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# The dynamics of the relationship between real estate and stock markets in an energy-based economy: The case of Qatar

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ABSTRACT

In this study, we investigate the dynamic linkages between the real estate and stock markets in Qatar. Using monthly data over the period 2006–2020, the nonlinear model of Enders and Siklos (2001) and the linear and nonlinear Autoregressive Distributed Lag (ARDL) models, our investigation seeks to trace the channel of transmission between the two markets outlined by two well-known theories: namely, the effects of wealth and of credit. The results show that the model of Enders and Siklos (2001) does not explain the dynamics of the relationship between the two markets. The linear ARDL provides some evidence to support the wealth effect but the model is mis-specified. The results from the nonlinear ARDL model support to the effect of wealth and provide evidence on the dynamic linkages between the two markets in the short run as well as the long run. In addition, when money supply, bank credit, oil prices, and currency reserves are in a downturn, we find a long-run relationship between their rate of decline and that of real estate prices, but in an upturn, the rate of increase of real estate prices has a long-run relationship with the rate of increase in the inflation rate. Our results show that the nonlinear ARDL model passes a battery of rigorous tests of robustness. The implications of the empirical results are also discussed.

## 1. Introduction

A number of studies claimed that adding real estate assets could improve the risk-return profile of portfolios, due to their low correlation with bonds and stock markets (Chan et al., 2011; Garmaise & Moskowitz, 2004; Gounopoulos et al., 2019; Lin & Lin, 2011; Liow & Ye, 2018; Liow et al., 2019). However, the connection between real estate and stock markets has turned out to be strong in turbulent periods, such as the burst of the Japanese bubble in the 1990s and the U.S. subprime crisis of 2008. In 2008, house prices fell dramatically in the U.S. and stock market prices plunged to record levels. The U.S. economy suffered a severe recession and, as a result, global stock markets, property prices and the global economy followed suit. The strong linkages between both markets in turbulent periods imply the fast transmission of spillover and fewer opportunities for reducing risk in the long run, raising deep concerns for investors and policymakers in countries with a great capacity for real estate activities (Crowe et al., 2013; Duran & Ozdogan, 2020; Lee & Choi, 2011; Liow et al., 2019; Zheng & Osmer, 2019; Zhou et al., 2016). The outbreak of COVID-19 has negatively affected project development, sales of real estate, and values and rates of return of the real estate sector (Tanrivermis, 2020). In consequence, investment strategies have become more complicated in both markets and the question of how these markets are linked is of great concern to investors and policymakers alike (Kiohos et al., 2017).

In this study, we examine the dynamics of the relationship between real estate and stock markets in the oil-and gas-rich country of

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Qatar using the nonlinear model of Enders and Siklos (2001), the linear Autoregressive Distributed Lag (ARDL) model of Pesaran et al. (2001), and nonlinear (ARDL) of Shin et al. (2014). Our research questions center on uncovering the directional linkages between the two markets and learning if there is evidence to support either of two prominent theories in the literature; namely the effects of wealth and of credit. Choosing the dominant theory in Qatar is important, since the outcome will help investors improve their strategies in both markets and guide policymakers to initiate effective policies on the financial economics of real estate development and investment in Qatar. We also intend to uncover the dynamic responses and the speed of adjustment to equilibrium between the fluctuations of both markets. Since Qatar has witnessed massive investments in real estate development and has undergone fundamental policy reforms due to the 2022 World Cup added to the initiatives for diversification plans from the hydrocarbon sector, we believe that the real estate market is likely to have unique and dynamic linkages with the stock market and this has captured the attention in our study.

Our paper contributes to the literature on the real estate-stock market nexus in the following ways. First, Qatar is the only state in the Gulf region to formulate a monthly real estate price index at national level.[1] Although previous studies have been conducted on developed and emerging markets (see Gounopoulos et al., 2019; Hong & Li, 2020; Hui & Ng, 2012; Kiohos et al., 2017; Lin & Fuerst, 2014; Liow & Ye, 2018; Sim & Chang, 2006; Tsai et al., 2012), our study therefore adds to the literature from an energy-based economy of Qatar. Second, the use of the recently developed nonlinear ARDL model of Shin et al. (2014) may be a valuable approach for reducing some of the limitations of earlier studies and revealing useful results about the dynamics of the relationship between the two markets based on advanced econometric techniques. Third, our study sheds light on the fiscal and monetary measures to aid business sectors due to the financial repercussions of the global pandemic caused by COVID-19 and various legislative and reforms introduced by Qatar since 2014 to propel the real estate sector, boost economic diversification and increase economic output, as part of Qatar's plan to strengthen the demand for residential and commercial real estate in anticipation of the 2022 World Cup.

Since December 5, 2010, when Qatar won the competition to host the World Cup, it has become the construction hotspot in the Gulf region. Owing to the record growth rates in its GDP and government revenues since 2010 up to the decline in oil prices between 2014 and 2016, Qatar has witnessed more than a 5% annual increase in its population, due to the influx of expatriates (Oxford Business Group, 2019).[2] The growth in population and economic output, boosted by the implementation of infrastructure projects, have imbued investors with positive sentiments about the stock market and the real estate sector. As a consequence, the real estate index grew by almost 15% year-on-year on average (QCB report, 2018). In addition, the market value of the Qatar stock exchange (QSE) reached record levels, rising from $88 billion in December 2010 to $166 billion in September 2015 (Al Refai & Hassan, 2018). However, with its hydrocarbon basis, the economy of Qatar was affected by a period of low oil prices due to excess supply in the global market between mid-2014 to mid-2016, and January 2020 to date, which has negatively affected the economy of Qatar as well as the stock market performance. This constrained government revenues, slowed some real estate projects, and increased the volatility of the stock market. For example, the market value of QSE decreased by almost 21% between January and March of 2020 due to negative sentiments of investors. In addition, the economic outlook of Qatar was blurred since June 2017 with the imposition of an economic blockade by its neighboring countries and the geopolitical risks in the region. However, due to the massive expenditure on infrastructure for the 2022 World Cup, Qatar has managed to turn the financial pressures and other challenges into opportunities to grow, especially in non-hydrocarbons sectors (Charfeddine & Al Refai, 2019).

In light of the motivation of our paper, we propose to test the following hypotheses:

**H1**. Stock market performance will lead the performance of the real estate sector in Qatar as a result of the wealth effect.

**H2**. Real estate market performance will lead the stock market in Qatar as a result of the credit effect.

**H3**. Macroeconomic factors have an asymmetric impact on the real estate prices of Qatar as an energy-dependent economy.

We believe that the direction of the relationship and which hypotheses to support should be relevant to market participants and policymakers in Qatar, and possibly to the whole Gulf region, since the Gulf states are heterogeneous in their economic and financial structure. In practice, both markets in Qatar have been a target for investment by individual and institutional investors, whether local, regional or international, especially since being chosen as host for the 2022 World Cup. If the wealth effect prevails, this should motivate investors to invest in the real estate sector by rebalancing their investment alternatives. If the effect of credit is evident, then the development of the real estate sector is a catalyst for economic activity in Qatar and, hence, individual and institutional investors should bid up firms' stocks, especially in booming periods, to achieve capital gains in future. Furthermore, because real estate prices are driven by economic activities, investors and policymakers alike should look into the economic determinants of the real estate market in Qatar for investment and policymaking decisions.

Our study could find no evidence of association between the real estate and stock markets in Qatar using the nonlinear model of Enders and Siklos (2001). The linear ARDL provides some evidence to support the wealth effect but the model is mis-specified. The results from the nonlinear ARDL model show support for the wealth, which describes the dynamics of the relationship between the two markets as asymmetric in the short run and symmetric in the long run. We also find that the money supply, bank credit, oil prices, and currency reserves have long-run relationship between their rate of decline and that of real estate prices. In addition, the rate of increase of real estate prices has a long-run relationship with the rate of increase in the inflation rate. The results could provide valuable implications on investment strategies and policymaking in Qatar.

[1] For example, the index is available on quarterly basis for the city of Dubai. Quarterly data are available for Saudi Arabia from 2015, but the index is unavailable for Bahrain, Kuwait and Oman.

[2] In fact, the population of Qatar in 2020 has increased by more than 50% since 2010.

The remainder of this paper is organized as follows. Section 2 presents the recent development in the real estate market in Qatar. Section 3 presents the literature review. Section 4 describes the data and methodology. Section 5 discusses the empirical part. Section 6 presents the conclusion of the study with implications for investors and policymakers.

