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Asymmetric Causal Relations Between COVID-19 Economic Supports and Real Estate Price Shocks

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The goal of this study is to examine the nature of causal relations between COVID-19 related economic supports and real estate shocks in 58 countries over the period of January 1, 2020 and September 3, 2022. To carry out the research, we first decompose the positive and negative shocks of real estate prices for each country. Second, we apply the wavelet transformation to real estate price index shocks and Oxford COVID-19 Government Response Economic Support Index by using a discrete wavelet transform. Finally, we employ the fractional frequency flexible Fourier form Toda-Yamamoto causality test to obtain the causal relations. The results of the study show that in most countries, COVID-19 economic supports have causal effects on real estate prices. Real estate market reactions differ across different time periods. Most of the asymmetric responses of the market takes place in the medium- and long-term. Our results may provide valuable insights for policymakers to

develop appropriate housing policies to create an environment for a stable real estate market and enhance price stability when monitoring real estate market developments.

Keywords

COVID-19, Economic Support, Real Estate, Wavelet Transformation, Asymmetric Causality, FFFF-TY test

1. Introduction

Economic development always requires building infrastructures, developing housing, improving the standard of living, and other related elements. Therefore, the real estate sector has always been a key sector in the economy (Ha, 2021). However, violations of the "fundamental laws of asset valuation" may generate bubbles in the real estate market, which will have substantial and long-lasting negative impacts on the growth of an entire economy. In fact, when real estate bubbles burst, they usually cause significant economic volatility and lead to crises (Pilinkienė *et al*., 2021). The main reason behind these crises is that risks that arise from price fluctuations in the real estate market potentially spill over to other economic sectors quickly and impact the macroeconomic stability of a nation adversely (Li *et al*., 2021). For example, asset bubble collapses were the primary cause of the 1997 Asian financial crisis, 2000 dot-com disaster, and the Global Financial Crisis (GFC) between 2007 and 2009 (Joyeux and Milunovich, 2015).

Throughout history, a number of boom-to-bust cycles have occurred in various financial markets (Tokic, 2005). All assets with long maturities, such as gold, currencies, stocks, and real estate, are susceptible to experiencing bubbles. Even if the basic worth of assets remains unchanged, traders may have constantly rising expectations about the price due to the unpredictability of the future (Fabozzi and Xiao, 2019). Thus, some of the prices formed in the market do not correspond to economic fundamentals, which causes asset bubbles. Typically, in asset bubbles, the expectations of investors of higher selling prices lead to higher prices (Stiglitz, 1990). Eventually, the bubbles must burst when market participants regain their rationality (Grover and Grover, 2014). Especially during the 2008 GFC, the importance of the housing market for the global economy became painfully apparent. Most importantly, the 2008–2009 GFC highlighted that the real estate industry is directly tied to household welfare, bank liquidity, and corporate debt (Pilinkienė *et al*., 2021). Moreover, the burst of the housing bubble, mainly in the United States, United Kingdom, and a few other countries, has been cited as the immediate cause of the GFC,

where the acceleration of loan defaults directly triggered immense declines in the value of mortgage-backed securities (Takayasu *et al*., 2010).

COVID-19 has changed living and working conditions significantly worldwide since the beginning of 2020. The pandemic has caused a dilemma that affects all economic sectors, particularly the real estate sectors. Even though a myriad of restrictions have been imposed to control the spread of the disease, the real estate sectors, including residential and commercial real estate and the mortgage market, have faced obscure difficulties, which triggered a rapid decline in the real estate market (Balemi *et al*., 2021). Due to the ongoing pandemic, many real estate investors hesitate to engage in the market, which has resulted in a steep decline in housing demand. Moreover, the market supply declined concurrently because of the inability of market developers to boost supply (Ha, 2021)**.** Consequently, there are lower revenues from commercial and residential properties as more people have left their flat in the cities, and more households have trouble paying off their mortgage (Balemi *et al*., 2021).

Various studies have investigated the impacts of pandemics on housing prices. For example, Francke and Korevaar (2021) examine plague and cholera outbreaks in Amsterdam and Paris throughout the 16-17th and 19th centuries, respectively. Their study reveals a large annual loss for aggregate property prices of around 6% on average until one year after the epidemic. In the same way, Wong (2008**)** investigates how the 2003 SARS outbreak in Hong Kong influenced the price of residential buildings. The SARS pandemic caused a fall in housing demand rather than a decrease in supply. The study documented that price often decreased by 1% to 3% when there was a direct impact from SARS.

Similarly, several studies have explored the impacts of COVID-19 on housing prices. For instance, Afxentiou *et al*. (2022) claim that housing prices in the U.S. have risen to record levels due to COVID-19, thus having a tremendous impact on the housing market. Additionally, as mortgage rates dropped to record lows during the pandemic, the housing price growth rate, which had started to rise before COVID-19, surged. Also, Nicola *et al*. (2020) state that COVID-19 has caused real estate uncertainty, since the pandemic reduced consumption, increased unemployment, and lowered worker salaries, which affected capacity to pay rent, mortgage, and other bills. From January 2018 to October 2020, the national house price index barely fluctuated because of COVID-19. In contrast, the high level of market uncertainty caused over a 30% decline in existing house sales between February and June 2020 (Balemi *et al*., 2021). In the U.S., housing starts fell by more than 30% in April and barely recovered in May. Likewise, U.K. construction production plummeted by 40% in April 2020 (OECD, 2020b).

