR-GARCHX shock response functions for the studied countries.

In contrast, the lack of significant impact of the COVID-19 pandemic on real estate stock returns in other countries is due to a variety of reasons. In the case of Australia, this absence is likely to result from the assistance provided by the government to the property sector, which consists of such things as commercial tenant relief, tax breaks for property owners or financial assistance to build or buy a home (Huynh et al. 2021). In Turkey, on the other hand, the resilience of the real estate financial market can be explained by the very strong demand for residential properties generated by foreigners. In particular, as (Ahsan and Sadak 2021) point out, the number of housing transactions declined in April and May 2020 and then increased dramatically as a result of lowering interest rates and launching government stimulus packages. A similar situation can be observed in the Moroccan real estate market, where, despite the ongoing pandemic, interest in the purchase of properties by foreigners is still very high, which is also due to very liberal regulations on the acquisition of dwellings by aliens (Prevost 2021).

5. Robustness Checks

GARCH-type models depend on the initial values of the coefficients (Zivot 2009). It may be that the estimated parameters correspond to local rather than global maximums. Therefore, in order to check the stability of the estimates presented in Table 2, we re-estimated GJR-GARCHX models for all the countries under study by changing the initial coefficient values beforehand. Specifically, the parameters estimated in Table 2 were used as

a starting point and then increased or decreased by 5%, 10%, 15%, 20% or 25%, respectively. No significant change in the generated parameters was observed in any of the analyzed cases.

Furthermore, the GJR-GARCH model is only one of several GARCH-type models that accounts for the asymmetric impact of positive and negative shocks. Taking this into account, the following asymmetric models were additionally estimated to confirm the reliability of the baseline results: The EGARCH of Nelson (1991), the SAARCH of Engle (1990), and the TARCh of Zakoian (1994). The estimation results of the new models (Table 3) are consistent with those presented in Table 2 which confirms the robustness of the baseline GJR-GARCHX models.

Table 3. Estimates of additional asymmetric GARCH-type models.

Variable	US	Australia	Poland	Turkey	Morocco	Jordan
Conditional volatility equation (EGARCHX)						
Constant	−4.055683 *	−0.576225	−6.666113	−13.101910 ***	−4.837369 **	NA
COVID19	0.701977	0.395548 *	0.200734	0.501505	−0.237770	NA
CWave23	−0.115050	−0.059870	−0.484480	−0.343260	−0.012890	NA
COVID19 × CWave23	−2.463610 **	−0.480260	−0.410610	−0.791810	−0.047360	NA
Joint significance †	$p > 0.10$	$p > 0.10$	$p > 0.10$	$p > 0.10$	$p > 0.10$	NA
Log-likelihood	945.9369	905.5441	915.6624	863.0055	820.4674	NA
Conditional volatility equation (SAARCHX)						
Constant	−9.553358 ***	−11.198190 ***	−9.994610 ***		−8.851563 ***	NA
COVID19	1.013982	1.024124	2.162423 ***	Not enough observations to estimate the model	0.041785	NA
CWave23	−0.445330 *	−0.738190	−0.261250		−0.424921 *	NA
COVID19 × CWave23	−3.858470 *	−2.235790	−2.380910 *		0.080146	NA
Joint significance †	$p < 0.05$	$p > 0.10$	$p < 0.01$		$p > 0.10$	NA
Log-likelihood	945.767	905.0433	917.945		821.1242	NA
Conditional volatility equation (TARCHX)						
Constant	−9.234961 ***	−11.165170 ***	−10.04424 ***	−9.478187 ***	−8.845685 ***	NA
COVID19	0.983270	1.033758	2.203767 ***	0.497031	0.013858	NA
CWave23	−0.521980 **	−0.762210	−0.267080	0.323462	−0.445720 *	NA
COVID19 × CWave23	−2.537060 *	−2.365700	−2.538890 *	0.963047	0.175666	NA
Joint significance †	$p < 0.01$	$p > 0.10$	$p < 0.01$	$p < 0.10$	$p > 0.10$	NA
Log-likelihood	945.845	904.2689	918.9061	864.776	821.3933	NA
N	295	293	288	284	285	237

Note: NA means not applicable. Significant at * 0.10; ** 0.05; *** 0.01 level. † The test was executed for parameters generated for COVID19, CWave23, and COVID19 × CWave23 covariates. Only the results for the conditional variance equation are provided since following Jiang (2012) the GARCH-type models are estimated for $\hat{\epsilon}_t$ from Equation (1).

6. Conclusions

Research shows that the impact of the pandemic on real estate stock returns varies both spatially and temporally. The pandemic outbreak was felt most strongly in the US and Poland financial markets, where an increase in infections caused a decline in stock returns and for the latter country increased their volatility. However, during the second and third waves of infections, only Poland and Jordan showed a negative correlation between the growth in the number of daily cases and the dependent variable. Looking at the results as a whole, we can say that, similarly to earlier studies, the real estate sector demonstrates a high resilience to the shock of the coronavirus outbreak.

This study has several limitations that are related to both data availability and methodological issues. In particular, due to the relatively short time series used in this study, it was not possible to use the high-order GJR-GARCHX model, which could potentially better explain the volatility of the analyzed real estate stock returns. In addition, the data we examined show little skewness, therefore, future research may consider the GJR-GARCHX model with the skewed GED. Additionally, further investigations can apply a panel GARCH model to control for the prospective dependence between real estate stock returns in different countries. Finally, it is also important to test how the currently observed fourth wave of the pandemic caused by the delta variant affects stock markets.

The results obtained in this study are important for all actors involved in the functioning of the stock market, including investors, portfolio managers, companies, and policy-makers. The latter can successfully limit or completely minimize the impact of the pandemic on the real estate sector through appropriate monetary or fiscal actions, as demonstrated by the experience of the countries analyzed in this paper.

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