## 2. Recent development in Qatar's real estate sector

Driven by the massive expenditure on infrastructure projects related to the 2022 World Cup and Qatar National Vision (QNV-2030), Qatar's real estate sector has thrived to become one of the key engines of Qatar's energy-based economy. The landscape of Qatar has undergone spectacular changes in the 15 years, with rapid growth of modern-looking towers, commercial blocs, shopping malls, entertainment venues, and chain hotels coming to the country, transforming Qatar to a global hub for business, real estate investment opportunity in the Gulf region, and potential host for many future mega-sport events.[3] The successful bid to host the World Cup has also propelled massive investments in various commercial and residential projects. Despite the political tensions, geopolitical risks, and the slowdown of the global economy due to COVID-19, Qatar's real estate sector is expected to recover over the next few years (Oxford Business Group, 2020).

According to the Supreme Committee for Delivery and Legacy (SC&DL),[4] Qatar announced that it will be spending more than $200 billion on construction projects such as stadiums, transportation systems, and residential projects to meet the requirements of the FIFA conditions, and educational facilities, medical centers, shopping malls, amusement parks and so on, based on the Qatar National Plan (QNV-2030) initiative. These projects represented lucrative investment contracts to private companies and their financiering banks, pushing up the value of their share prices to record levels (Al Refai & Hassan, 2018). The projected economic growth of Qatar from 2010 until crude oil prices began to fall in mid-2014 has made Qatar the fastest growing economy in the Gulf region and one of the fastest in the world. The implementation of these projects contributed to the surge in the demand for land and real estate properties (Oxford Business Group, 2018; QCB report, 2018), (see also Fig. 1a).

The positive performance of the stock market from 2010 did not last, due to the blockade on Qatar By Bahrain, Saudi Arabia, the UAE and Egypt on June 5, 2017. A day before the blockade started (i.e., June 4, 2017), the market value of QSE was almost US146 billion (QSE website). The QSE index fell by almost 15% in the first 100 days of the blockade and a further 3% by September 2017. However, the stock market had recovered within two years, offsetting most of its financial losses (Charfeddine & Al Refai, 2019) (see Fig. 1b). Fig. 1a also shows the downward pressure that the blockade inflicted on the real estate index. Before the start of the blockade, Qatar Central Bank (QCB hereafter) estimated that the growth of revenues from real estate transactions would increase by 21% in the next 5 years. After June 2017, residential and commercial prices fell by almost 10%, while residential and commercial rents went down by almost 20%. The blockade caused the real estate index to fall by almost 17% between June 2017 and the end of the second quarter of 2018 (QCB report, 2018). Fig. 1a clearly shows that the real estate index has not been on track to offset the downturn trend since the blockade or to recover to pre-blockade levels, especially during regional geopolitical risks and global economic uncertainties due to COVID-19.

To ease the loss of hydrocarbons revenues due to COVID-19 and the blockade since 2017, Qatar initiated stimuluses and monetary measures amount to 10% of GDP since June 2020 and introduced legislative reforms especially since 2017 in private sector for the purpose of attracting foreign investments and increasing the productivity of the non-hydrocarbons sectors (Fetch, 2020). In the real estate sector, Qatar introduced the "Foreign Real Estate Ownership Law", which allows Gulf nationals and non-Qataris to buy commercial and residential projects in specific areas (e.g., West Bay Lagoon, The Pearl, Lusail, Barwa Al-Khor, Al-Wakra and Al-Waab Cities). The owners have permission to use property for personal or financial benefits.[5] Special resident visas are issued to buyers, which allow them to live in Qatar without sponsorship. In addition, Gulf nationals and non-Qataris can invest in land and own it especially for business and agriculture.[6] Given that Qatar is anticipating a vast number of visitors for the World Cup, the addition of residential entertainment venues and accommodations is essential to meet the 2022 FIFA requirements and expectations of football fans, which should boost the performance of the real estate sector in the near future.

## 3. Literature review

The question of whether real estate could provide risk reduction benefits has been questioned in the literature. The answer may depend on the direction of the relationship between the real estate and stock markets (Lin & Lin, 2011; Tsai et al., 2012). There are two dominant theoretical frameworks in which to explain the relationship; the first is the wealth effect, which suggests that the transmission is channeled from the stock market to the real estate market. The rationale behind the theory states that when stock prices increase, households will rebalance their portfolio and have a tendency to sell shares and buy other assets such as real estate (see Gounopoulos et al., 2019; Kiohos et al., 2017). Earlier studies such as that by Okunev et al. (2000) provided evidence from the U.S. market of the wealth effect using nonlinear causality tests. Tsai et al. (2012) provided similar results from the U.S. market using the threshold cointegration model. Several studies showed that this theory is valid for many developed and emerging markets. For example, Kiohos

[3] For example, Qatar has recently won the host of the 2030 Asian Games and plans to bid for the 2032 Olympic Games.

[4] The SC&DL supervises the implementation, progress and operation of the 2022 World Cup projects.

[5] In fact, properties in some specified areas under the Foreign Real Estate Ownership Law maybe held freehold to non-Qataris, while others are subject to a leasehold right for 99 years.

[6] Especially in specified areas such as free economic zones, see Charfeddine and Al Refai (2019).

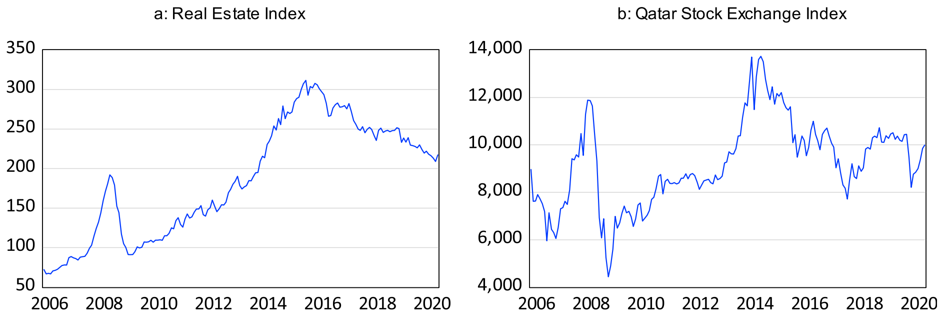


**Fig. 1.** Monthly real estate and Qatar Exchange (QE-20) indices: 2006–2020.

et al. (2017) found strong support for the wealth effect in the long run for Germany and in the short run for the UK using the Error Correction (EC) model. Gounopoulos et al. (2019) provided similar results in the short and the long run in Greece using the linear ARDL, even though Greece has experienced a debt crisis and downfall of the housing market in the past decade. Zhou et al. (2016) also found results supporting the wealth effect for 31 provinces in China using panel cointegration.

According to Tsai et al. (2012), Cerutti et al. (2017) and Hong and Li (2020), the wealth effect is likely to be plausible in booming market periods and more noticeable when the stock market is performing better than the real estate market. For example, Tsai et al. (2012) found a wealth effect during periods when stock prices exceed housing prices over a certain level in the U.S. market using the model of Enders and Siklos (2001). Using the Markov regime-switching model, Liow and Ye (2018) found a wealth effect during periods of boom with high return volatility for the U.S., Japan, Singapore, Germany and Canada.

The second theory is the credit effect, which is a channel of dependence running from housing market to the stock market. The theory supports the view that higher property prices increase the value of collateral and stimulate economic activity, which could decrease the cost of debt and increase the financing resources for businesses and households. In such a case, capital gains will lead investors to bid up the value of a firm's stock (Gounopoulos et al., 2019; Tsai et al., 2012). Various studies showed that the credit effect was also valid in many developed and emerging markets (see Bahmani-Oskooee & Ghodsi, 2018; Mallick & Mahalik, 2012; Sim & Chang, 2006). For example, Sim and Chang (2006) found that housing prices Granger-cause the stock prices in South Korea, supporting the existence of the credit effect. Lin and Lin (2011), found similar results in Singapore and Taiwan using the Granger causality test. In Greece, Gounopoulos et al. (2019) also provided support for the credit effect in the short run, while Kapopoulos and Siokis (2005) found similar results from the urban real estate prices.

Various studies reported mixed results on both theories for developed and emerging markets. Lou (2017) found mixed results in Italy, Spain and Greece using the quantile regression. Hong and Li (2020) found the wealth effect in the short run using the wavelet method, but a long-term credit effect. Using the wavelet method, Su et al. (2019) found support to the credit effect in China in the long run and the linkages in the short run only during the financial crisis of 2008. Kapopoulos and Siokis (2005) found the wealth effect in the metropolitan areas in Greece and a credit effect in the urban areas, and Gounopoulos et al. (2019) confirmed support for the credit effect in the short and long run and the wealth effect in the long run using two econometric model: the ARDL and the model of Enders and Siklos (2001). Bahmani-Oskooee and Ghodsi (2018) found that most U.S. states exhibit the credit effect using the nonlinear ARDL, while a few shows the presence of wealth effect. Other studies found mixed results based on the sample and model used include Lean (2012) in Malaysia, Lin and Fuerst (2014) in ten Asian countries, and Xiao-Lin et al. (2015) in the U.S.