Considering the extensive impacts of COVID 19 on the real estate sector, this study aims to reveal the causal relations between COVID-19 economic supports and real estate prices by using a discrete wavelet transformation (DWT) and fractional frequency flexible Fourier form Toda-Yamamoto (FFFF-TY)

causality tests. The purpose of carrying out these econometric tests is to provide evidence to the following three research questions:

- Do the effects of economic supports cause real estate price shocks?
- Are the causal effects symmetric or asymmetric? What about their time scales?
- Are these asymmetric effects permanent or transitory?

Our study contributes to the existing real estate literature in many ways. First, to the best of the knowledge of the authors, this is the one of the first studies to examine the effects of COVID-19 related economic supports on real estate shocks that consider the asymmetric effects along with carrying out an analysis within a time domain. Secondly, the econometric methods that we use to provide answers to the research questions should be considered as the main contribution of the paper to the existing literature. Thirdly, country specific results can be used by market participants to make better informed investment, borrowing, lending and regulatory decisions, which may create value for them. Finally, our study focuses on the effects of COVID-19 economic supports rather than the pandemic itself by exploring those effects for different time scales, especially for the immediate effects.

The remainder of the paper is organized as follows: Section 2 presents the theoretical background, while Section 3 describes the data and methods used for the data analysis. Section 4 outlines the findings, and finally, Section 5 concludes the study.

2. Theoretical Background

The real estate sector is one of the key leading sectors in the economy, as changes in the real estate market tend to have long-term impacts on economic development (Pilinkienė *et al*., 2021; Zhao *et al*., 2017; Wang *et al*., 2020). Moreover, the real estate market tends to have strong bonds with the financial markets. Characteristically, price bubbles that start in a particular economic sector or geographical area frequently spread to the rest of the system through latent financial connections (Joyeux and Milunovich, 2015). Real estate speculations played significant roles in the financial crises of 1797, 1819, 1837, and 1857 and the savings and loan crisis that started in 1989. Even the Great Depression was triggered by the Florida real estate bubble in 1923–1926. Likewise, the economic stagnation in Japan after the 1990s referred to as the "Lost Twenty Years" was prompted by the Japanese real estate bubble in 1986–1991. In addition, the Asian financial turmoil was caused by the Southeast Asia bubble in 1991–1997. Finally, the subprime crisis in 2001–2008 in the United States was closely connected to the real estate bubble (Phillips and Yu, 2011; Wang *et al*., 2020).

Real estate has been a key speculative asset throughout history (Glaeser, 2017). Investors may ignore the underlying value and bid up the prices, expecting others would do the same. Hence, a type of speculation that does not rely on future income streams creates a bubble. According to Grover and Grover (2014), real estate bubbles challenge the notion that market participants are rational in their performance; why would anyone pay a price for commercial real estate that is more than its fundamental value? Although there is no universal definition of a real estate bubble, the situation in which the market price of an asset significantly deviates from its underlying value due to speculative trading activities is often considered a real estate bubble (Phillips and Yu, 2011). Similarly, Hui and Yue (2006) define a housing bubble as the portion of the house price that differs from the theoretical housing value based on the market. In general, a bubble is a period when the price of an asset rises absurdly high. Then, an inevitable price adjustment is a burst. Furthermore, booms and bubbles in the real estate industry are unavoidable (Abidoye *et al*., 2019).

According to Tien *et al*. (2019), real estate bubbles have five stages: *shift, boom, excitement, profit,* and *panic.* The shift occurs when investors recognize a new paradigm, such as a new product, technology, or low-interest record rate. As more investors enter the market, prices climb moderately during the boom. Hence, the boom is set. Fear of missing out on the market causes more people to buy assets. People get excited, house prices increase, and nobody considers caution. The profit stage is for those who know that it is difficult to rebound when the bubble bursts. Those who recognize the indicators of a bubble can sell their assets and make a profit. When asset prices rise and fall swiftly, investors are desperate to sell, thus causing them to panic.

A real estate bubble usually occurs when the housing market departs from its fundamentals due to temporary external pressures that stimulate demand. However, each housing bubble is based on a number of underlying reasons. Looking at the factors that have contributed to the formation of housing bubbles in both the Hong Kong and Chinese markets, it seems there are some common causes, such as the influx of hot money and a lack of a diversity of investing tools (Hui and Yue, 2006)**.** According to Björklund and Söderberg (1999), who examine the Swedish real estate market in 1985–1994, the increasing price-to-rent ratio in housing led to bubble formation. Gale and Allen (2007) argue that credit growth causes asset bubbles. During the recent crisis, countries with loose monetary policies witnessed faster credit expansion due to global imbalances.

