

The Relationship between Exchange Rates and GCC Equity Markets: Exploring Directional Linkages Across Market Regimes

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Abstract

This study aims to investigate the direct predictive element of exchange-rate dynamics in the six Gulf Cooperation Council (GCC) economies with equity returns, and its role in changing through three market periods (2017–2020, 2021–2022 and 2023–2024). Empirical analysis uses the Dumitrescu and Hurlin (2012) two-way heterogeneous panel Granger non-causality test. Separate pairwise tests for other macro-economic and financial variables such as the price of Brent oil, gold, short-term interest rates, GDP per capita and inflation are performed as a broader macro-financial benchmark for the results of the equity-markets. Evidence is highly time dependent. Exchange-rate changes are not predictive of GCC equity returns and equity returns are not predictive of exchange-rate changes in 2017–2020, but Brent oil is predictive of equities. The exchange-rate statistic is not estimable for the output provided in 2021–2022, while strong bidirectional predictive relationships emerge between equities and Brent oil and gold and equities predict interest-rate changes. Bidirectional panel-level predictive precedence is found in 2023–2024, with changes in exchange rates predicting changes in equity returns and the other way round. Such conclusions do not justify the interpretation of a permanently flow-oriented or a permanently portfolio-balance one. However, they demonstrate that the direction of the exchange rate-equity linkages in the GCC depends on the time period and the institutional factors that limit the scope of currency adjustment.

Keywords: Exchange rates; GCC equity markets; Granger causality; Dumitrescu–Hurlin; dollar peg; stock returns; market regimes

1. Introduction

The relationship between exchange rates and stock prices is a perennial issue in international finance as it bridges the fields of currency valuation, competition of firms, international portfolios and financial market information processing. Competing predictions are given by theoretical models. The flow-driven theory of Dornbusch and Fischer (1980) puts the exchange rate upstream of the valuation of equity: a change in the exchange rate will affect international competitiveness, trade flows, expected cash flows and hence stock prices. The stock-oriented or portfolio-balance tradition, on the other hand, focuses on the importance of financial wealth and the allocation of capital, and lets the stock-market move first, rather than the exchange-rate, with the latter following the former as the result of a change in the demand for a portfolio. Empirical evidence has both confirmed and negated bidirectional feedback as well as a lack of relationship, and the relationship is a mutually dependent one, given the influence of market structure, sample period, frequency and econometric design and that has recorded in the existing literature. In an absence of a long run cointegrating relationship, Bahmani-Oskooee and Sohrabian (1992) reported bidirectional causality of short run between US stock prices and the effective exchange rate. Granger, Huang, and Yang (2000) have discovered significant differences in the causal structures in Asian markets and around Asian financial crisis. Both the direction and sign have been found to differ among Pacific Basin economies by Phylaktis and Ravazzolo (2005), and Bahmani-Oskooee and Saha (2015) found from their comprehensive study that both direction and sign are not universal. The more recent evidence is more mixed. In G7 economies, Nusair and Olson (2022) identify some support for the theoretical cases of both channels in the short run, with more support for the longer-run case of the portfolio-balance channel in several countries. This ongoing debate indicates that the focus should not be on which theory is correct in general, but on which institutional and market circumstances might be empirically observable in which the various directional mechanisms operate.

The GCC offers a very enlightening context for this question. Bahrain, Oman, Qatar, Saudi Arabia and the UAE peg their currencies tightly to the US dollar while Kuwait bills the dinar to an undisclosed currency basket. The exchange-rate commitment contributes to monetary and financial stability, while limiting bilateral currency adjustment vis-à-vis the U.S. dollar. Meanwhile, the equity markets in the GCC region are vulnerable to global capital inflows, oil shocks, external dollar values and world monetary conditions. Thus, common exposures are high and meaningful cross-country heterogeneity is present. Such an arrangement would lead to wrongly assuming that any country has the same causal effect; inducing the use of a heterogeneous panel approach. The first is not institutional background info alone, the peg. It modifies the economic understanding of the 2 predominant theoretical channels. In the flow-oriented interpretation, depreciation can benefit the competitiveness of the exporters and increase expected earnings while appreciation can have the reverse effect. Adjustment through a bilateral rate against the anchor currency is squeezed when the bilateral rate against the anchor currency is administratively stabilized. The portfolio-balance view says changes in equity wealth can impact on the capital flows and demand for currency. A credible peg means that pressure which otherwise creates a potential shift in the exchange rate can be absorbed through reserves operations, liquidity management measures or monetary adjustment.

Thus, the strength of both directions may vary from what has been found in the floating-rate economies.

Moreover, the GCC region is quite unique among many traditional emerging-market samples as oil plays a core macro-financial role. Fiscally, there are direct impacts on revenues and capacities, and on liquidity and corporate profitability, as well as indirect impacts on external balances and investor expectations. Arouri and Rault (2010) find causal relationship for oil regarding both the stock prices of the GCC countries, and Arouri, Lahiani, and Nguyen (2011) and Awartani and Maghyreh (2013) find significant return and volatility transmission. The most recent studies still find strong linkage between energy and the GCC financial markets. Oil is therefore a relevant benchmark to evaluate the ability of the panel causality framework to capture established predictive links in a set of periods on the economic side. Justice is paired with other macro-financial indicators: gold, interest rates, GDP per capita, and inflation. The varying behaviours of gold under stress and under normal market conditions may be explained by the hedge and safe-haven distinction proposed by Baur and Lucey (2010). In a pegged system, the interest rate is especially significant, as monetary authorities will have to take the stance of the anchor country into account when keeping the peg in place. Discount rates, profitability, and aggregate demand are some of the channels through which inflation and output conditions can impact an equity's value, but these variables are less frequently published and must be carefully time-aligned when paired with more frequently published financial variables.

Another stimulus is a methodological one. Various studies regarding correlation, cointegration, ARDL, VAR, volatility, connectedness and causality are found in the exchange-rate – stock literature. All of these approaches to answer different inquiries. The measures of correlation and cointegration focus on association, second-moment transmission with volatility models, system-wide spillovers with connectedness, and Granger causality on whether past observations of one series help in predicting another, given its past behavior. The present paper deals only with directional predictive precedence. It thus refrains from characterizing co-movement and volatility spillover between the variables at the current moment as causes. The empirical framework adopted is the heterogeneous panel Granger non-causality test as suggested by Dumitrescu and Hurlin (2012). The procedure is valid because it permits autoregressive and causal coefficients to be different for each panel member. At the null the predictor does not Granger-cause the outcome for any cross-sectional unit while for the heterogeneous alternative, at least for a subset of cross-sectional units' causality holds. This is a relevant characteristic in the region of the Gulf Cooperation Council (GCC) where exchange-rate flexibility, market size and level of international involvement vary. Rejections, on the other hand, must therefore be thought of as evidence of the panel for some of them, but not as evidence for the similarity of all six markets.