A number of studies argued that economic variables display nonlinearities due to the business cycle (Enders & Siklos, 2001; Gounopoulos et al., 2019). Studies investigating linkages of economic variables within linear frameworks assumed that the impact of shocks is symmetrical, i.e., the impact of a positive shock is identical but opposite to the impact of a negative shock. However, this assumption is restrictive, since there are potential asymmetries regarding the magnitude and direction of impacts. Because real estate prices and stock prices are driven by economic activities, they are also expected to display nonlinearities during different economic phases. The imposition of such symmetry can lead to bias in estimating the impact of these shocks. In addition, treating the effects of shocks as symmetric implies that volatility in real estate/stock prices has no impact on the net movement in the prices of stock/real estate. Therefore, researchers stress that in empirical analysis, it is vital to account for nonlinearity to improve the implications for market participants and policymakers (Katrakilidis & Trachanas, 2012; Abdelaziz Eissa and Al Refai, 2019; Tsagkanos et al., 2019; Tsagkanos & Siriopoulos, 2015). This implies that linear models adopted in the literature may not conform to nonlinear properties in stock and real estate prices and therefore, empirical results could be misleading (see Gounopoulos et al., 2019; Lin & Fuerst, 2014; Liow & Yang, 2005; Su, 2011; Tsai et al., 2012).

Due to the lack of evidence on such a relationship from the Gulf region, our study on the linkages between both markets in Qatar is crucial for both investors and policymakers. Our findings may help policymakers to evaluate the effectiveness of the fiscal and monetary measures to lessen the negative consequences of COVID-19 on business sectors and the legislative and economic reforms to boost the real estate sector and increase economic diversification. Policymakers may also conform with findings in improving and introducing regulations needed to enhance the real state sector and boost financial market performance in Qatar, especially due to the economic blockade and the ongoing global pandemic since March 2020. Other market participants such as financiers and investors might benefit from such relationship for their future financing and investment decisions especially once the blockade and the global pandemic come to an end.

## 4. Data and methodology

### 4.1. Data

Our dataset for the real estate index (REI) from April 2006 to September 2020 is sourced from QCB.[7] QE-20 index represents market performance of Qatar stock exchange, which measures the 20th largest and most liquid shares listed on QSE (out of 47 companies currently listed as of December 2020). The QE-20 index and macroeconomic factors were collected from DataStream, with a total number of 174 observations. We transformed both series into their national growth.

### 4.2. Methodology

#### 4.2.1. The nonlinear model of Enders and Siklos (2001).

The model of cointegrated variables that assumes linear and symmetric adjustment is given as:

$$\begin{aligned} & Y_t = \alpha_0 + \alpha_1 X_t + \upsilon_t \\ & \Delta\upsilon_t = \rho\upsilon_{t-1} + \sum_{i=1}^{P}\delta_i\upsilon_{t-i} + \omega_t \end{aligned} \tag{1}$$

where $\Delta$ is the first difference, $Y_t,\ X_t$ are $(n \times 1)$ vector of variables integrated of degree 1, and $\alpha_1$ is an $(n \times n)$ matrix, $\upsilon_t$ is an $(n \times\ 1)$ vector of error terms distributed as $\upsilon_t \tilde{} iid(0,\sigma^2)$, which measures the deviation from equilibrium between $Y_t,\ X_t$, and $\omega_t$ is an error term. Engle and Granger (1987) examined the presence of cointegration between $Y_t,\ X_t$ in Equation (1). When $\rho \neq 0$, then the variables are cointegrated. Enders and Siklos (2001) adjusted the cointegration relationship to account for nonlinear adjustments in Equation (1) as follows:

$$\Delta\upsilon_t = \rho_1 I_t\upsilon_{t-1} \ + \ \rho_2(1 - I_t)\upsilon_{t-1} + \sum_{k=1}^{P}\varphi_k\Delta\upsilon_{t-k} \ + \omega_t \tag{2}$$

where $\rho_1,\ \rho_2, \varphi_k$ are coefficients, $p$ is the number of lags determined by the Schwarz Information Criterion (SIC) to avoid the serial correlation in the regression residuals (see Tsagkanos & Siriopoulos, 2015; Tsagkanos et al., 2019), $I_t$ is called the Heaviside indicator function which can be specified based on the lagged values of $\upsilon_t$ as: $I_t\ = 1\ if\ \upsilon_{t-1}\ \geq \tau$, 0 otherwise (Threshold model; TAR), or $I_t\ = 1\ if\ \Delta\upsilon_{t-1}\ \geq \tau$, 0 otherwise (Momentum model; M-TAR). The TAR model captures the deep movements in the deviations from the long-run equilibrium, while the MTAR model captures steep movements in the series (Tsagkanos & Siriopoulos, 2015). $\rho_1,\ \rho_2$ coefficients represent the speed of adjustment when deviations from long-run equilibrium exist. If cointegration exists between $Y_t, X_t$, then $\rho_1 < 0,\ \rho_2 < 0$. If $(|\rho_1| \leq |\rho_2|)$, then increases are persistent and decreases move faster to equilibrium. Enders and Siklos (2001) developed two tests to estimate their asymmetric models. The $\Phi$ statistics tests for the null hypothesis as: $H_0 = \rho_1 =\ \rho_2 = 0$ using an F-statistic. The t-max tests the null hypothesis with the largest $\rho_1\ = 0$ between $\rho_1,\ \rho_2$ using the t-statistic. Since Enders and Siklos (2001) did not tabulate the critical values of Φ and t-max, these are calculated on the basis of Monte Carlo simulations for the 5% level of significance for 10,000 simulations.

The estimation of threshold parameter $\tau$ in TAR and M-TAR models can be set to 0 or determined according to Chan's (1993) grid search (see Tsai et al., 2012). Since Enders and Siklos (2001) proposed estimating both TAR and M-TAR models when the threshold is set as $\tau\ = 0,\ \tau \neq 0$, only $\tau \neq 0$ is employed and reported here because we have no knowledge of its value a priori. The endogenous search for the threshold values requires the disposal of the highest and lowest 15% of the threshold values; then the threshold values that fall within the remaining 70% are used to locate the threshold parameter $\tau$.

#### 4.2.2. The nonlinear Autoregressive Distributed Lag (NARDL) model

If the variables are not cointegrated using the Enders and Siklos (2001) model, we proceed with our analysis to the linear and nonlinear ARDL models. Shin et al. (2014) developed an important extension to their well-known model the so-called linear ARDL of Pesaran et al. (2001). The new model allows the linkage between the short- and long-run asymmetries between variables to be captured. In addition, it has many advantages over other traditional cointegration models. For example, it works better with a small sample; moreover, it can be applied regardless of whether the order of the variables is I(0), I(1), or a mix of I(0) and I(1). Therefore, the symmetric and asymmetric relationships between the dependent and independent variable can be investigated using linear and nonlinear formats (Sek, 2017). These advantages, obviously, may also be valid for nonlinear threshold Error Correction or smooth transition models; however, they may suffer from the convergence problem due to the proliferation of the number of parameters. This is not the case with the NARDL model (Raheem, 2017). Traditionally, Engle and Granger's (1987) model can be applied to test for the dynamic relationship between I(1) variables, as follows:

[7] QCB collects the data from the Ministry of Justice to construct the index after seasonally adjusting the series, which is based on information on the prices and rents of commercial and residential properties.

$$\Delta y_t = \mu + \rho_y y_{t-1} + \rho_X X_{t-1} + \sum_{t=1}^{p-1} \propto_i \Delta y_{t-1} + \sum_{i=0}^{q-1} \beta_i \Delta X_{t-1} + \varepsilon_t \tag{3}$$

In our study, $X$ indicates the real estate/stock prices, while $y$ refers to the stock/real estate prices. Δ is the difference operator and ε is an error term. Equation (3) assumes that the relationship between stock prices and real estate prices is linear, but this becomes irrelevant when these relationships are nonlinear and/or asymmetric (see Abdelaziz Eissa and Al Refai, 2019; Atil et al., 2014). The NARDL model overcomes this shortcoming by allowing asymmetries on the short- and long-runs by decomposing the endogenous variables – stocks/real estate – into its positive $X$t+ and negative $X$t-partial sums of increases and decreases, as follows:

$$X_t^+ = \sum_{j=1}^{t} \Delta X_j^+ = \max\left(\Delta X_j^t, 0\right), \ and\ X_t^- = \sum_{j=1}^{t} \Delta X_j^- = \min\left(\Delta X_j^t, 0\right) \tag{4}$$