According to Williams and Nedovic-Budic (2016)**,** who explore the policy framework that shaped the real estate boom and crisis and the recovery response from 2007 to 2015, it was clear that in many Irish banks, governance and risk management practices were weak or non-existent before the crash. As a result, credit risk controls failed to prevent extreme concentrations in property lending,

mainly commercial property, and high exposure to individual borrowers and wholesale funding. Likewise, the great US housing bubble was reportedly caused by several factors, including inadequate and excessive regulations, and political pressure on banks to extend mortgages to borrowers who were not qualified. In addition, the greed of overpaid and arrogant Wall Street financiers who invented novel financial instruments intended to avoid capital requirements and achieve extreme leverage led to conflicts of interest on the part of appraisers, auditors, and rating agencies (Acharya and Richardson, 2009; Lowenstein, 2006; Apgar and Duda, 2003; Moran, 2009; Hardaway, 2009; Diomande *et al*., 2009; Enrich and Paletta, 2008) So, after the subprime mortgage lending industry generated a worldwide economic crisis, governments throughout the world started to implement vital crisis management measures (Boelhouwer, 2017).

History demonstrates how national governments stepped in throughout every real estate crisis. Each government formulated and implemented real estate policies appropriate for its context to stabilize the real estate market. Short-term policies aim to solve or minimize the problems such as direct financial aid. In contrast, long-term policies are directed to avoid similar problems in the future and design the foundations for new growth. Similarly, the COVID-19 pandemic demonstrates the significance of the role of the state as an economic stimulator. As the real estate market is immensely related to the economic and social impacts of the COVID-19 pandemic, failure to address these issues with government stimulation measures may lead to economic instability and terrible social consequences (Pilinkienė *et al*., 2021). Since the start of the pandemic, national governments have included monetary and fiscal policy instruments in economic stimulus measures, such as loan deferrals, interest rate compensation mechanisms, payments to households, and wage and downtime compensations. For example, in the first two months of the pandemic in 2020, national governments declared plans to allocate US$10 trillion, i.e., three times as much as the value of the measures used to stimulate the global economy in the GFC of 2008–2009 (Cassim *et al*., 2020).

In truth, there is no definitive answer as to which measures governments should take to combat the consequences of the COVID-19 pandemic. For instance, the Lithuanian government enacted the Economic and Financial Action Plan for COVID-19 to stimulate the economy (Pilinkienė *et al*., 2021). In addition, rental contracts were extended or allowed early termination to help tenants comply with lockdown regulations in Argentina, Austria, Belgium, Germany, the Netherlands, Portugal, and Spain (OECD, 2020a). Likewise, Ireland, the Netherlands, and Spain froze rent on renewals during lockdowns. Furthermore, several nations expanded the scope and quantity of housing subsidies. For example, Ireland, Luxembourg, and Russia simplified eligibility requirements for housing subsidies during the financial crisis to increase access to financial support (OECD, 2020a).

Moreover, Latvia authorized the deferral of real estate tax payments. Correspondingly, Portuguese councils exempted homeowners in the short-term holiday rental market from income and real estate capital gain taxes to encourage affordable rental market lettings. Furthermore, economic support programs were implemented in various nations to increase social housing and boost the post-crisis recovery of the construction sector. Where housing was limited before the crisis, developers were given additional finance and easier credit conditions (Argentina, Austria, India, Ireland, Israel, the Netherlands, Russia, and the United States). Also, construction permits were streamlined in the Netherlands, and housing associations received additional cash to increase social housing. Finally, the EU supported building renovations to improve housing quality, especially energy efficiency (European Commission, 2020).

3. Data and Methods

To investigate the effects of COVID-19 economic supports on the real estate market, we use the Oxford COVID-19 Government Response Economic Support Index as a proxy for country-specific COVID-19 economic supports and real estate price index as a proxy for the real estate market. The Oxford COVID-19 Government Response Tracker (OxCGRT) is the first tool to track and compare the policy responses of countries in battling the global COVID-19 outbreak (UNESCO, 2020). The OxCGRT compiles systematic data on the policy steps implemented by countries to combat COVID-19. Since January 1, 2020, the diverse policy responses have been monitored in over 180 countries using 23 indicators, such as school closures, travel restrictions, and vaccination policies. These policies are evaluated according to a scale that measures the extent of governmental intervention during the COVID-19 outbreak, and the results obtained are compiled into a set of policy indices. The data can assist decision-makers and the public in gaining a consistent understanding of government responses, thus supporting efforts to combat the pandemic (Hale et al., 2021).

The OxCGRT has developed four policy indices, including the Overall Government Response Index, Containment and Health Index, Stringency Index, and Economic Support Index, that aggregate the data into a single value between 0 and 100. This measures the number and extent that a government has acted upon essential indicators. The goal of forming the index is not to determine if a government policy has been effectively executed. The overall government response index documents how the response of governments has changed across all database indicators, becoming stronger or weaker throughout an outbreak. All ordinal indicators are used in forming the index. The economic support index mainly documents two measures, that is, income assistance and debt relief. It is also calculated by utilizing all ordinal indicators of economic policies (Hale et al., 2021).

The time series of the plots of economic supports are given in the online Appendix (http://www.gssinst.org/irer/wp-content/uploads/2023/01/v25-no4-3_COVID-19-Support-and-Real-Estate-Shocks_Appendices.pdf). As can be seen in the figures, it seems that the European countries have provided more and longer lasting economic supports than the others among the sample countries.

We extract real estate price index data from the Refinitiv Eikon dataset. Our empirical analysis includes 58 countries. Table 1 presents the country names and abbreviations.