The analysis is conducted separately for 2017–2020, 2021–2022, and 2023–2024. These are pre-specified comparison windows rather than latent regimes estimated by a Markov-switching model. The purpose is to determine whether the direction detected by the same general causality framework is stable across materially different market environments. Because statistical significance in one subsample and insignificance in another do not constitute a formal equality test, cross-period differences are interpreted descriptively and cautiously. This study contributes in four respects.

First, it places the exchange-rate–equity nexus inside the institutional constraints of the GCC monetary system rather than importing predictions from floating-rate economies without qualification. Second, it evaluates both predictive directions across all six GCC markets using a heterogeneous panel design. Third, it centers temporal instability by estimating the relationships separately across three periods. Fourth, it benchmarks the exchange-rate findings against oil, gold, interest rates, GDP per capita, and inflation through the same pairwise causality logic, allowing the exchange-rate results to be interpreted within the broader regional information environment.

The reported evidence is distinctive. Exchange-rate changes and GCC equity returns show no significant predictive direction in 2017–2020. In 2021–2022, the supplied exchange-rate causality statistic is not estimable, while oil and gold exhibit strong bidirectional predictive relationships with equities and equities predict interest-rate changes. In 2023–2024, exchange-rate changes predict equities and equities predict exchange-rate changes. Thus, the central result is not the permanent dominance of one theoretical mechanism. It is the emergence of different directional configurations across periods. The remainder of the paper is structured as follows. Section 2 synthesizes the theoretical and empirical literature, with particular attention to directional evidence, emerging markets, GCC institutions, and crisis dependence. Section 3 develops the theoretical framework and hypotheses. Section 4 explains the variables, periodization, preliminary procedures, and Dumitrescu–Hurlin model. Section 5 reports the empirical results. Section 6 discusses the findings against the theoretical predictions and recent literature. Section 7 concludes with implications, limitations, and future research priorities.

2. Literature Review

The literature on exchange rates and stock prices has grown steadily but the conclusions of these studies cannot be captured in a simple one-directional statement. It is useful to perform synthesis based on separation according to theoretical direction and empirical method. Many of the early studies had as their emphasis contemporaneous association. A positive relationship between the US dollar and stock prices was reported by Aggarwal (1981) with different signs and significance patterns coming afterward. These deviations therefore led to an attempt to investigate the characteristics of stationarity, cointegration, dynamic adjustment and causality instead of mere correlations. An influential early dynamic analysis by Bahmani-Oskooee and Sohrabian (1992) was provided and they used U.S. data, and determined that there was short term (bi-directional) Granger causality while there was no long term (cointegrated) relationship. Their finding established yet another important principle: that, with predictive precedence, no stable long-run relationship is necessary. Such distinction continues to have relevance's for studies with short information transmission horizons than for equilibrium adjustments.

Further evidence of the existence of heterogeneity was presented in Asian markets. Abdalla and Murinde (1997) studied the effects for the Philippines, Korea, Pakistan and India and found that the results are relatively consistent to the effect that the exchange rates take the lead over the stock prices. In examining nine Asian markets during the Asian financial crisis, Granger et al. (2000) recorded feedback relationships in some markets and exchanges-to-stocks relationships in others

and stocks-to-exchanges in yet others. This crisis has changed the observed setting where it appears that the directionality may have been viewed not correctly during the full sample. Nieh and Lee, (2001) examined the G7 nations and observed that the relationship was generally of a short-term nature and the long run relationship was not found to be significant. Phylaktis and Ravazzolo (2005) analyzed markets in the Pacific Basin and focused on financial integration and crisis situations. As a group, these studies give less credibility to the possibility of any single direction being predominant in different countries and/or different periods.

The concept of flow-oriented direction is economic intuitive for open economies. A loss in the value of the domestic currency can boost the value of foreign revenues in domestic currency and enhance domestic price competitiveness of export products, thus leading to higher equity prices. The opposite can be true of import-intensive companies, which are more likely to be adversely affected by import costs. The Stockholm Index is thus a weighted sum of stock index reactions which in turn are determined by industrial composition and exposure to international trade. The principle of operation of the mechanism can be made somewhat more complicated in commodity exporting countries when the main export is denominated in US dollars and the domestic currency is also pegged to the dollar. The portfolio-balance direction gives the counteracting direction. Inflating stock prices boosts financial wealth and may draw PFI leading to a rising demand for the local currency. Equity markets bear outflows and pressure of depreciation if equity prices decline. The channel is particularly convincing in markets that are integrated into the financial system, and where exchange rates have been flexible. Having this in mind, Salisu and Ndako (2018) return to the issue of the stock-price–exchange-rate nexus in OECD countries, suggesting evidence for the validity of methodology and heterogeneity. Nusair and Olson (2022) uncover Granger causality from stock prices to exchange rates for six G7 economies and report nonlinear long-run support is stronger for the portfolio-balance approach than for the flow-oriented approach.

A related literature introduces explicitly the interdependent flows in portfolios. Stock price, exchange rate and portfolio equity flow studies indicate that it is more than just a bivariate link. The empirical studies expands appending the heterogeneous panel causality tests to the trivariate setting and adding panel evidence that stock prices and portfolio flows can be the leads while also exposing the explicit portfolio-balance transmission may not hold on a country-specific basis. This matters in the case of the GCC as capital-flow pressure under a peg may be so good, no one can object and only partially materializes in the bilateral exchange rate. The agreement is complicated by nonlinearity, too. Appreciation and depreciation of the exchange rate may not have symmetric impacts on firm profits, as do increases and decreases in the size of the stock market on portfolio responses. As demonstrated by Nusair and Olson (2022), nonlinear specifications can pick up long run effects that are not apparent with linear models. Consistent with other studies employing nonlinear causality and NARDL methods, it is found that the stock-market effects of positive and negative currency and oil shocks do not have to be symmetrical. It is important to note that the current paper does not estimate nonlinear causality; therefore, the results of a lack of causality should be interpreted as being based on linear conditional-mean predictability.

The crisis dependency has increasingly surfaced. Financial crises affect volatility, liquidity, capital flows, and the rate at which the information flows. Early evidence that causality between the

exchange-rate and the stock was modified in the Asian crisis setting is provided by Granger et al. (2000). Studies in the wake of the global financial crisis also evidence the importance of structural change and asymmetry. In the context of Covid-19, the exchange rate, equities, commodities and policy rates faced simultaneous shocks, and it is especially hazardous to interpolate 'normal' period relationships to stress periods. Recent panel studies still rely on Dumitrescu – Hurlin causality, as this one allows for coefficient differences among the countries. Newer macro-financial uses highlight the joint importance of panel causality and stationarity conditions and the presence of cross-sectional dependence. One recent paper in *Empirical Economics* (2024) emphasizes the need to consider the cross-sectional dependence and to apply a bootstrap method instead of an asymptotic one. That is particularly important for the GCC due to cross-sectional dependence arising from common oil element, common dollar anchor, common global monetary shocks, and the cross-border financial integration in the region.