Therefore, Equation (3) becomes:

$$\Delta y_t = \mu + \rho_y y_{t-1} + \rho_X^+ X_{t-1}^+ + \rho_X^- X_{t-1}^- + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{q-1} \left(\beta_i^+ \Delta X_{t-i}^+ + \beta_i^- \Delta X_{t-i}^-\right) + \varepsilon_t \tag{5}$$

The lag length of the dependent and the exogenous variables are represented by $p$ and $q$ respectively. The Wald test can be used to check for the symmetric long-run relationship using the following null hypothesis:

$$\theta^+ = \theta^- \ with\ \theta^+ = -\frac{\rho_X^+}{\rho_y} and\ \theta^- = -\frac{\rho_X^-}{\rho_y} \tag{6}$$

The Wald test can be used to test the short-run symmetry of:

$$\beta_i^+ = \beta_i^- \ \ for\ all\ i = 0, \ldots\ldots q-1 \tag{7}$$

The non-rejection of either the long-run symmetry or the short-run symmetry will yield the co-integrating NARDL model with short-run asymmetry in Equation (8) and with long-run asymmetry in Equation (9):

$$\Delta y_t = \mu + \rho_y y_{t-1} + \rho_X X_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{q-1} \left(\beta_i^+ \Delta X_{t-i}^+ + \beta_i^- \Delta X_{t-i}^-\right) + \varepsilon_t \tag{8}$$

$$\Delta y_t = \mu + \rho_y y_{t-1} + \rho_X^+ X_{t-1}^+ + \rho_X^- X_{t-1}^- + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{q-1} \beta_i \Delta X_{t-i} + \varepsilon_t \tag{9}$$

The asymmetry in the NARDL model indicates that the asymmetric responses to positive and negative shocks are captured by the positive $m_h^+$ and negative $m_h^-$ dynamic multipliers associated with unit changes in $X^+$ and $X^-$, as follows:

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial oil_t^+} \ \text{ and } \ m_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial oil_t^-} \quad \text{with h} = 0, 1, 2\ldots\ldots \tag{10}$$

where $\mathrm{h} \to \infty, m_h^+ \to \theta^+ \ and\ m_h^- \to \theta^-$ by construction.

Given the mixed results in the literature on the relationship between real estate and stock markets (wealth and/or credit effects), no assumptions on the nature of the long-run and short-run dynamics of such a relationship can be given a priori. Therefore, we explore in

**Table 1**
Descriptive statistics of QE-20 and REI returns.

| Variable | QE-20 | REI |
|---|---|---|
| Mean | 0.0006 | 0.0064 |
| Maximum | 0.2198 | 0.1138 |
| Minimum | −0.2960 | −0.2095 |
| Standard Deviation | 0.0707 | 0.0439 |
| Skewness | −0.7528 | −0.9191 |
| Kurtosis | 5.9978 | 6.6979 |
| Jarque-Bera | 81.119[a] | 122.929[a] |
| Ljung-Box (LB) Q(12) | 12.211 | 78.468[a] |
| Ljung-Box (LB) $Q^2$(12) | 81.909[a] | 64.513[a] |
| Random walk hypothesis | 0.6892 | 4.0657[a] |

Notes: QE-20 denotes the Qatar index of the largest 20 shares while REI denotes the Real Estate Index published by QCB.

[a] Denotes significant at 1% level. Q(12) and $Q^2$(12) refers to the Ljung Box tests for level and squared returns.

two steps the dynamics between the real estate and stock markets using Enders and Siklos (2001) and the linear and NARDL methods: first, we assume that the real estate index is the dependent variable (testing for the wealth effect), and second, we assume that the stock index is the dependent variable (testing for the credit effect).

## 5. Empirical results

### 5.1. Descriptive statistics

In Table 1, we report the descriptive statistics of real estate and stock returns after first differencing the series. The average return was positive for both markets but higher for the real estate. This suggests that the average return from investing in properties in Qatar outperformed the returns from the investment in stocks. Furthermore, a higher standard deviation for stock returns than for real estate provides initial evidence of a higher risk in stocks than in real estate. This finding does not support the risk-return relationship and asset pricing, where the higher risk in investable assets is compensated for by higher returns. The real estate returns in monthly rates are less volatile and yet provided higher returns on average over the sample period. Table 1 also shows that both series exhibited negative skewness, while the test statistic of kurtosis exceeded its normal value, especially for the real estate returns. The Jarque-Bera test indicated that both series are not normally distributed. The LB statistic indicated that real estate returns were significantly correlated at 1% level for both the level and the squared returns. The squared series also shows a high dependence pattern for the long run, which suggests evidence of the ARCH effect in both series, especially for the stock returns.

To further investigate the properties of both series, we also conducted a random walk test. The test statistic shows that the null hypothesis – that the stock prices follow a random walk – was not rejected. This evidence is in line with the view in the literature that stock prices follow a random walk process and cannot be predicted. Thus, the investment strategies in the Qatar stock exchange based on past returns may not be a good indicator of the future performance of returns. At the same time, the null hypothesis that real estate prices move randomly is rejected. This suggests that property prices in Qatar can be fairly predicted. This evidence is supported by strong and positive serial correlation in the real estate returns as indicated by the Ljung-Box Q(12) test statistic.

### 5.2. Standard unit root and nonlinear unit root with a structural break

Table 2 reports the integration properties of the two variables for both level values and first differences to make sure that neither variable of I(2) are integrated. We report the results of unit root tests using the ADF, ADF-GLS, and PP tests, along with nonlinear unit root tests with a structural break, such as those of Lee and Strazicich, Perron, and Zivot-Andrews. The appropriate lag length for all tests is selected on the basis of the SIC, and the number of breakpoints selected is set to 1 for both intercept and trend. The empirical results from the unit root tests are shown in Table 2; they indicate that the time series under study are nonstationary in levels, but stationary when first differencing. This suggests that none of the variables of I(2) is integrated. In this case, the nonlinear cointegration model of Enders and Siklos (2001) and linear and nonlinear ARDL models can be used to capture the dynamics of the relationship between the two markets.

### 5.3. Results of Enders and Siklos (2001) nonlinear cointegration model

The results of the Enders and Siklos (2001) model, a widely used one to test the relationship, are reported in Table 3. In Panel A, we report the results of the credit effect (the dependent variable is QE-20) for both the TAR and M-TAR models, while Panel B reports the results of the wealth effect (dependent variable is REI). The critical values for the 5% level of significance are based on 10,000 simulations for Monte Carlo experimentation. As can be seen from Table (3) Panels A and B, the Φ statistics accepts the null hypothesis: H0: $\rho1 = \rho2 = 0$ of no cointegration between the two variables under TAR and M-TAR models. In addition, the F-statistic to test the null hypothesis of symmetric relationship: H0: $\rho1 = \rho2$ also can be accepted under both models. Although the t-max values were found to be significant at a 5% level, the findings show smaller statistics than their critical values for the F-joint and the F-stat for both models, which suggest absence of cointegration with unknown thresholds. Therefore, we could not establish the presence of wealth or credit effects between the two markets. The results are quite surprising since various studies such as Gounopoulos et al. (2019), Kapopoulos and Siokis

**Table 2**
Unit root: Standard tests and nonlinear unit root tests with a structural break.

| Standard unit root | QE-20 | | REI | |
|---|---|---|---|---|
| | Level | First difference | Level | First difference |
| ADF | −2.592 | −13.213* | −1.536 | −6.387* |
| ADF-GLS | −2.417 | −3.552* | −1.671 | −5.431* |
| PP | −2.988 | −13.213* | −0.923 | −11.250* |
| **Nonlinear unit root with a structural break** | | | | |
| | | Breakpoint | | Breakpoint |
| Lee-Strazicich | −4.285** | December 2013 | −3.081** | May 2014 |
| Perron | −3.599* | April 2013 | −3.973* | February 2014 |
| Zivot-Andrews | −3.189* | August 2014 | −2.841* | February 2016 |

Notes: *, ** stand for 1% and 5% level of significance, respectively. The breakpoint selected for each test was based on the intercept and trend in series.