In determining the countries to include in the sample, we consider those that have permanent support programs and significant fluctuations in their support levels during the study period. The study period is limited with the availability of index data, which starts on January 1, 2020, and ends on March 3, 2022. However, the start and end dates of economic supports vary across countries. Thus, the time period is different for each country. Table 2 presents the start and end dates for economic support, as well as the number of observations for each country in the sample.

Table 1 Country Names and Abbreviations

Argentina - ARG	Finland - FIN	Malaysia - MYS	Spain - ESP
Australia - AUS	France - FRA	Malta - MLT	Sri Lanka - LKA
Bahrain - BHR	Germany - DEU	Mexico - MEX	Sweden - SWE
Belgium - BEL	Greece - GRC	Morocco - MAR	Switzerland - CHE
Brazil - BRA	Hong Kong - HKG	Netherland - NLD	Taiwan - TWN
Bulgaria - BGR	Hungary - HUN	New Zealand - NZL	Thailand - THA
Canada - CAN	India - IND	Peru - PER	Turkey - TUR
Chile - CHL	Ireland - IRL	Philippines - PHL	U.A.E. - ARE
China - CHN	Israel - ISR	Poland - POL	UK - GBR
Croatia - HRV	Italy - ITA	Portugal - PRT	US - USA
Cyprus - CYP	Japan - JAP	Qatar - QAT	Venezuela – VEN
Denmark - DNK	Jordan - JOR	Romania - ROU	Vietnam – VNM
Egypt - EGY	Kuwait - KWT	Saudi Arabia - SAU	South Africa - ZAF
Estonia - EST	Lithuania - LTU	Singapore - SGP	
Austria - AUT	Luxemburg - LUX	Slovakia – SVK	

To investigate the nexus between COVID-19 economic supports and the real estate market, it is important to consider the use of econometric methods that take nonlinearity into account, which is a frequently seen economic variable during turmoil times such as crises and pandemics like COVID-19. As such, we prefer to employ methods that can be applied to analyze the relationship between nonlinear variables. Thus, to investigate the nexus between COVID-19 economic supports and the real estate market, we employ a three-step procedure. In the first step, we decompose the positive and negative shocks of real estate prices for each country in the sample by using the approach in

Granger and Yoon (2002). To show how we decompose the real estate prices into positive and negative shocks, we will start with a random walk process of Z and W.

$$Z_t = Z_{t-1} + e_t = Z_0 + \sum_{i=1}^{t} e_i \quad (1)$$

$$W_t = W_{t-1} + \varepsilon_t = W_0 + \sum_{i=1}^{t} \varepsilon_i \quad (2)$$

where Z_t and W_t are variables that we explore if there is a causality between them; t=1,2,3…,T, e_i and ε_i white noise error terms. Positive and negative shocks are defined as $e_i^+ = \max(e_i, 0)$, $e_i^- = \min(e_i, 0)$, $\varepsilon_i^+ = \max(\varepsilon_i, 0)$, $\varepsilon_i^- = \min(\varepsilon_i, 0)$. Since $e_i = e_i^+ + e_i^-$ and $\varepsilon_i = \varepsilon_i^+ + \varepsilon_i^-$, we rewrite Equations (1) and (2), respectively, as follows:

Table 2 Start and End Dates of Economic Supports

	Start Date DDMM YY	End Date DDMM YY	Obser-vations		Start Date DDMM YY	End Date DDMM YY	Obser-vations
ARE	03.31.20	11.11.21	423	JAP	03.13.20	03.09.22	519
ARG	03.20.20	03.09.22	514	JOR	03.17.20	03.09.22	517
AUS	03.11.20	03.29.21	274	KWT	03.31.20	03.09.22	507
AUT	03.13.20	03.09.22	519	LKA	04.23.20	03.09.22	490
BEL	03.05.20	12.30.21	476	LTU	03.16.20	03.09.22	518
BGR	03.27.20	03.09.22	509	LUX	03.16.20	02.25.22	510
BHR	01.31.20	12.30.21	500	MAR	03.20.20	03.09.22	514
BRA	03.16.20	03.09.22	518	MEX	10.08.20	03.09.22	370
CAN	03.13.20	03.09.22	519	MLT	03.12.20	03.09.22	520
CHE	03.18.20	03.09.22	516	MYS	03.31.20	03.09.22	507
CHL	03.26.20	08.26.21	371	NLD	3.16.20	03.09.22	518
CHN	04.10.20	03.09.22	499	NZL	3.16.20	03.09.22	518
CYP	02.28.20	03.09.22	529	PER	3.13.20	03.09.22	519
DEU	03.13.20	03.09.22	519	PHL	4.03.20	04.02.21	261
DNK	03.06.20	09.03.21	391	POL	3.17.20	03.09.22	517
EGY	03.20.20	03.09.22	514	PRT	3.06.20	12.30.21	475
ESP	03.16.20	09.03.21	518	QAT	3.27.20	03.09.22	509
EST	02.28.20	07.02.21	351	ROU	3.20.20	03.09.22	514
FIN	03.13.20	03.09.22	519	SAU	4.02.20	08.20.21	362
FRA	03.13.20	03.09.22	519	SGP	3.31.20	03.09.22	507
GBR	03.16.20	03.09.22	518	SVK	03.17.20	03.09.22	517
GRC	03.17.20	03.09.22	517	SWE	03.10.20	03.09.22	522
HKG	02.25.20	03.09.22	532	THA	03.31.20	03.09.22	507
HRV	03.16.20	12.31.21	470	TUR	04.06.20	08.10.21	352
HUN	03.17.20	03.09.22	517	TWN	03.09.20	03.09.22	523
IND	02.28.20	03.09.22	529	USA	03.26.20	09.30.21	396
IRL	03.13.20	03.09.22	519	VEN	03.20.20	12.09.21	450
ISR	03.06.20	03.09.22	524	VNM	04.08.20	10.14.21	397
ITA	03.16.20	03.09.22	518	ZAF	04.20.20	03.09.21	493