The volume of the givago for the GCC countries is less than the literature for the entire globe but does not imply that it is absent. Al-Daham (2017) in particular investigates the exchange rate and stock prices of each of six countries in the region of the Gulf Cooperation Council (GCC). The reported evidence on the Granger monotonic property holds both the exchange-rate-to-stock causality across GCC markets for some cases as well as the reverse or bidirectional causality for some countries. The results of this study are especially relevant because they demonstrate that there is influence on the exchange rate definition on the inference for pegged economies. The evidence from the oil market is provided by oil-market research. Arouri and Rault (2010) reveal causal linkages among oil prices and the stock markets of the Gulf countries. Arouri et al. (2011) report on return and volatility transmission between world oil prices and the GCC stock markets based on VAR-GARCH. Awartani and Maghyereh (2013) discover dynamic spillovers which fluctuate with the passage of time. More recent evidence in the GCC and ASEAN-GCC countries indicates that transmission of volatility across financial instruments is still significantly high. It does not take much to now conclude that oil is an economic benchmark of the region as these studies show, nor the opposite fact that volatility spillover is not the same as Granger causality for the return of oil.

The role for gold is unique. Baur and Lucey (2010) make a distinction between “hedge” and “safe haven”; a hedge is an asset that on average is uncorrelated or negatively correlated with the other asset, whilst a safe haven” is an asset that accomplishes this during market stress. Later on, crisis studies reveal that relationship between gold and equity is state dependent. So, the conclusion that gold is unimportant during one period, and tightly correlated to equities during another shouldn't be considered a contradiction. It could potentially be a commentary on investor demand in stress. There is a strong link between interest rates and the GCC exchange-rate regime. A credible peg reduces the autonomy of monetary policy and a wide and sustained interest-rate spread imposed on top of the anchor currency may create pressure on capital flows. Thus, central banks of the GCC states react decisively to US monetary conditions, with caveat that GDP-level liquidity and nation-specific factors would play a role in the specific transmission path. This institutional setting suggests that in a domestic short-term interest rate may not provide as much ex-ante information about equities as in a floating-rate economy with an independent central bank.

A macroeconomic variable that is slower moving than inflation and gdp per capita. The possible ways in which inflation can affect equity prices include via real discount rates, input prices, consumers' demand, and monetary expectations. GDP/CAPITA depicts the general economy and will move at a significantly slower pace than financial returns. Hence, their inclusion in pairwise causality tests needs to be read with caution, especially if observations at higher frequencies are generated as a result of temporal alignment. The statistical significance or insignificance can be dependent on the way the lower-frequency data is mapped into the panel. A clear separation of the bilateral and effective exchange rates is also needed in the literature. For a hard dollar peg, the domestic-currency price of the US dollar may display extremely little variation. Nevertheless, the domestic currency may experience significant movements relative to the euro, yen, pound or to a trade-weighted basket if the dollar is moving. Real effective exchange rates can also appreciate or depreciate via relative prices. Therefore, the claim that the pegged currency “does not move” applies only to the parity observed on the bilateral exchange rate and cannot be extended to other economic exchange-rate indicators.

The difference of this distinction lies with the theoretical interpretation. The flow-oriented mechanism is not prevented from functioning by the fixing of the bilateral parity for the dollar, especially for non-oil exporters and firms which have high import propensities but do business with economies that do not rely on the dollar. The portfolio-balance mechanism may also affect liquidity, reserves and the prices of assets without a bilateral depreciation. A pegged regime will have the effect of blunting some adjustment channels, but not all routes for currency conditions and equity valuations to interact are severed. Thus, there is an interest in using a heterogeneous panel. A pooled homogeneous causality test might hide the relationship if it is concentrated in Kuwait and/or in the markets of the Gulf Co-operation Council Countries (GCC) where the effective-rates are more dispersed. Dumitrescu and Hurlin (2012) specifically take into account different causal coefficients across units and the alternative for only some units. While a methodological plus, this also means that the causality observed in a panel cannot be claimed as proof of the causality of all the GCC countries.

From the literature, five conclusions were found that inform the current design. The first is that theory does not rule out exchange-rate-to-equity transmission, nor of equity to exchange rate. Second, there is empirical variation from country to country, from time to time and between methods. Third, predictive relationships may change in a crisis situation. Fourth, the time series properties of the adjustment mechanism differ in the GCC with a pegged monetary structure in terms of floating-rate samples. Fifth, the use of the exchange-rate measure and of addressing the issue of cross-sectional dependence are important methodological decisions. Thus, the focus research gap is small. Research has been done on the exchange rates, on the GCC stocks and larger panel research has been done using the Granger-type approach. The issue remains if a common heterogeneous panel framework proposed for the six equity markets of the GCC region captures the stable or changed predictive directions of exchanges over the three periods, and second, how do the exchanges results compare with the regional predictive power of oil, gold, interest rates, GDP per capita and inflation.

3. Theoretical Framework and Hypotheses

The theoretical analysis is based on the flow-oriented model, the portfolio-balance model and the implications of a pegged exchange-rate model in terms of institutional issues. However, the goal is not one theory to be picked prior to estimation. Rather, the direction predicted by each theory is used, and the way in which the GCC monetary system might weaken, change or restrict any noticeable relationship is explained. Current-account approaches to exchange-rate determination pioneered by Dornbusch and Fischer (1980) form the basis of the flow-oriented model. Mobility in currency has an impact on the competitiveness of domestic companies. Depreciation can lower the foreign currency price of exports, boost foreign demand, enhance expected foreign currency revenue, and prop up foreign currency value of equity shares. Export competitiveness can be negatively affected by appreciation. In import-dependent companies, however, depreciation can increase the costs of domestic imported inputs and lead to less profit relative to the more depreciated company. The net exposure in the stock indexes thus depends on the size and magnitude of export and import exposures. In the case of the GCC, this mechanism is adjusted with economic structure. Hydrocarbon exports are a big part of external revenues and are mainly invoiced in US Dollar. A bilateral depreciation vis-à-vis the dollar is not the usual adjustment approach for currencies that are pegged to the dollar. However, fluctuations of the dollar against other currencies alter the effective external value of the currencies of the Gulf Cooperation Council (GCC) countries. Thus, sectors which are not automatically covered by the peg, such as non-hydrocarbon firms, tourism, aviation, logistics, manufacturing, and import-intensive sectors, may continue to be vulnerable to currency conditions. The portfolio-balance model has the reverse causality. An increase of equity prices leads to an increase in financial wealth and may lead to demand by domestic and foreign portfolio. Across-border purchases generate currency demand and by the flexible regime may help the appreciation. Inflows can turn into outflows and pressure on equity value in case of declines. The mechanism performs the forecasting of stock prices before the exchange rates. But it is the very last exchange-rate adjustment that is impossible under a hard peg. Monetary authorities can buffer capital-flow effects either by releasing foreign reserves or by engaging in domestic liquidity measures, which may cause capital-flow effects to show up off the observed bilateral rate.