**Table 3**
Results of Enders and Siklos (2001) model: Threshold (TAR) and Momentum (M-TAR).

| Panel A: Credit effect (Dependent variable: QE-20) | | | t-value | Panel B: Wealth effect (Dependent variable: REI) | | |
|---|---|---|---|---|---|---|
| Threshold model with $\tau$ endogenously determined | | | | Threshold model with $\tau$ endogenously determined | | |
| Variable | Coefficient | Standard error | | Coefficient | Standard error | t-value |
| Above $\tau$ | −0.1385 | 0.0481 | −2.879** | −0.0742 | 0.0549 | −1.352 |
| Below $\tau$ | −0.0543 | 0.0344 | −1.578 | −0.1781 | 0.0515 | −3.458* |
| $\rho1$ | 0.0197 | 0.0772 | 0.255 | 0.0582 | 0.0772 | 0.754 |
| $\rho2$ | 0.0452 | 0.0757 | 0.597 | 0.0488 | 0.0764 | 0.639 |
| Threshold $\tau$ | 0.362 | | | 0.104 | | |
| Lags determined by BIC | 2 | | | 2 | | |
| | | Critical values (5%) | | | Critical values (5%) | |
| t-max | −1.581 | −1.876 | | −1.351 | −1.879 | |
| F-joint ($\Phi$) | 5.372 | 7.021 | | 6.7274 | 7.015 | |
| $H_0: \rho1 = \rho2 = 0$ | | | | | | |
| F-statistic: $H_0: \rho1 = \rho2$ | 2.042 | 6.583 | | 1.981 | 6.429 | |
| Momentum model with $\tau$ endogenously determined | | | | Momentum model with $\tau$ endogenously determined | | |
| Above $\tau$ | −0.1367 | 0.0541 | −2.527** | −0.1725 | 0.0559 | −3.086* |
| Below $\tau$ | −0.0636 | 0.0325 | −1.957*** | −0.0936 | 0.0514 | −1.821*** |
| $\rho1$ | 0.0109 | 0.0767 | 0.1421 | 0.0316 | 0.0784 | 0.403 |
| $\rho2$ | 0.0334 | 0.0754 | 0.4430 | 0.0283 | 0.0762 | 0.372 |
| Threshold $\tau$ | 0.0716 | | | −0.002 | | |
| Lags determined by BIC | 2 | | | 2 | | |
| | | Critical values (5%) | | | Critical values (5%) | |
| t-max | −1.954 | −1.804 | | −1.823 | −1.810 | |
| F-joint($\Phi$) | 5.0153 | 8.100 | | 6.262 | 8.006 | |
| $H_0: \rho1 = \rho2 = 0$ | | | | | | |
| F-stats: $H_0: \rho1 = \rho2$ | 1.363 | 8.293 | | 1.109 | 8.021 | |

Notes: The $\Phi$ test examines the null hypothesis of no cointegration using the F-test. The coefficients $\rho1$ and $\rho2$ measure the speed of adjustment above or below the estimated threshold $\tau$. The hypothesis of symmetric adjustment is tested as: $\rho1 = \rho2$. Maximum optimal lag chosen is 8. *, ** and *** denote significance levels at 1%, 5% and 10%, respectively.

(2005), and Tsai et al. (2012) amongst others, found significant long-run relationship between the two markets using either the TAR or the M-TAR. To confirm our empirical results, we re-examined the relationship with threshold $\tau = 0$, as suggested in Enders and Siklos (2001). We also used the Monte Carlo experiment to provide the critical values for 5% level of significance. Like previous outcomes, these findings (not reported) do not establish a relationship between the two markets and any evidence to postulate the validity of either credit or wealth effects in Qatar.

### *5.4. Results of the linear ARDL model*

Since the nonlinear model of Enders and Siklos (2001) provided insignificant cointegration, and both variables are not I(2), we proceeded to estimate Equation (5) (symmetric ARDL) and applied the General-to-Specific approach (GETS) to arrive at the final

**Table 4**
Empirical results using the symmetric linear ARDL model.

| Panel A: Credit effect hypothesis | | Panel B: Wealth effect hypothesis | |
|---|---|---|---|
| Dependent variable: QE-20 | | Dependent variable: REI | |
| Variable | Coefficient | Variable | Coefficient |
| $Stock_{t-1}$ | −0.09 | $Real_{t-1}$ | −0.065 |
| $Real_{t-1}$ | 0.015 | $Stock_{t-1}$ | 0.143 |
| $\Delta Real_{t-5}$ | −0.53 | $\Delta Stock_{t-3}$ | 0.117 |
| ΔRealt-1 | 0.36 | ΔStockt-4 | 0.128 |
| Constant | 0.659 | Constant | −0.954 |
| Diagnostic tests | | | |
| $L_{Real}$ | −0.135 | $L_{Stock}$ | 2.207 |
| $\chi$2SC | 11.53 | $\chi^2_{SC}$ | 5.012 |
| $\chi$2NOR | 46.36* | $\chi^2_{NOR}$ | 5.80*** |
| $\chi$2HET | 29.53** | $\chi^2_{HET}$ | 46.03* |
| tBDM | −1.28 | $t_{BDM}$ | −6.64 |
| FPSS | 2.45 | $F_{PSS}$ | 28.67 |

Notes: We followed the general-to-specific (GETS) procedure to select the ARDL specification. $t_{BDM}$ is the BDM t-statistic, while $F_{PSS}$ denotes the PSS F-statistic testing the null hypothesis $\rho = \theta = 0$. The long-run coefficient Ly is defined by $\beta = -\theta/\rho$. Pesaran et al. (2001) tabulate the 5% critical values for k = 1 as follows: $t_{crit} = -3.22$; $F_{crit} = 5.73$. Empirical p-values are quoted for the BDM t-statistic and the PSS F-statistic.

specification with a maximum lag order of 8. Table 4 presents the bound F-statistics, $t_{BDM}$ and the model estimation results for testing both theories in panel A and panel B. Panel A tested the credit effect (the dependent variable was QE-20) while Panel B tested the wealth effect (dependent variable is REI). In Panel A, the bound F-statistic and $t_{BDM}$ test indicate that, in the long run, real estate prices do not co move with stock prices. Moreover, the F-statistic, 2.45, and $t_{BDM}$ test −1.28 do not exceed the critical upper bound, so we are unable to confirm the existence of the credit effect. However, the results were different when we tested the wealth effect in Panel B. The bound F-statistic and $t_{BDM}$ test indicated that, in the long run, real estate prices do co-move with stock prices and therefore, we were considering a long-run cointegration relationship. Moreover, the F-statistic, 28.67, and $t_{BDM}$ test −6.64 exceeded the critical upper bound. Therefore, we were in a position to accept the wealth effect hypothesis using this linear framework.

To confirm whether the estimated model in Panel B was adequately specified to accept the wealth effect theory, we obtained a number of diagnostic test statistics including the Jarque-Bera (J-B) for error normality, ARCH test for conditional heteroskedasticity and symmetry (see Table (4), bottom). The results show that the two models pass all the diagnostic tests with the exception of the normality test, suggesting error normality, so we were unable to accept the wealth effect to explain the real estate and stock market dynamics in Qatar using the linear ARDL framework, due to mis-specification issues.

### 5.5. *Results of the nonlinear ARDL model*

We re-estimated the relationship between the two variables using the NARDL model to overcome the linear mis-specification problem. It is worth stating that the NARDL model represents an improvement over the threshold cointegration framework developed by Enders and Siklos (2001), because the NARDL model accounts for short- and long-run asymmetries simultaneously, while the Enders and Siklos (2001) approach relaxes the hypothesis of linear cointegration in favor of nonlinear cointegration and accounts only for long-run asymmetry (Rezitis, 2019). Tables 5–7 report the bound F-statistic, $t_{BDM}$ test and present the results of the estimated models. We also applied the GETS procedure in estimating Equation (7), with maximum lag order set to 8. Because the literature put strong emphasis on differentiating between long- and short-term dynamics in cointegration models, we provide three specifications to explore the real estate and stock prices equilibrium in the NARDL model. The first model evaluated whether the relationship was symmetric in the short run and asymmetric in the long run for both theories (Table 5). The second one evaluated whether the relationship was asymmetric in the short run but symmetric in the long run (Table 6). Finally, in Table 7 we evaluated whether the relationship was asymmetric in both the short and the long run.

The results of the NARDL for the credit effect hypothesis are presented in Panel A of Tables (5)–(7). Subjected to the bound F-statistic and $t_{BDM}$ test from Panel A in Table (5), using short-run symmetric and long-run asymmetric specifications, the statistics of 2.34 and −1.28 for the F-statistic, and $t_{BDM}$ test respectively do not exceed the upper limits. We also obtained similar results (see Panel A, Table (6)) when using short-run asymmetry and long-run symmetry, with 3.85 for the F-statistic and −1.36 for the $t_{BDM}$ test. When we consider asymmetry in the short and the long run (see Table (7)), the results do not change and the variables show no sign of co-movement. The results, with no long-run cointegration relationship, forbid support for the credit effect theory. Similar diagnostic tests conducted on the model specifications in Panel A in Tables (5)–(7) support the rejection of the credit effect theory. These diagnostic tests confirm that the three models do not pass the normality test and hence the dynamics of the real estate and stock market prices are not normal as well as being mis-specified.