$$Z_t = Z_0 + \sum_{i=1}^{t} e_i^+ + \sum_{i=1}^{t} e_i^- \quad (3)$$

$$W_t = W_0 + \sum_{i=1}^{t} \varepsilon_i^+ + \sum_{i=1}^{t} \varepsilon_i^- \quad (4)$$

In the second step, we apply a wavelet transformation to real estate price index shocks, as well as the Oxford COVID-19 Government Response Economic Support Index by using a DWT. The major advantage of using a DWT is that it allows us to work with a non-stationary time series, as well as in a combined time-and-scale domain. With the help of DWT, differences in the results can be obtained in the time frequency domain. By using a DWT over a continuous wavelet transform (CWT), we avoid the complexities and informational redundancy of CWTs (Ha et al., 2018). The DWT allows us to decompose each time series into components that correspond to different time scales. A short time scale is associated with high frequency, while a long time scale represents low frequency.

To calculate the DWT in this study, we employ the maximal overlap discrete wavelet transform (MODWT), since it has some advantages over the classical DWT as mentioned in Polanco-Martínez *et al*. (2018). The first of these advantages is that unlike the classical DWT, one can apply this method to any sample size. In addition, the transformations lead to changes in the transformed coefficients over time. Finally, in contrast to DWT, the MODWT is a nonorthogonal approximation. Also, we use the Daubechies least asymmetric wavelet with a length of 8 (LA8), because of its orthogonality, due to having almost symmetric and "compact support and good smoothness" features (Ha *et al*., 2018). With wavelet transforms, the frequencies are d1, which represents Days 0-2 - immediate market reactions; d2, Days 4-32 - short-term reactions; d3, Days 64-128 - medium-term reactions; and d4 - Days 256-512 - long-term reactions.

In the third stage, we carry out the FFFF-TY causality test to obtain the causal relations between the COVID-19 economic supports of each country and the country-specific real estate price index increases and decreases. As mentioned in Polanco-Martínez *et al*. (2018), the reason why we employ a separate causality test is that wavelet correlations, whether they are individual, multiple or rolling-window, fail to allow us to test the presence of causal relations between two variables, instead just indicating the correlations. To determine the direction of the causal relationship between the COVID-19 economic supports of each country and the country-specific real estate price index shocks, we use the following lag augmented vector autoregression (LA-VAR) model which is augmented by including the Fourier function:

$$Z_t = \beta_0 + \beta_1 \sin\left(\frac{2\pi kt}{T}\right) + \beta_2 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{l+d\,max} \theta_i Z_{t-i} + \sum_{i=1}^{l+d\,max} \phi_i W_{t-i} + u_t \quad (5)$$

$$W_t = \delta_0 + \delta_1 \sin\left(\frac{2\pi kt}{T}\right) + \delta_2 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{l+dmax} \varphi_i W_{t-i} + \sum_{i=1}^{l+dmax} \phi_i Z_{t-i} + \vartheta_t \quad (6)$$

where l and dmax indicate the optimal lag length of the VAR model, and the maximum degree of the integration level of the variables respectively. Also, *k* is frequency; t is trend and *T* is the number of observations in the sample, respectively. According to Nazlioglu *et al*. (2016), to determine the optimal frequency value (k), one can estimate the model for the integer values in $1 \leq k \leq 5$ and select *k,* which correspond to the minimum sum of the square of the residuals to determine the optimal frequency value (k). On the other hand, as Christopoulos and Leon-Ledesma (2011) suggest, fractional frequencies enable the identification of permanent breaks while the use of an integer frequency provides evidence of transitory breaks. For this reason, we also use fractional frequencies to identify the permanent breaks in the causality testing instead of only relying on searches of optimal frequency within the interval of integer frequencies by selecting the optimal k in the interval of [0.1, 0.2, 0.3,…,5]. This causality approach is known as the FFFF-TY causality test (Pata and Yilanci, 2020).

To determine if the COVID-19 economic supports cause either positive and/or negative shocks in real estate prices by using the LA-VAR model in Equations (5) and (6), we test the null hypothesis of the null hypothesis, $\phi = 0$, $\forall_i$ = 1, 2, . . ., *l*. The test statistic in this causality test is the Wald statistic and critical values are obtained via bootstrap simulations.

4. Empirical Findings

Table 3 summarizes the empirical findings of the study. As evident in Table 3, in almost every country in the sample with the exception of HKG and SWE, COVID-19 economic supports have causal effects on real estate prices. Also, these effects are subject to change across different frequencies and periods, such as immediate market reaction as well as short-run, medium run and long-run market reactions. Finally, the effects of economic supports on real estate prices are asymmetric. Thus, it is fair to conclude that our results provide evidence to answer the three research questions. The following are the details of our empirical analysis based on the research questions.