This gestalt thus predisposes attendances in the GCC settings to "softening" as opposed to theoretical irrelevance. Limited variation in the exchange-rate variable can make it difficult for either of these theoretical channels to be statistically identified when the exchange rate is a bilateral dollar rate for a hard-pegged currency. Predictive relationships can still exist when there is an effective-rate variation or basket variation within the measure. Finally, there is some heterogeneity, due to the basket arrangement undertaken by Kuwait. These traits render it inappropriate to give homogeneous causal-coefficients in all 6 countries. Mechanisms can change when markets are under stress, both becoming stronger and weaker. Equity repricing, capital flows, commodity price dynamics, and global monetary reactions are growing and more rapid during times of uncertainty. Meanwhile, officials in charge of a peg could be more active in reserve and liquidity management. A crisis may thus enhance the transmission of information between markets, and diminish the bilateral exchange rate variation as observed. It is not a question of "more causality during crisis" as

the observed result of allowing for adjustment will differ according to where the adjustment is permitted.

Oil is included as a benchmark channel since it has a direct impact on the fiscal revenues, the external balances, the liquidity and the corporate earning of the GCC. Upward oil prices can help bolster government purchase power and improve investor expectations, and downward oil prices can do the opposite. Reserve accumulation is also a source of spillovers of oil prices on the sustainability and credibility of exchange-rate policies. The expected relationship with oil is thus strong but does not necessarily depend on the sign and size of the relationship. Gold offers a means of risk-allocation. The safe-haven umbrella could crest during equity-level stresses, with average-period demand among investors being rather tenuous. In a crisis situation bidirectional predictability can happen either when both markets react in turn to shifts in risk aversion and/or portfolio rebalancing. It does not necessarily confirm the gold was an effective downside protector if it comes about like this.

Interest rates are an example of the monetary channel. In a pegged regime the domestic policy rate will be limited due to the requirement to maintain the parity of the domestic currency, especially if capital mobility is high. Thus, against the background of such domestic factors, domestic interest rates are more likely to be influenced by the anchor country's monetary policy than by domestic stock market data. Rather, if an equity-to-interest-rate Granger relationship is detected it should be interpreted as a means of predictive ordering and common adjustment and not as a reflection of how much stock markets matter for central bank policy. The empirical hypotheses pick up with the direction of predictive information and do not force signs. H1o: None of the panel members' equity returns can be considered as being Granger-caused by exchange-rate changes. The authors of H2o claim that they find no evidence for a Granger causal relation of quality GDP returns of the members of the GCC group with exchange-rate levels. The equivalent pairwise nulls are tested in both forward and backward directions for Brent oil, gold, interest rates, GDP per capita and inflation. Since the null is rejected, the predictive precedence is guaranteed for at least a part of the GCC panel. The period-specific estimates also determine the stability of classification for each pair for the time periods 2017–2020, 2021–2022, and 2023–2024.

4. Data and Methodology

The empirical panel includes Saudi Arabia, United Arab Emirates, Qatar, Kuwait, Oman and Bahrain. Market variable is the percentage return on the main equity index of each country. The measure of the exchange rate of the underlying data set is the focal explanatory variable. The variables to be measured are: Brent crude oil, gold futures, short-term interest rate, GDP per capita and inflation. The empirical target is the directionality of the predictability: therefore, each pair of variables are placed in both directions, instead of all the facts in a single structural regression. Financial price is represented as the percentage change for use in stationary causality tests. Equity returns are derived from the natural log of a closing level of an index. Exchange-rate changes are computed from the exchange-rate series, in a manner that is consistent over time. The price changes of Brent and gold are considered on the same footing. Where these variables are subject to

stochastic properties, they are applied in change form and their interest-rate and inflation variables are accordingly entered in this form. The transformation is performed on GDP per capita as per the stationary representation in the underlying panel. The true transformation should maintain the economic significance of the series and not be used for a Granger test of non-stationary levels.

The analysis uses the three established sample windows: 2017–2020, 2021–2022, and 2023–2024. These windows are considered as externally-specified comparative periods. They are not Markov switching nor are they produced by an endogenous structural-break procedure. Therefore, the term market regimes in the paper is a descriptive one. The comparison across periods is whether the panel null is to be rejected within each period exponent, and is not really a formal statistical test of the equality or difference between the two period-specific coefficients. The causal conditions for panel should be determined at the preliminary level based on statistical analysis. Descriptive statistics for all variables for the periods should be included, especially for the exchange rate measure, and the variance should be reported. This is crucial as there is no exchange rate causality statistic reportable in the supplied 2021-2022 output. The variation in the exchange rate and effective sample size need be taken into account before an economic interpretation of the outcome can be put forward.

Another aspect that is important is cross sectional dependence. Both equity markets in the GCC nations are exposed to oil, have global risk factors, monetary ties with the United States, and regional financial integration. Hence, Pesaran (2007) type dependence testing is suitable. When cross sectional independence is not accepted, mechanical application of procedures that require the assumption of independence in their derivation of asymptotics for inference should not be based on the assumption of independence. The last methodological studies on the heterogeneous panel Granger causality focus on the validity of bootstrap distributions in the presence of cross-sectional dependence. The standard Dumitrescu–Hurlin test assumes stationarity, which must be verified. A material cross-sectional dependence suggests that the following second-generation alternative by Pesaran (2007) that applies a cross-sectional augmentation to the panel unit-root model is appropriate. The common factors in the cross-section are also pushed through the cross-section averages, and the statistic used is the CIPS augmentation of the Dickey–Fuller test. Where dependence is strong, e.g., in the case of common dependence, first generation tests should not be offered as an alternative to dependence aware procedures, but rather as supplementary evidence where the assumptions of the test are tenable. The tested test is the heterogeneous panel Granger non-causality test of Dumitrescu and Hurlin (2012). The bivariate model for each crosssectional unit i and time t is:

$$y_{it} = \alpha_i + \sum_{k=1}^K \gamma_{i,k} y_{i,t-k} + \sum_{k=1}^K \beta_{i,k} x_{i,t-k} + \varepsilon_{it}.$$

The base of this model is the regression of y on x with a common lag order K that was presented above, where y is the variable of interest, x is the predictor of interest, α_i account for individual effects, $\gamma_{i,k}$ are autoregressive coefficients for the units, $\beta_{i,k}$ are causal coefficients for the units, and ε_{it} is the disturbance. An estimation of the model is done separately for each pair and then reversed to test the opposite direction. So, the same causality structure – due to Dumitrescu – Hurlin – is used twice (with x and y switched).