**Table 5**
Short-run symmetry, long-run asymmetry using the NARDL model.

| Panel A: Credit effect hypothesis | | Panel B: Wealth effect hypothesis | |
|---|---|---|---|
| Dependent variable: QE-20 | | Dependent variable: REI | |
| Variable | Coefficient | Variable | Coefficient |
| $Stock_{t-1}$ | −0.08 | $Real_{t-1}$ | −0.067 |
| $Real^{+}{}_{t-1}$ | −0.049 | $Stock^{+}{}_{t-1}$ | 0.178 |
| $Real^{-}{}_{t-1}$ | −0.058 | $Stock^{-}{}_{t-1}$ | 0.155 |
| $\Delta Stock_{t-2}$ | −0.07 | $\Delta Stock_{t-3}$ | 0.099 |
| $\Delta Real_{t-1}$ | 0.401 | $\Delta Stock_{t-4}$ | 0.138 |
| $\Delta Real_{t-5}$ | −0.48 | Constant | 0.427 |
| Constant | 0.57 | | |
| Diagnostic tests | | | |
| $L^{+}{}_{Real}$ | −0.67 | $L^{+}{}_{Stock}$ | 1.98 |
| $L^{-}{}_{Real}$ | −1.58 | $L^{-}{}_{Stock}$ | 1.84 |
| $\chi$2SC | 6.91 | $\chi$2SC | 5.51 |
| $\chi$2NOR | 27.56* | $\chi$2NOR | 5.04*** |
| $\chi$2HET | 65.61* | $\chi$2HET | 57.73* |
| tBDM | −1.28 | tBDM | −4.69 |
| FPSS | 2.34 | FPSS | 18.75 |
| $W_{LR}$ | 0.91 | $W_{LR}$ | 1.59 |

Notes: L + Real/Stock and L-Real/Stock denote the long-run coefficients associated with positive/negative changes of real estate and stock prices. $W_{LR}$ refers to the Wald test of long-run symmetry while $W_{SR}$ denotes the Wald test of short-run symmetry. Pesaran et al. (2001) tabulate the 5% critical values for k = 1 as follows: t*crit* = −3.22; F*crit* = 5.73. Empirical p-values are quoted for the BDM t-statistic and the PSS F-statistic.

**Table 6**
Short-run asymmetry, long-run symmetry using the NARDL model.

| Panel A: Credit effect hypothesis | | Panel B: Wealth effect hypothesis | |
|---|---|---|---|
| Dependent variable: QE-20 | | Dependent variable: REI | |
| $Stock_{t-1}$ | −0.071 | $Real_{t-1}$ | −0.068 |
| $Real_{t-1}$ | −0.023 | $Stock_{t-1}$ | 0.139 |
| $\Delta Real^{+}_{t-5}$ | −0.583 | $\Delta Stock^{+}_{t-1}$ | −0.163 |
| $\Delta Real^{+}_{t-8}$ | −0.585 | $\Delta Stock^{+}_{t-3}$ | 0.165 |
| $\Delta Real^{-}_{t-1}$ | 0.637 | $\Delta Stock^{-}_{t-1}$ | 0.169 |
| $\Delta Real^{-}_{t-3}$ | −0.586 | $\Delta Stock^{-}_{t-4}$ | 0.179 |
| $\Delta Real^{-}_{t-8}$ | 0.526 | Constant | −0.884 |
| Constant | 0.540 | | |
| Diagnostic tests | | | |
| $L_{Real}$ | −0.35 | $L_{Stock}$ | 2.07 |
| $\chi2$ SC | 8.85 | $\chi2$ SC | 6.43 |
| $\chi2$ NOR | 9.73* | $\chi2$ NOR | 1.964 |
| $\chi2$ HET | 78.89* | $\chi2$ HET | 52.91* |
| tBDM | −1.36 | tBDM | −7.39 |
| FPSS | 3.85 | FPSS | 25.87 |
| $W_{SR}$ | −3.95* | $W_{SR}$ | 6.49** |

Notes: L Real/Stock denotes the long-run coefficients associated with changes of real estate/stock prices. $W_{SR}$ denotes the Wald test of short-run symmetry. Pesaran et al. (2001) tabulate the 5% critical values for k = 1 as follows: $tcrit = -3.22$; $Fcrit = 5.73$. Empirical p-values are quoted for the BDM t-statistic and the PSS F-statistic.

**Table 7**
Short-run asymmetry, long-run asymmetry using the NARDL model.

| Panel A: Wealth effect hypothesis | | Panel B: Credit effect hypothesis | |
|---|---|---|---|
| Dependent variable: QE-20 | | Dependent variable: REI | |
| $Stock_{t-1}$ | −0.049 | $Real_{t-1}$ | −0.077 |
| $Real^{+}_{t-1}$ | −0.028 | $Stock^{+}_{t-1}$ | 0.143 |
| $Real^{-}_{t-1}$ | −0.039 | $Stock^{-}_{t-1}$ | 0.142 |
| $\Delta Real^{+}_{t-5}$ | −0.547 | $\Delta Stock^{+}_{t-1}$ | −0.164 |
| $\Delta Real^{+}_{t-8}$ | −0.543 | $\Delta Stock^{+}_{t-3}$ | 0.167 |
| $\Delta Real^{-}_{t-1}$ | 0.620 | $\Delta Stock^{-}_{t-1}$ | 0.153 |
| $\Delta Real^{-}_{t-3}$ | −0.578 | $\Delta Stock^{-}_{t-4}$ | 0.178 |
| $\Delta Real^{-}_{t-8}$ | 0.535 | Constant | 0.386 |
| Constant | 0.464 | | |
| Diagnostics tests | | | |
| $L^{+}_{Real}$ | −0.54 | $L^{+}_{Stock}$ | 1.97 |
| $L^{-}_{Real}$ | −0.76 | $L^{-}_{Stock}$ | 1.94 |
| $\chi2SC$ | 9.49 | $\chi2SC$ | 6.19 |
| $\chi2NOR$ | 9.18** | $\chi2NOR$ | 1.964 |
| $\chi2HET$ | 93.25* | $\chi2HET$ | 58.93* |
| tBDM | −1.18 | tBDM | −3.58 |
| FPSS | 2.67 | FPSS | 17.09 |
| $W_{LR}$ | 0.43 | $W_{LR}$ | 0.099 |
| $W_{SR}$ | −2.29** | $W_{SR}$ | 5.13** |

Notes: L + Real/Stock and L-Real/Stock denote the long-run coefficients associated with positive/negative changes of real estate/stock prices, respectively. $W_{LR}$ refers to the Wald test of long-run symmetry while $W_{SR}$ denotes the Wald test of short-run symmetry. Pesaran et al. (2001) tabulate the 5% critical values for k = 1 as follows: $tcrit = -3.22$; $Fcrit = 5.73$. Empirical p-values are quoted for the BDM t-statistic and the PSS F-statistic.

When we tested the wealth effect in Panel B in Tables (5)–(7), the results were considerably different. Panel B in these tables also reports the bound F-statistic and $t_{BDM}$ test for the results of the three model specifications. From the bound F-statistic and $t_{BDM}$ test, we found that real estate and stock prices did indeed co-move in the long run. The F-statistics 18.75, 25.87 and 17.09, and the $t_{BDM}$ test −4.69, −7.39, and −3.58 respectively exceeded the critical upper bounds of the three model specifications. Unlike the results reported in Panel A from Tables (5)–(7), the results initially point to the empirical evidence on the dynamic co-movement between the real estate and the stock prices. Before making any inferences on which model specification to choose, we also judged the adequacy of each model using the J-B, the LM statistic, and ARCH effects. The results indicated that the NARDL model passed all the diagnostic tests when the relationship was asymmetric in the short run and symmetric in the long run (Panel B, Table 6), suggesting normality, an absence of autocorrelation, and ARCH effects. Hence, we find a long-run cointegration relationship to support the wealth effect theory since the dynamic specification in Table (6) is adequately specified. The results of the Wald test, however, do not invalidate the null hypothesis of long-run symmetry in real estate prices in relation to stock prices. The co-integrating coefficient from Table 6 is 2.07, which is significant at the 5% level. It can be seen, therefore, that when stock prices increase, real estate prices tend to increase and investors can benefit from rebalancing their portfolio to buy real estate assets.