Table 3 Summary of Empirical Findings

	M	P/T	S	P/T	MD	P/T	L	P/T		M	P/T	S	P/T	MD	P/T	L	P/T
ARE^{+}	-	-	-	-	✓	P	✓	P	ARE^{-}	-	-	-	-	✓	P	✓	P
ARG^{+}	✓	P	-	-	✓	P	✓	T	ARG^{-}	✓	P	-	-	✓	P	✓	P
AUS^{+}	✓	P	✓	P	✓	P	✓	P	AUS^{-}	✓	P	✓	P	✓	P	✓	P
AUT^{+}	✓	P	✓	P	✓	T	✓	T	AUT^{-}	✓	P	✓	P	✓	T	✓	T
BEL^{+}	-	-	-	-	-	-	✓	P	BEL^{-}	-	-	-	-	-	-	✓	P
BGR^{+}	-	-	-	-	✓	P	✓	T	BGR^{-}	-	-	-	-	✓	P	✓	T
BHR^{+}	-	-	-	-	✓	T	✓	P	BHR^{-}	-	-	-	-	✓	T	✓	P
BRA^{+}	-	-	-	-	-	-	✓	P	BRA^{-}	-	-	-	-	-	-	✓	P
CAN^{+}	✓	P	-	-	✓	P	✓	T	CAN^{-}	✓	P	-	-	✓	P	✓	T
CHE^{+}	✓	P	✓	P	✓	P	✓	P	CHE^{-}	✓	P	✓	P	✓	P	✓	P
CHL^{+}	-	-	-	-	✓	P	-	-	CHL^{-}	-	-	-	-	✓	P	-	-
CHN^{+}	-	-	-	-	✓	T	-	-	CHN^{-}	-	-	-	-	✓	T	-	-
CYP^{+}	-	-	-	-	✓	P	✓	P	CYP^{-}	-	-	-	-	✓	P	✓	P
DEU^{+}	-	-	-	-	✓	P	✓	P	DEU^{-}	-	-	✓	P	✓	P	✓	P
DNK^{+}	-	-	-	-	✓	P	✓	T	DNK^{-}	-	-	-	-	✓	P	✓	T
EGY^{+}	-	-	-	-	-	-	✓	P	EGY^{-}	-	-	-	-	-	-	✓	P
ESP^{+}	✓	P	✓	P	✓	T	✓	P	ESP^{-}	✓	P	✓	P	✓	T	✓	P
EST^{+}	-	-	-	-	✓	P	✓	P	EST^{-}	-	-	-	-	✓	P	✓	P
FIN^{+}	-	-	-	-	✓	P	✓	P	FIN^{-}	-	-	-	-	✓	P	✓	P
FRA^{+}	-	-	-	-	-	-	✓	T	FRA^{-}	-	-	-	-	-	-	✓	P
GBR^{+}	✓	P	✓	P	✓	P	✓	T	GBR^{-}	✓	P	✓	P	✓	P	✓	T
GRC^{+}	-	-	-	-	✓	P	✓	T	GRC^{-}	-	-	-	-	✓	T	✓	T
HKG^{+}	-	-	-	-	-	-	-	-	HKG^{-}	-	-	-	-	-	-	-	-
HRV^{+}	-	-	-	-	-	-	✓	T	HRV^{-}	-	-	-	-	✓	P	✓	T
HUN^{+}	-	-	-	-	-	-	✓	P	HUN^{-}	-	-	-	-	✓	P	✓	P
IND^{+}	-	-	-	-	-	-	✓	T	IND^{-}	-	-	-	-	-	-	✓	T
IRL^{+}	✓	P	✓	P	✓	P	✓	P	IRL^{-}	-	-	✓	P	✓	P	✓	P
ISR^{+}	-	-	✓	P	✓	P	✓	P	ISR^{-}	-	-	✓	P	✓	P	✓	P
ITA^{+}	-	-	-	-	✓	P	✓	P	ITA^{-}	-	-	-	-	✓	P	✓	P
JAP^{+}	-	-	-	-	✓	P	✓	P	JAP^{-}	-	-	-	-	✓	T	✓	P
JOR^{+}	-	-	-	-	-	-	✓	T	JOR^{-}	-	-	-	-	-	-	✓	P
KWT^{+}	-	-	-	-	✓	P	✓	T	KWT^{-}	-	-	-	-	✓	P	✓	P
LKA^{+}	-	-	-	-	✓	P	✓	P	LKA^{-}	-	-	-	-	✓	P	✓	P
LTU^{+}	-	-	✓	P	✓	P	✓	P	LTU^{-}	-	-	-	-	✓	P	✓	P
LUX^{+}	-	-	-	-	-	-	✓	P	LUX^{-}	-	-	-	-	-	-	✓	P
MAR^{+}	-	-	-	-	-	-	✓	P	MAR^{-}	-	-	-	-	-	-	✓	P
MEX^{+}	-	-	-	-	-	-	✓	T	MEX^{-}	-	-	-	-	✓	P	✓	T
MLT^{+}	✓	P	✓	P	✓	P	✓	P	MLT^{-}	✓	P	-	-	-	-	-	-
MYS^{+}	✓	P	✓	P	✓	P	✓	T	MYS^{-}	✓	P	✓	P	✓	P	✓	T
NLD^{+}	-	-	-	-	✓	T	✓	T	NLD^{-}	-	-	-	-	✓	P	✓	T
NZL^{+}	-	-	-	-	✓	T	✓	T	NZL^{-}	✓	P	-	-	✓	T	✓	T
PER^{+}	✓	P	-	-	✓	P	✓	T	PER^{-}	✓	P	-	-	✓	P	✓	T
PHL^{+}	-	-	-	-	✓	P	✓	P	PHL^{-}	-	-	-	-	✓	P	✓	P
POL^{+}	-	-	-	-	✓	T	✓	T	POL^{-}	-	-	✓	P	✓	T	✓	T
PRT^{+}	✓	P	-	-	✓	P	✓	P	PRT^{-}	✓	P	-	-	✓	P	✓	P
QAT^{+}	-	-	-	-	-	-	✓	T	QAT^{-}	-	-	-	-	-	-	✓	T