The homogeneous non-causality null is $H_0: \beta_{i,1} = \dots = \beta_{i,K} = 0$, for all i . The heterogeneous alternative permits at least one unit to deviate from the restriction and for another unit to uphold the restriction. This is one of the significant differences in the context of interpretation. For at least one of the GCC markets, the rejection applies, indicating that there is some piece of statistically significant incremental predictive information in the past x values for y . That does not mean there are causal relationships in each country.

The Wald test starts with Wald statistics for the K restrictions for each cross section. Dumitrescu and Hurlin take the averages of these statistics to get $\bar{W}$. They then come up with standardized statistics for panel inference, such as the asymptotic $\bar{Z}$ and a finite-sample standardized transformation. The values for $\bar{W}$ and $\bar{Z}$ are displayed in the reported tables; in some cases, the underlying outputs include the finite-sample adjusted statistic. The decision rule depends upon the appropriate probability value and the level of significance used. It is a matter of substance and methodological choice as to the length of the lag. Lopez and Weber (2018) discuss bootstrap inference, and information-criterion-based lag selection, such as the AIC, BIC, and HQIC, for the Dumitrescu–Hurlin procedure that is implemented in `xtgcause`. The supplied results use one lag in 2017–2020 and 2021–2022 and two lags in 2023–2024. Different lag orders may yield different granger results; therefore, such difference should be made transparent explicitly. With this in mind, caution is required when comparing the results across periods unless a robustness exercise re-estimates all of the periods at a common lag.

The using of a multivariate regression would not be controls for "Brent", gold, interest rates, GDP per capita, and inflation. They are variables which are separately benchmarked against equity returns. It would give a false impression to refer to them as controls. Their intent is to enable comparison: do other variables relevant for economic research have comparative precedence in the same panel orthodoxy, and do they help to represent the information environment of each period more? In 2021–2022, the exchange-rate result cannot be computed and the result needs special consideration. However, it shouldn't automatically be considered as evidence that the currency pegs were particularly credible and strain free. If the variation within each unit is low, too few observations are selected for the specified lag, collinearity, and/or limitations of the estimation are present, a Dumitrescu–Hurlin statistic can break down. The statistic shows limited variation of the exchange rate, consistent with this result. The most defensible claim is thus that based on the provided specification, the exchange rate predictive precedence had not been estimated for 2021–2022; the different economic reason must be upheld by the underlying variation diagnostics.

Inference under cross sectional dependence should be transparent, too. Dumitrescu and Hurlin derive the heterogeneous panel test under special orders of asymptotic approximation as well as investigating its robustness by means of simulations. With the presence of cross-sectional dependence, the bootstrap critical values are becoming more commonly added to the traditional statistics. Thus, the literature of Empirical Economics 2024 explicitly highlights the options after testing for dependence, both asymptotic and bootstrap distribution. When underlying data are available, the bootstrap inference is a good robustness exercise for a six-country level panel of the GCC countries. Lastly, the terms causality is limited throughout the paper. Predictive precedence in the conditional mean is known as Granger causality. Does not define a structural treatment effect, a

policy mechanism or an exogenous shock transmission. Information can be incorporated into one market earlier than another due to common factors. Thus, the paper only speaks of “Granger-causes,” “predicts,” or “contains incremental predictive information,” but not in the sense of one variable causing the other economically in an unqualified way.

5. Empirical Results

The non-causality test between equity returns of GCC and change in exchange rate shows that the values of $\bar{W}$, $\bar{Z}$ and probability value are 1.0922, 0.1596, and 0.8732, respectively. The reverse direction is also insignificant, with $\bar{W}$ of 0.7541, $\bar{Z}$ of -0.4259, and $p = 0.6702$. The panel thus does not offer any evidence for a predictive lead and follow in either direction between equity returns and exchange rate changes during this period. The changes in the benchmark variables provide clarity to the overall conclusion. Brent oil Granger-causes GCC equity returns at the 1% level, with $\bar{W} = 2.8745$, $\bar{Z} = 3.2467$, and $p = 0.0012$. The opposite move in the oil to equity ratio trade is negligible at typical ratios. Equity returns have no tendency to predict gold, interest rates, GDP per capita or inflation, nor do they predict these. The missing inflation to equities row is now $\bar{W} = 0.9604$, $\bar{Z} = -0.0687$ and $p = 0.9453$, which means that the homogeneous non-causality null is not rejected. The former configuration is thus not the same as no configuration at all, but selected. This set of panels identifies the predictive information for oil and equity while it overlooks the relationship between the two. This reinforces the interpretation that it is a null for that specific pair of variables for the specification being used, but does not provide evidence that the test powers are all equal across variables as displayed in Table 1, and is a result of the 2017-2020 period.

Table 1. Dumitrescu–Hurlin panel Granger non-causality results, 2017–2020 (lag = 1, N = 6)

Direction	$\bar{W}$ -bar	$\bar{Z}$ -bar	p-value	Decision
Exchange rate → equities	1.0922	0.1596	0.8732	Do not reject
Brent oil → equities	2.8745	3.2467	0.0012	Reject***
Gold futures → equities	1.3932	0.6810	0.4959	Do not reject
Interest rate → equities	0.3839	-1.0671	0.2859	Do not reject
GDP per capita → equities	0.4129	-1.0168	0.3092	Do not reject
Inflation → equities	0.9604	-0.0687	0.9453	Do not reject
Equities → exchange rate	0.7541	-0.4259	0.6702	Do not reject
Equities → Brent oil	1.8099	1.4027	0.1607	Do not reject
Equities → gold futures	0.3577	-1.1125	0.2659	Do not reject

Equities → interest rate	0.6116	-0.6727	0.5011	Do not reject
Equities → GDP per capita	0.8581	-0.2458	0.8058	Do not reject
Equities → inflation	0.4175	-1.0090	0.3130	Do not reject

Note. H0: no Granger causality for any panel unit. *** denotes significance at the 1% level.

The period of pandemic in 2021–2022 is presented in Table 2. The exchange-rate statistic does not appear in the provided output, nor does it show up as a computable. This is not changed to a zero or a non-significant probability, but is retained as “not estimable”. If no estimable statistic is present the rejection decision for exchange rate → equities or equities → exchange rate cannot be made from this output.

The other factors show a significant predictive network. Equities Granger-causes Brent and Brent Granger-causes equities with p-values < 0.001; W-bar = 5.5367 and Z-bar = 7.8577 respectively. Equities Granger-cause Brent and Brent Granger-cause equities with W-bar = 5.5367 and Z-bar = 7.8577; both p-values are also below 0.001. Bidirectional predictive precedence is also present in the case of gold. Gold → equities produce W-bar = 7.1441 and Z-bar = 10.6419, and equities → gold produces W-bar = 4.8276 and Z-bar = 6.6297, with both probabilities below 0.001. The result of interest rates is one-sided in 2021–2022. Interest rate → equities is insignificant (W-bar = 1.6490, Z-bar = 1.1240, p = 0.2610), whereas equities → interest rate is strongly significant (W-bar = 5.5571, Z-bar = 7.8932, p < 0.001). GDP per capita and inflation continue to be negligible in both directions. So, the mid-term period has been receding with positive oil and gold reaction and equity-to-interest predictive causality; and the causality of exchange rate is not be determined from the provided statistic.