The conclusion from our investigation shows that in describing the dynamics of real estate and stock markets in Qatar, the wealth effect is evident using the NARDL, which is of great importance for investors concerned about their investment strategies and for policymakers concerned about policy reforms. The results imply that, in the long run, positive changes in Qatar stock exchange have long-run positive impacts on the real estate sector. The results can imply to investors that their long-term investment strategies in both markets could affect their portfolio's performance. In the short run, however, negative changes in the Qatar stock exchange have greater impact on real estate prices. This could be explained by the negative sentiments of investors about the downswings of Qatari stocks due to political tensions in the Gulf region, oil price fluctuations in the last five years, and the FIFA probes about the legitimacy of Qatar to host the World Cup (see for instance Al Refai and Abdelaziz Eissa, 2017; Charfeddine & Al Refai, 2019). The tense periods referred to above put the real estate plans in Qatar at risk, causing, in the short run, to react immediately to the asymmetric negative news from the stock market, in a way that disrupts their usual behavior and hedging policy (see Al Refai & Hassan, 2018). In addition, investors will benefit from the confirmed long-run relationship between the two markets in making their long-run investment decisions and rebalancing their asset portfolios. Moreover, these results could be very helpful to the policy makers who are seeking to promote the real estate sector in both the long and the short run, and could attract regional and international investors.

It's important to note that the advancement and development of econometric techniques, especially that of the NARDL by Shin et al. (2014), give more powerful methods of uncovering the true relationship dynamics than do the linear ARDL and the nonlinear model of Enders and Siklos (2001) model. In general, the results support recent studies on the wealth effect theory, such as Kiohos et al. (2017), Gounopoulos et al. (2019) and Zhou et al. (2016) amongst others, for developed and emerging markets, especially using the newly developed nonlinear techniques. The results also support the work of Katrakilidis and Trachanas (2012), Kiohos et al. (2017), Bahmani-Oskooee and Ghodsi (2018) and Gounopoulos et al. (2019), amongst others, on the validity of accounting for both short- and long-run performance between the two markets to disclose their true dynamics over time.

### 5.6. *Speed of adjustment to the long-run equilibrium*

In view of the results of the NARDL model, we proceeded to set up the adjustment to equilibrium. Figure (2) shows the cumulative dynamic multipliers acquired from Equation (10), indicating the pattern of change of real estate prices to a new long-run equilibrium following a positive or negative shock in stock prices. The real estate adjustment to positive and negative shocks of stock prices will be described by continuous black and dashed black lines respectively. Whereas, the broken red, which represents the asymmetry line, reflects the difference between the positive and negative reaction of multipliers to shocks in stock prices. The 95% confidence intervals are shown by the red dotted line. If the zero-line falls between the upper and lower bands, the asymmetric effect will not be significant at 5% level of significance.

This analysis shows the dynamic multipliers for real estate prices (see Figure (2)) under each of four combinations of long- and short-run asymmetry (a, b, c and d). Interestingly, Figure 2c shows that in the short run a symmetry restriction changes the shape of the dynamic multipliers, leading to severe overshooting except were set up beforehand. The diagnostic tests show that invalid short-run restrictions produce a grave misspecification in the model, from which we may infer that we ought to properly account for inherent nonlinearities in the short run. If we do not, we risk missing a short-run relationship and estimating a model's dynamics wrongly. With regard to real estate prices, the results of both long-run asymmetric models (Fig. 2c and d) are notably close to one another. This implies that, in the very short run (four weeks), cyclical downturns have a swift and marked effect on real estate prices, that it takes a relatively

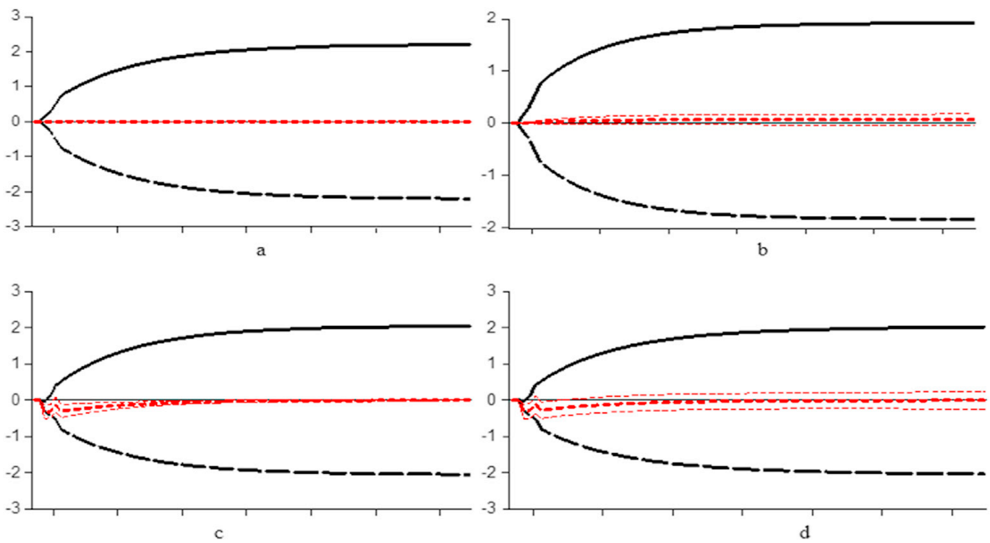


**Fig. 2.** The cumulative dynamic multipliers of positive and negative shocks in stock prices on real estate.

long time to adjust altogether to a new equilibrium, and that within 15 months a boom phase is gradually adjusted to.

### 5.7. Economic determinants of real estate market in Qatar

The previous analysis shows that the wealth effect plays a significant role in driving real estate prices. Economic activity could also have an effect on wealth and drive real estate market dynamics in Qatar, since a large proportion of real estate price movements is related to business cycles (see Bouchouicha & Ftiti, 2012; Leung, 2004). We therefore investigate the effect of the money supply (M2), bank credit, the private sector, currency reserves, and the inflation rate on the real estate market.[8] In addition, since Qatar is energy-dependent, oil prices are linked to the level of economic activity, income and employment growth, and future prospects for Qatar's economic outlook, which therefore drives the sentiments of investors on the prospects of stock market performance (see Al Refai, Zeitun, & Abdelaziz Eissa, 2021). Moreover, the accumulation of foreign currency serves to cushion the economy of Qatar against external shocks as well as being a source of government support to credit expansion for investment in the infrastructure and real estate. In view of this, we include oil prices and foreign currency reserves as factors in our investigation. We consider the following NARDL specification[9]:

$$\Delta y_t = \mu + \rho_y y_{t-1} + \rho_X^+ X_{t-1}^+ + \rho_X^- X_{t-1}^- + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{q-1} \beta_i \Delta X_{t-i} + \varepsilon_t \tag{11}$$

where $x_t$ indicates the explanatory variables, while $y_t$ refers to the real estate price index (REI). $\Delta$ is the difference operator and $\varepsilon$ is an error term. We also include the stock price index (QSE-20) along with the economic variables, since the wealth effect was found to be evident in explaining the dynamics of the real estate prices. Table 8 reports the results of Equation (11), with the use of the GETS procedure and a lag order of 8 to arrive at the model's final specification. From the bound F-statistics, we find that these variables dynamically co-move with the real estate prices in the long run. The adequacy of the model specifications judged by J-B, LM statistics, and ARCH effects (see Table 8, bottom) show that the nonlinear ARDL model passes all the diagnostic tests, suggesting normality and an absence of autocorrelation and ARCH effects. The empirical results therefore imply that the co-movements of macroeconomic variables are adequately specified by the NARDL model. Therefore, we are thus in a position to assess their relation to the changes in Qatar's real estate market.

The results in Table 8 show a significant long-run relationship between real estate prices and money supply, bank credit, oil prices, and currency reserves, in the downturn periods, while the inflation rate has an impact on real estate prices in the upturn periods. It may conceivably be the case that in oil-exporting countries, such as Qatar, declining oil prices reduce investments and jobs, which reduces the demand for real estate properties (see Kilian & Zhou, 2018; Nazlioglu et al., 2016). Moreover, the contraction of the money supply and bank credit significantly affects real estate prices in Qatar. According to Adams and Fuss (2010), and Xu and Chen (2012), a restrictive monetary policy means lower reserves and deposits for lending financial institutions, and lower ability to make loans, thereby lessening the demand for properties and leading to lower real estate prices.