(Continued…)

(Table 3 Continued)

	M	P/T	S	P/T	MD	P/T	L	P/T		M	P/T	S	P/T	MD	P/T	L	P/T
ROU^{+}	-	-	-	-	✓	P	✓	P	ROU^{-}	-	-	✓	P	✓	P	✓	P
SAU^{+}	✓	P	✓	P	✓	P	✓	T	SAU^{-}	✓	P	-	-	✓	P	✓	T
SGP^{+}	-	-	✓	P	-	-	-	-	SGP^{-}	-	-	✓	P	-	-	✓	P
SVK^{+}	-	-	-	-	-	-	✓	P	SVK^{-}	-	-	-	-	-	-	✓	P
SWE^{+}	-	-	-	-	-	-	-	-	SWE^{-}	-	-	-	-	-	-	-	-
THA^{+}	-	-	-	-	-	-	✓	P	THA^{-}	-	-	-	-	-	-	✓	P
TUR^{+}	-	-	-	-	-	-	✓	T	TUR^{-}	-	-	-	-	-	-	✓	T
TWN^{+}	-	-	-	-	✓	T	✓	P	TWN^{-}	-	-	-	-	✓	T	✓	P
USA^{+}	-	-	-	-	✓	P	✓	T	USA^{-}	-	-	-	-	✓	P	✓	T
VEN^{+}	-	-	-	-	✓	P	✓	P	VEN^{-}	-	-	-	-	✓	P	✓	P
VNM^{+}	-	-	-	-	✓	P	-	-	VNM^{-}	-	-	-	-	✓	P	-	-
ZAF^{+}	-	-	-	-	✓	P	✓	T	ZAF-	-	-	-	-	✓	T	✓	T

Notes: M, Immediate Market Reaction; S, Short-term; MD, Mid-term; L, Long-term; P, Permanent; T, Temporary or Transitory.

*Do the economic supports cause real estate price shocks?

The answer to this question is, as we indicated earlier, mostly yes. The real estate market of the following countries react to COVID-19 economic supports immediately or in the very short-term, which is 2 days or less: ARG, AUS, AUT, CAN, CHE, ESP, GBR, IRL, MLT, MYS, NZL, PER, PRT, and SAU. The countries that we find evidence of causality that runs from COVID-19 economic supports to real estate prices in the short-term *(Days 4-32)* are: AUS, AUT, CHE, DEU, ESP, GBR, IRL, ISR, LTU, MLT, MYS, POL, ROU, SAU, and SGP; in the medium-term *(Days 64-128)*: ARG, AUS, AUT, BGR, BHR, CAN, CHE, CHL, CHN, CYP, DEU, DNK, ESP, EST, FIN, GBR, GRC, HRV, HUN, IRL, ISR, ITA, JAP, KWT, LKA, LYU, MEX, MLT, MYS, NLF, NZL, PER, PHL, POL, PRT, TOU, SAU, TWN, USA, VEN, VNM, and ZAF; and in the long-term *(256th-512th)*: ARG, AUS, AUT, BEL, BGR, BHR, BRA, CAN, CHE, CYP, DEU, DNK, EGY, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IND, IRL, ISR, ITA, JAP, JOR, KWT, LKA, LTU, LUX, MAR, MEX, MLT, MYS, NLD, NZL, PER, PHL, POL, PRT, QAT, ROU, SAU, SGP, SVK, THA, TUR, TWN, USA, VEN, and ZAF.

In countries like AUS, AUT, CHE, ESP, GBR, and MYS, we find evidence of causal effects that run from economic supports to real estate prices in all frequencies. This finding is interesting because except for MYS, all of the other countries are developed countries and have a highly developed real estate market and mortgage system. The case of MYS could be explained by a higher percentage of firms that received government supports i.e., 85% - 90% compared to other emerging markets (Kuriakose *et al*., 2021).

The overall results of the study show that most of the significant causal effects of economic supports on real estate prices are taking place in the medium- and long-term. This may imply that these effects are mostly perceived as permanent, not transitory, by the real estate market participants as they observe that the economic supports are significant over time. Therefore, money injections to stimulate the economy through economic support programs were primarily channeled towards asset accumulation, particularly in real estate investments by the investors possibly to be well-prepared for future unexpected crises like pandemics.