Table 2. Dumitrescu–Hurlin panel Granger non-causality results, 2021–2022 (lag = 1, N = 6)

Direction	W-bar	Z-bar	p-value	Decision
Exchange rate → equities	—	—	—	Not estimable
Equities → exchange rate	—	—	—	Not estimable
Brent oil → equities	5.5367	7.8577	0.0000	Reject***
Equities → Brent oil	5.3110	7.4669	0.0000	Reject***
Gold futures → equities	7.1441	10.6419	0.0000	Reject***
Equities → gold futures	4.8276	6.6297	0.0000	Reject***
Interest rate →	1.6490	1.1240	0.2610	Do not reject

equities				
Equities → interest rate	5.5571	7.8932	0.0000	Reject***
GDP per capita → equities	1.4156	0.7199	0.4716	Do not reject
Equities → GDP per capita	0.2528	-1.2942	0.1956	Do not reject
Inflation → equities	1.2430	0.4208	0.6739	Do not reject
Equities → inflation	0.2245	-1.3433	0.1792	Do not reject

Note. H0: no Granger causality for any panel unit. Exchange-rate statistics are not estimable in the supplied output. *** denotes significance at the 1% level.

Table 3 represents the result of 2023–2024 compared to the previous periods, and shows significant differences. Exchange-rate changes Granger-cause GCC equity returns, with $W\text{-bar} = 4.5211$, $Z\text{-bar} = 3.0877$, and $p = 0.0020$. The reverse direction is also significant: $W\text{-bar} = 4.1099$, $Z\text{-bar} = 2.5841$, $p = 0.0098$. Thus, the two are reported as being bidirectional at the 1% level for the specified lag of 2. Brent oil continues to predict equities strongly, with $W\text{-bar} = 4.9294$, $Z\text{-bar} = 3.5877$, and $p = 0.0003$. The opposite relationship, equities → Brent is not significant except at the 10% level, with $p = 0.0701$. The “predominantly oil → equities” classification, therefore, is the most defensible version of bidirectionality as opposed to unqualified bidirectionality at the conventional 5% level, with weak reverse evidence at 10%. There is no significance in either direction in 2023–2024 with gold. Interest rate, GDP per capita and inflation have the same negligible impact at normal levels. However, it is important to note the results are retrospective and the strong gold feedback observed during 2021–2022 has not been as apparent that this time.

Table 3. Dumitrescu–Hurlin panel Granger non-causality results, 2023–2024 (lag = 2, N = 6)

Direction	W-bar	Z-bar	p-value	Decision
Exchange rate → equities	4.5211	3.0877	0.0020	Reject***
Brent oil → equities	4.9294	3.5877	0.0003	Reject***
Gold futures → equities	1.2908	-0.8686	0.3850	Do not reject
Interest rate → equities	2.0772	0.0946	0.9247	Do not reject
GDP per capita → equities	1.1628	-1.0254	0.3052	Do not reject
Inflation → equities	2.0734	0.0899	0.9284	Do not reject
Equities → exchange rate	4.1099	2.5841	0.0098	Reject***
Equities → Brent oil	3.4788	1.8112	0.0701	Reject*

Equities → gold futures	1.1196	−1.0783	0.2809	Do not reject
Equities → interest rate	3.1582	1.4185	0.1560	Do not reject
Equities → GDP per capita	1.3022	−0.8546	0.3928	Do not reject
Equities → inflation	1.4753	−0.6427	0.5204	Do not reject

Note. H0: no Granger causality for any panel unit. *** and * denote significance at the 1% and 10% levels, respectively.

The cross-period synthesis table has been reorganized to emphasize the key points of transition, but does not state any formal conditions of equality between periods. The exchange rate and equities have had an undecidable movement in 2017-2020; not estimable movement in 2021-2022; and predictive precedence both ways in 2023-2024. Equities grew strong and had oil as a good predictor only in the middle period and mainly so. Gold plays no role in the first and last periods, but plays a role in the middle period – bidirectionally. The predictability of interest rates seems to be the case for equities to rates only in 2021-2022. The non-causality hypothesis cannot be rejected for either direction or any reported period in either direction, using GDP per capita and inflation. The two statistical qualifications are required. First, the outcome for the post-period exchange-rate relies on lag two while the first 2 periods rely on lag one. Thus the comparison will include a change in sample period as well as a change in the lag structure. The outcome holds true for every specification reported, but a common-lag robustness exercise is required prior to concluding that the difference between the cross periods is solely due to market conditions. Second, for a subset of the gcc markets the predictive causality is rejected by rejection of the panel. If an individual Wald result is not provided, it is not possible to determine if a country has a large, pronounced post-period relationship, or a small, less pronounced one.

Table 4. Cross-period synthesis of directional predictive relationships

Variable pair	2017–2020	2021–2022	2023–2024
Exchange rate ↔ equities	No detected direction	Not estimable	Bidirectional (1%)
Brent oil ↔ equities	Oil → equities (1%)	Bidirectional (1%)	Oil → equities (1%); reverse only at 10%
Gold ↔ equities	No detected direction	Bidirectional (1%)	No detected direction
Interest rate ↔ equities	No detected direction	Equities → interest rate (1%)	No detected direction
GDP per capita ↔ equities	No detected direction	No detected direction	No detected direction
Inflation ↔ equities	No detected direction	No detected direction	No detected direction

Note. Classifications summarize the reported pairwise panel tests; they are not formal tests of equality across periods.

6. Discussion

The empirical results do not support the notion that the exchange-rate–equity relationship is stable in the GCC. Predictive direction is not found in 2017–2020, the exchange-rate test cannot be estimated from the 2021–2022 output, and bidirectional predictive precedence seems to be present in 2023–2024. This seems more indicative of conditional financial integration than permanent dominance of one or the other mechanism, flow-oriented or portfolio-balance. The first period null is an economically reasonable one for a pegged system. When bilateral exchange-rate variation becomes tight, exchange-rate changes could offer only a small amount of incremental information for equity returns. In turn, the equity-market adjustment can result in capital-flow pressure even though this does not necessarily trigger an obvious bilateral exchange-rate effect, as the monetary authorities can dampen the pressure by building up reserves and adjusting liquidity. This is an institutional interpretation of the peg, and should be treated as conditional on the specific exchange-rate measure. When the dollar parity is frozen, effective or cross rates may fluctuate. This is also consistent with the general empirical literature in which null relationships are the norm when stress episodes are not present. According to Granger et al., (2000), causal configuration between markets in Asia is different between crisis and non-crisis. Nieh and Lee (2001) conclude that the power relationships in the G7 are generally of short duration. Studies over the last many decades report significant disagreement as reported by Bahmani-Oskooee and Saha (2015). This, indeed, is not a barren finding, to be explained as a failure of the test, in the absence of causality in 2017–2020. Simultaneously, the pronounced Brent oil finding has shown that the returns in the equity markets of the GCC were not informationally isolated. This finding of oil-to-equity causality is in line with the fiscal and corporate reliance on oil in the region, and with the previous research in the GCC conducted by Arouri and Rault (2010), Arouri et al. (2011), and Awartani and Maghyreh (2013). The result should be regarded more as confirmatory and not as new. The interest of its analytical value is that it highlights the fact that a variable which is econometrically significant in a region has predictive value when the exchange-rate variable fails to achieve it.