The results also show that real estate prices increases when inflation increases. This means that higher inflation will raise the prices of construction materials, and real estate developers will spend more when building new properties, and this will lead to an increase in the prices of newly-built properties (see for instance Lee & Lee, 2014). Our results on the foreign currency reserves are interesting, since Qatar is energy-dependent and relies on foreign currency accumulation to shield its economy from external shocks. According to Franklin and Carletti (2013), foreign currency accumulation may affect real estate prices in the presence of abundant liquidity for domestic investments. The findings derived from this study show that the economic fundamentals of Qatar have nonlinear and long-run relationship with real estate prices. Such results provide more implications for policymakers and investors in managing their portfolio and asset allocations in Qatar and possibly the economies of the GCC region. Investors in Qatar should consider broad macroeconomic conditions when investing in the real estate market. Moreover, policymakers should carefully monitor fundamental changes in the overall economy of Qatar, given their impact on the real estate market in the downturn periods.

## 6. Conclusion and implications

This study investigates the dynamic linkages between real estate and stock markets in Qatar using the nonlinear model of Enders and Siklos (2001) and the linear and nonlinear ARDL models of cointegration. The results show that the nonlinear model of Enders and Siklos (2001) does not provide evidence to support either the wealth or the credit effect theory. The linear ARDL explains the relationship and supports the wealth effect but diagnostic tests reveal that the model is mis-specified. The results from the NARDL model provide evidence to support the wealth effect, which better describes the relationship as asymmetric in the short run and symmetric in

[8] These variables are the only ones available on a monthly basis on DataStream. We are aware that other variables may affect the real estate market, such as GDP, employment, interest rates, and the construction index but these variables are either unavailable on a monthly basis or unsuitable for analysis, such as static interest rates.

[9] Our results from the symmetric ARDL model show that oil prices, M2 and the bank credit have a long-run relationship with the real estate prices, while currency reserves and inflation rate do not show signs of co-movements with real estate prices. The diagnostics using test statistics such as Jarque-Bera for error normality, LM or autocorrelation, and ARCH for heteroskedasticity show that the linear ARDL model does not pass these tests. Results are available upon request.

**Table 8**
Results of the asymmetric impact of macroeconomic determinants on real estate market in Qatar.

| Oil prices | | Money supply (M2) | | Bank credit | | Inflation | | QSE-20 | | Currency reserves | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $OIL^{+}_{t-1}$ | −0.03 | $M2^{+}_{t-1}$ | 0.103 | $CREDIT^{+}_{t-1}$ | −0.03 | $INF^{+}_{t-1}$ | 0.341 | $QSE^{+}_{t-1}$ | 0.24* | $RES^{+}$ | −0.013 |
| $OIL^{-}_{t-1}$ | −0.07* | $M2^{-}_{t-1}$ | 0.324** | $CREDIT^{-}_{t-1}$ | −0.52*** | $INF^{-}_{t-1}$ | 0.931 | $QSE^{-}_{t-1}$ | 0.25* | $RES^{-}_{t-1}$ | −0.03** |
| $\Delta OIL^{-}$ | 0.011 | $\Delta M2^{+}$ | −0.28** | $\Delta CREDIT^{-}$ | 0.35 | | | $\Delta QSE^{+}$ | 0.001 | $\Delta RES^{+}$ | 0.02 |
| $\Delta OIL^{-}_{t-1}$ | 0.01 | $\Delta M2^{-}$ | 0.69* | $\Delta CREDIT^{-}_{t-1}$ | 1.04* | | | $\Delta QSE^{+}_{t-1}$ | −0.21* | $\Delta RES^{+}_{t-1}$ | 0.03 |
| $\Delta OIL^{-}_{t-2}$ | 0.07** | | | | | | | $\Delta QSE^{+}_{t-2}$ | −0.16** | $\Delta RES^{+}_{t-2}$ | −0.002 |
| | | | | | | | | $\Delta QSE^{-}$ | −0.05 | $\Delta RES^{+}_{t-3}$ | 0.09** |
| | | | | | | | | | | $\Delta RES^{-}$ | 0.03 |
| $L^{+}_{OIL}$ | −0.16 | $L^{+}_{M2}$ | 0.58 | $L^{+}_{CREDIT}$ | 0.21 | $L^{+}_{INF}$ | 0.99*** | $L^{+}_{QSE}$ | 1.38* | $L^{+}_{RES}$ | 0.07** |
| $L^{-}_{OIL}$ | 0.42* | $L^{-}_{M2}$ | 1.85* | $L^{-}_{CREDIT}$ | 2.9** | $L^{-}_{INF}$ | 0.19 | $L^{-}_{QSE}$ | 1.46* | $L^{-}_{RES}$ | −0.02 |
| Diagnostics tests | | | | | | | | | | | |
| $\chi^{2}_{SC}$ | 2.87 | | | | | | | | | | |
| $\chi^{2}_{NOR}$ | 1.36 | | | | | | | | | | |
| $\chi^{2}_{HET}$ | 48.26* | | | | | | | | | | |

Note: $L^{+}$ and $L^{-}$ denote long-run coefficients associated with positive and negative changes of Oil prices, Money supply, Bank credit, Inflation, Currency reserves, and QSE20. Pesaran et al. (2001) tabulate the 5% critical values for k = 1 as follows: F*crit* = 5.73. Empirical p-values are quoted for the PSS F-statistic.

the long run. The results from the multifactor model show a significant long-run relationship between the real estate market and the money supply, bank credit, oil prices, and currency reserves in downturn periods, while the inflation rate has a significant long-run relationship with the real estate market in the upturn. Our results also show that the NARDL passes rigorous robustness tests, unlike the linear ARDL model for According to the dynamic multiplier's effects, in the short run, the real estate prices react rapidly to stock prices cyclical downturns. However, reaching a new equilibrium is a relatively prolonged process. Overall, our results from using the NARDL approach indicate that greater care is required in the modeling of time series data. Linear models are unsatisfactory because they may lead first to mis-specification about the true nature of economic relationships, and in turn to misleading policy recommendations.

The results may be useful for investors and policymakers. First, demonstrating the direction of the relationship could aid investors and policymakers in Qatar to predict future performance and the driving force between the two markets. Second, the dynamics of the two markets show long-run symmetric co-movement, which, in terms of risk reduction, shows that both assets may be added in the same portfolio. The evident wealth effect should signal to investors that booming stock market periods could provide investment opportunities in the real estate sector for future capital gains. Therefore, investors who include properties in their portfolios could in the long term cash in future capital gains. However, such an investment strategy in the short run should be discouraging to investors. Since Qatar is a unique and interesting case, further investigation on the interactions between the two markets using switching approaches is needed for understanding their feedback effects during high and low volatility regimes, and spillovers. Furthermore, some studies suggest that real estate investments in a small-land state may be questionable; we leave such speculations to future research.

To revive both markets, the Qatari government recently announced stimulus and monetary measures due to the repercussions of COVID-19 along with support and incentive programs amounted to QR75 billion to the private sector, including the real estate sector, should go a long way in shoring up business, consumer's and investors' sentiments. Near-term, the QR10 billion stock purchase program which corresponding to 44 days' turnover of the QSE index's constituents based on their 2019 traded values creates an important safety net for the Qatari stocks in 2020. As a direct result of these measures, the QSE achieved total gains of QR11.39 billion in the following two sessions, with an increase in market value to QR478.03 billion, compared to QR466.4 billion before. It is expected that if the global economic recovery is slower than expected, the Qatari government should continue to initiate other exemptions and stimulus measures to boost both markets.

In a political breakthrough, Saudi Arabia has agreed to lift its land, sea, and airspace blockade on Qatar on the eve of the Gulf summit on January 5, 2021, in a major step towards ending the political tension with Qatar. With the 2022 World Cup just two years away, the possibility of resuming the political relationships and lifting of the blockade could propel the performance of both markets in the long run, along with the medical breakthrough of vaccines to end the global pandemic by the summer of 2021 for many countries. This will revive the global economy and increase the global demand for hydrocarbons, which will sustain the fiscal budget of Qatar and increase its economic output. The strategic objectives of QNV-2030 are to improve Qatar's ranking as a business competitor and make it an innovation-based economy. Future economic and monetary measures for stimulating the financial and real estate markets are needed until the world defeat COVID-19 and gradually recover from the global pandemic.

## CRediT authorship contribution statement

**Hisham Al Refai:** Conceptualization, Methodology, Software, Data curation, Validation, Visualization, Writing – original draft. **Mohamad Abdelaziz Eissa:** Conceptualization, Methodology, Software, Data curation, Writing – review & editing. **Rami Zeitun:** Visualization, Writing – review & editing.

## Declaration of competing interest

All authors have no conflict of interest when writing this paper.


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