*Are the causal effects symmetric or asymmetric? What about their time scales?

In this study, we analyze the changes in real estate prices by considering the frequency and time domains. Thus, to complete our analysis, our focus is to determine if the effects of economic supports differ when there is an increase and decrease in real estate prices. Thus, we need to decompose the real estate price as positive and negative shocks. The reason why we do so is that in the sample countries, there are different trends in real estate prices. There is no doubt that the effects of COVID-19 economic supports on real estate prices are asymmetric. As such, we focus on the asymmetry in real estate prices in the frequency domain. In other words, the effects tend to change depending on whether the market is rising or falling. Yet, these asymmetric effects differ in terms of time scales across the countries in the sample. For example, while there are immediate market effects in IRL and NZL, and short-term effects in DEU, LTU, MLT, POL, ROU, and SAU, there are both medium-and long-term effects in countries like HRV, HUN, MEX, MLT, and SGP. Most frequently, COVID-19 economic supports seem to cause negative shocks (price falls) on real estate prices both in the medium-and long-term.

*Are these asymmetric effects permanent or transitory?

The results of our study show that there is no evidence of transitory effects of economic supports on real estate prices in all frequencies in any country. On the other hand, we find evidence that confirms the permanent asymmetric effects of economic supports on real estate prices only in AUS and CHE in all the time scales. The policy response of the Australian government to COVID-19 was mainly based on 'emergency Keynesianism' and consisted of using fiscal stimulus packages to protect the value of assets in the economy, as well as to prevent systemic failure (Martin *et al*., 2021). Those fiscal packages might be the main reason for the economic supports to be channeled to the Australian stock market for all time scales. The countries that we find evidence of permanent asymmetric effects of supports on real estate shocks in at least one time scale are: immediate - ARG, AUS, AUT, CAN, CHE, ESP, GBR, MLT, MYS, PER, PRT, and SAU; short-term - AUS, AUT, CHE, ESP, GBR, IRL, ISR, MYS, and SGP; medium-term - ARE, ARG, AUS, BGR, CAN, CHE, CHL, CYP, DEU, DNK, EST, FIN, GBR, IRL, ISR, ITA, KWT, LKA, LTU,

MYS, PER, PHL, PRT, ROU, SAU, USA, VEN, and VNM; and long-term - ARE, AUS, BEL, BHR, BRA, CHE, CYP, DEU, EGY, ESP, EST, FIN, HUN, IRL, ISR, ITA, JAP, LKA, LTU, LUX, MAR, PHL, PRT, ROU, SVK, THA, TWN, and VEN. On the other hand, there are few countries that we find evidence of transitory effects in both the medium- and long term. Thus, based on these findings, we can conclude that there are permanent effects of COVID-19 economic supports on real estate prices by considering structural breaks, which is one of the benefits of using an FFFF-TY causality test, in all frequencies. Except for GRC, JAP, and ZAF, the countries where there is a permanent effect of supports on rising real estate prices, the effects are transitory on falling prices in the medium-term. Also, we obtain evidence that show the transitory rises in real estate prices in NLD in the medium-term and permanent falls in prices in ARG, FRA, JOR, and KWT in the long-term. These results also prove that the effects of structural breaks differ across countries and time scales, as implied by the method employed in this study.

5. Conclusion

This study is designed to answer three important research questions about the effects of COVID-19 economic supports on real estate markets. These questions are: Do economic supports have a causal effect on real estate price shocks? Are these causal effects asymmetric? Are they permanent or transitory? The empirical results of this study indicate that except for two countries, Hong Kong and Sweden, COVID-19 related economic supports have a causal effect on real estate prices. They also show that these causal effects are asymmetric for most of the countries in the sample and have changing patterns depending on the time scales. Finally, they are transitory for some countries, and permanent for others. Therefore, it is fair to conclude that the results of this study have important implications for individuals, real estate market strategists, and policy makers, since real estate prices are affected by important macroeconomic variables such as inflation and income, and COVID-19 itself. However, the real estate sector has the potential to create effects on economic activity. Most importantly, since there are permanent effects of COVID-19 economic supports on real estate prices, this implies that economic supports have the potential to create asymmetric shocks in the real estate market. These shocks may trigger speculations and bubbles in the real estate markets and eventually lead to the burst of real estate bubbles. Based on all of these conclusions, the findings inform real estate market participants that they have to make their purchasing or selling decision based on the following evidence. First, they have to determine whether the effects are asymmetric. Second, they have to determine whether the effects are permanent or temporary. If the real estate investor is risk averse, the study results would provide valuable inputs for them especially about the country that they intend to invest in. More importantly, they will benefit from portfolio diversification by using the findings of our study.

Our results may provide valuable insights for policymakers to develop appropriate housing policies to create an environment for a stable real estate market as well as to enhance price and financial stability when monitoring real estate market developments. For real estate firms, our findings show that they can protect themselves against negative stock market reactions by diversifying their investments across different countries during health crises (Chu *et al*., 2021). Given the results of our study, future studies may wish to extend the analysis of the nexus between COVID-19 economic supports and real estate prices in individual countries to obtain country-specific results. To explain the nature of the asymmetric causal relations of COVID-19 economic supports and real estate prices, various macroeconomic variables could be considered, which is beyond the scope of this study and therefore left to future studies.

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