Particularly caution is needed for the 2021–2022 period. The values for the exchange-rate measurements during 2021–2022 are of special interest to be given careful interpretation as the test statistic was not estimable in this period. This can be tempting to regard as direct proof that the pegs were in full defence, in the face of a great world shock. Without 'descriptive confirmation' that conclusion would be too strong. But non-estimability is firstly an econometric fact. The result is convergence with restricted currency adjustment if there is little variation across the panel units in the exchange-rate series. For such issues to do with sample size, lag structure or data construction, statement of economic implication is different. Hence it is necessary to clearly state the exchange-rate result for the middle period as "not estimable with the provided specification. This is more rigorous than simply saying that it is “no relationship” as a failed test is not the same as not rejecting a valid test result in which it is simply a zero. It is also a more stringent standard than considering it to be evidence of peg credibility. Determination of these interpretations is a matter of the decisive descriptive exchange-rate variance by country and period. The other findings for 2021–2022 indicate significant increased growth in the intensity of predictive linkage. Equity and oil prices are bidirectional, equity and gold prices are bidirectional, and short-term interest rates are predicting equity prices (short-term). These findings suggest that the information transmission

during this period was wide enough to be observed across exchanges even though this test was not able to be classified as a focal exchange-rate test. That is important, as it precludes a story of the entire financial system going limp, from a statistical standpoint. The gold result confirms the hypothesis that there are changed relationships across the assets in crisis periods, not necessarily the safe haven performance. Baur and Lucey (2010) examine safe haven behavior in the sense of the relationship in stress times, and Dumitrescu–Hurlin perform a predictive ordering test. Bidirectional Granger causality between gold and equities is, thus, not necessarily downside protection but rather information flow in time.

The difference needs to be kept in a Q2 discussion level. The equity interest-rate association for the mean time also ought to be deciphered with precaution. GCC-pegs domestic rates heavily affected by ‘monetary stance’ the governor has to apply to keep up with the dollar peg’. A substantial equity → interest outcome does not suggest that the central banks' actions on policy were induced by stock markets in the region. Both are able to react to the same shock globally but at different speeds. It can time such common factor, and is compatible with granger precedence. The post period result posts evidence for both theoretical directions reported under the specification. The exchange rate → equities finding implies the flow-oriented perspective that currency conditions provide information that is useful for corporate valuation. The result of equities being first is in line with the portfolio-balance hypothesis that information flow comes first in the stock market before it comes to the currency market. The bidirectional classification is similar to some previous studies like Granger et al. (2000) feedback relationships or Bahmani-Oskooee and Sohrabian (1992) earlier study. But, an analysis of the institutional arrangements in the GCC is not so straightforward to label both theories as being proved. But if the exchange-rate measure has an effective or basket component, the post-period relationship may also obtain despite bilateral dollar pegs that are maintained.

7. Conclusion

Dumitrescu and Hurlin (2012) heterogeneous panel Granger non-causality approach is used in this research to assess the directional predictive relations between the change of exchange-rate and the returns of the GCC equities in the three periods: 2017–2020, 2021–2022, and 2023–2024. Theoretically, the six-country setting is important because of five currencies that are hard pegged to the US dollar and one that is basket pegged (Kuwait). Conventional flow-oriented and portfolio balance explanations assume a currency adjustment which can be mitigated by the institutional framework. Results indicate that there is no predictive direction for the exchange-rate–equity relationship in the period 2017-2020. The only variable that forecasts equities in that time is the price of Brent oil. The exchange-rate statistic is not estimable from the output provided and thus is not classified as causal or non-causal in 2021–2022. There are also notable, bi-directional predictive leads between equities and Brent oil, as well as between equities and gold during the same period of time, and equity to interest-rate precedence during this time. A bidirectional panel classification is created during 2023-2024 with exchange-rate changes predicting GCC equity returns and vice versa. Brent still forecasts equities with just light negative evidence at the 10% level. Thus, there is no evidence for either theoretical model to become permanently dominant. That flow-oriented

direction is only mentioned in the last period, and the direction in terms of portfolio-balances is mentioned there too. The more defensible conclusion is that exchange-rate – equity predictability is conditional on the period of the markets, the variation in the exchange rates, and institutional setting in the GCC region. The results also indicate the significance of the exact causal language. The Dumitrescu–Hurlin rejection requires that for at least a sub-set of the panel members, the lagged values of one of the variables provide incremental prediction power for the other. It doesn't suggest a structural causation and doesn't imply that this relationship exists among all six GCC nations. Similarly, the non-estimable mid-period exchange-rate statistic cannot be translated into a casual or institutional interpretation without looking into the variance and the sample conditions of the statistics.

There are a number of restrictions to future research. Cross sectional dependence may be tested and bootstrap inference reported as needed. When appropriate, CIPS or other dependence aware procedures should be used to document stationarity. Common-lag robustness estimation should be used to cope with the varying lag orders across periods. Wald evidence country-specific would detect the markets in the GCC region that create panel rejections. Finally, bilateral and effective exchange-rate measures should be compared; the idea of exchange-rate peg is having only one dimension of freedom of currency movement, and it does not stop exchange-rate changes that are economically relevant. The results in this study clearly indicate that there is no universal or stable directional relationship between the exchange rates and GCC equities within these bounds. It varies by the three periods, oil shows more stability and other macro-financial factors have sporadic or non-existent links. The conclusion for GCC financial research is that exchange-rate institutions and market conditions have to be regarded as variables in and of themselves, rather than merely background variables, in interpreting linkages among asset prices.

References

- Abdalla, I. S. A., & Murinde, V. (1997). Exchange rate and stock price interactions in emerging financial markets: Evidence on India, Korea, Pakistan and the Philippines. *Applied Financial Economics*, 7(1), 25–35.
- Aggarwal, R. (1981). Exchange rates and stock prices: A study of the U.S. capital markets under floating exchange rates. *Akron Business and Economic Review*, 12, 7–12.
- Al-Daham, J. (2017). Relationship between exchange rates and stock prices: GCC perspectives. *International Journal of Economics and Financial Issues*, 7(2), 11–24.
- Arouri, M. E. H., Lahiani, A., & Nguyen, D. K. (2011). Return and volatility transmission between world oil prices and stock markets of the GCC countries. *Economic Modelling*, 28(4), 1815–1825. <https://doi.org/10.1016/j.econmod.2011.03.012>
- Arouri, M. E. H., & Rault, C. (2010). Causal relationships between oil and stock prices: Some new evidence from Gulf oil-exporting countries. *International Economics*, 122, 41–56.
- Awartani, B., & Maghyereh, A. I. (2013). Dynamic spillovers between oil and stock markets in the Gulf Cooperation Council countries. *Energy Economics*, 36, 28–42.
- Bahmani-Oskooee, M., & Saha, S. (2015). On the relation between stock prices and exchange rates: A review article. *Journal of Economic Studies*, 42(4), 707–732.
- Bahmani-Oskooee, M., & Sohrabian, A. (1992). Stock prices and the effective exchange rate of the dollar. *Applied Economics*, 24(4), 459–464.
- Baur, D. G., & Lucey, B. M. (2010). Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. *Financial Review*, 45(2), 217–229.
- Branson, W. H., Halttunen, H., & Masson, P. (1977). Exchange rates in the short run: The dollar–Deutschemmark rate. *European Economic Review*, 10(3), 303–324.
- Dornbusch, R., & Fischer, S. (1980). Exchange rates and the current account. *American Economic Review*, 70(5), 960–971.
- Dumitrescu, E.-I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic Modelling*, 29(4), 1450–1460. <https://doi.org/10.1016/j.econmod.2012.02.014>
- Frankel, J. A. (1983). Monetary and portfolio-balance models of exchange rate determination. In J. S. Bhandari & B. H. Putnam (Eds.), *Economic interdependence and flexible exchange rates*. MIT Press.
- Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3), 424–438.
- Granger, C. W. J., Huang, B.-N., & Yang, C.-W. (2000). A bivariate causality between stock prices and exchange rates: Evidence from recent Asian flu. *Quarterly Review of Economics and Finance*, 40(3), 337–354.

- Liang, C.-C., Lin, J.-B., & Hsu, H.-C. (2013). Reexamining the relationships between stock prices and exchange rates in ASEAN-5 using panel Granger causality approach. *Economic Modelling*, 32, 560–563.
- Lopez, L., & Weber, S. (2018). Testing for Granger causality in panel data. *Stata Journal*, 17(4), 972–984. <https://doi.org/10.1177/1536867X1801700412>
- Nieh, C.-C., & Lee, C.-F. (2001). Dynamic relationship between stock prices and exchange rates for G-7 countries. *Quarterly Review of Economics and Finance*, 41(4), 477–490.
- Nusair, S. A., & Olson, D. (2022). Dynamic relationship between exchange rates and stock prices for the G7 countries: A nonlinear ARDL approach. *Journal of International Financial Markets, Institutions and Money*, 78, 101541. <https://doi.org/10.1016/j.intfin.2022.101541>
- Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265–312. <https://doi.org/10.1002/jae.951>
- Phylaktis, K., & Ravazzolo, F. (2005). Stock prices and exchange rate dynamics. *Journal of International Money and Finance*, 24(7), 1031–1053.
- Roll, R. (1992). Industrial structure and the comparative behavior of international stock market indices. *Journal of Finance*, 47(1), 3–41.
- Salisu, A. A., & Ndako, U. B. (2018). Modelling stock price–exchange rate nexus in OECD countries: A new perspective. *Economic Modelling*, 74, 105–123.
- Xie, Z., Chen, S.-W., & Wu, A.-C. (2020). The foreign exchange and stock market nexus: New international evidence. *International Review of Economics & Finance*, 67, 240–266.
- Umar, Z., Jareño, F., & Escribano, A. (2021). Dynamic return and volatility connectedness for dominant agricultural commodity markets during the COVID-19 pandemic era. *Applied Economics*, 53, 5341–5354.
- Reboredo, J. C. (2012). Modelling oil price and exchange rate co-movements. *Journal of Policy Modeling*, 34(3), 419–440.
- Basher, S. A., Haug, A. A., & Sadorsky, P. (2012). Oil prices, exchange rates and emerging stock markets. *Energy Economics*, 34(1), 227–240.
- Chkili, W., & Nguyen, D. K. (2014). Exchange rate movements and stock market returns in a regime-switching environment: Evidence for BRICS countries. *Research in International Business and Finance*, 31, 46–56.
- Tsagkanos, A., & Siriopoulos, C. (2013). A long-run relationship between stock price index and exchange rate: A structural nonparametric cointegrating regression approach. *Journal of International Financial Markets, Institutions and Money*, 25, 106–118.
- Moore, T., & Wang, P. (2014). Dynamic linkage between real exchange rates and stock prices: Evidence from developed and emerging Asian markets. *International Review of Economics & Finance*, 29, 1–11.

- Caporale, G. M., Hunter, J., & Ali, F. M. (2014). On the linkages between stock prices and exchange rates: Evidence from the banking crisis of 2007–2010. *International Review of Financial Analysis*, 33, 87–103.
- Chkili, W. (2016). Dynamic correlations and hedging effectiveness between gold and stock markets: Evidence for BRICS countries. *Research in International Business and Finance*, 38, 22–34.
- Aloui, R., Aïssa, M. S. B., & Nguyen, D. K. (2011). Global financial crisis, extreme interdependences, and contagion effects: The role of economic structure? *Journal of Banking & Finance*, 35(1), 130–141.
- Raza, N., Shahzad, S. J. H., Tiwari, A. K., & Shahbaz, M. (2016). Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. *Resources Policy*, 49, 290–301.
- Singhal, S., Choudhary, S., & Biswal, P. C. (2019). Return and volatility linkages among international crude oil price, gold price, exchange rate and stock markets: Evidence from Mexico. *Resources Policy*, 60, 255–261.
- Jain, A., & Biswal, P. C. (2016). Dynamic linkages among oil price, gold price, exchange rate, and stock market in India. *Resources Policy*, 49, 179–185.
- Ftiti, Z., Guesmi, K., Teulon, F., & Chouachi, S. (2016). Relationship between crude oil prices and economic growth in selected OPEC countries. *Journal of Applied Business Research*, 32(1), 11–22.
- Maghyereh, A. I., Awartani, B., & Bouri, E. (2016). The directional volatility connectedness between crude oil and equity markets: New evidence from implied volatility indexes. *Energy Economics*, 57, 78–93.
- Yoon, S.-M., Al Mamun, M., Uddin, G. S., & Kang, S. H. (2019). Network connectedness and net spillover between financial and commodity markets. *North American Journal of Economics and Finance*, 48, 801–818.
- Antonakakis, N., Chatziantoniou, I., & Filis, G. (2017). Oil shocks and stock markets: Dynamic connectedness under the prism of recent geopolitical and economic unrest. *International Review of Financial Analysis*, 50, 1–26.