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COVID-19 and FDI nexus in Pakistan: fresh evidence from QARDL and time-varying casualty techniques

Muhammad Zubair Chishti[1,2,3*]

Abstract

While the COVID-19 pandemic's detrimental repercussions on global economic growth are not exactly measured, there is widespread agreement among the policy-makers that it can deteriorate the global economy drastically. To this end, several studies have endeavored to analyze the harmful effects of COVID-19 on economic activities; however, the scholars mainly focus on the developed nations and less attention is paid to the developing economies. Hence, the considerable effects of COVID-19 necessitate to more research in this area specifically for developing economies. To fill this literature gap, the recent article tends to divulge the impacts of COVID-19 on one of the vital macroeconomic variables, i.e., foreign direct investment inflows (FDI) with the consort of energy prices (EPI) and real exchange rates (EXR) for Pakistan. To this end, we deploy the two proxies (viz., new deaths and new cases) for COVID-19 to find the reliable and more directional results. For analysis purpose, we use the several advanced econometric techniques. The results of QARDL suggest that COVID-19 significantly reduces the FDI inflows in Pakistan due to rise in COVID-19, while employing the both proxies. However, based on the results, we suggest that the variable of new deaths is more reliable proxy to capture the effects of COVID-19. Similarly, we infer that EPI and EXR also lead to decrease the FDI inflows. Besides, the quantile Granger causality and TVGC tests also support our results by confirming the casual nexus from COVID-19 and EPI to FDI.

Keywords COVID-19, FDI inflows, Energy price, QARDL, Pakistan

Introduction

In the recent decade, Pakistan is listed among the emerging economies on account of the rapid rise in the Pakistan's annual GDP growth rate [44]. The annual GDP rate of Pakistan, on average, was recorded by 4.23% approximately during the last decade while excluding the year of 2020 due to COVID-19 [79]. Like the other developing economies, Pakistan's economy is also crippling with the dearth of capital as the saving–investment and exports–imports gaps indicate. Furthermore, the inadequate local savings makes Pakistan an unequipped economy that cannot fulfill the required investment needs. To handle this exigency, the Pakistan's economy often seeks for external financing sources. Thus, the policy-makers advise to channel the foreign capital in the form of foreign direct investment (FDI) from industrially advanced nations to developing nations in order to foster economic growth by expediting the industrialization and shrinking the unemployment rate [43].

FDI is a vital source of foreign capital for economic development in emerging and developing economies such that it can trigger the continuous long-term GDP growth by boosting industrialization, increasing productivity, enhancing employment rate and transferring the new technologies and skills [53]. The host countries

*Correspondence:
Muhammad Zubair Chishti
chishtimz9@gmail.com; mzchishti@eco.qau.edu.pk
[1] Business School, Zhengzhou University, Henan, China
[2] School of Economics, Quaid I Azam University, Islamabad, Pakistan
[3] School of Economics, University of Chakwal, Chakwal, Pakistan

enjoy many benefits due to FDI. For instance, it assists in decreasing the dependency on foreign aids and dispenses a unique amalgam of innovation, technological how-know, training, managerial expertise, marketing networks and long-term finance. The FDI inflow rate varies from nation to nation on account of difference in the economic, political and social infrastructures across the economies [2]. Also, many local factors work as determinants of FDI inflows that appeal the FDI in a nation. The scholars have the mutual consensus on that exchange rate, market size, trade openness, inflation rate, infrastructure and human capital are the main determinants of FDI inflows [8, 36]. Besides, the decision by investors regarding the investment in a host country is also based on the solid reasons while considering the several other business factors. The prior studies on FDI underline the two main motives for FDI: efficiency seeking and market seeking. Whereas the efficiency seeking is concerned, the investors take the advantages of lower input cost in the host countries. As for the market seeking, it means that investors target to serve the foreign markets [55, 61]. Ultimately, it promotes the two types of FDI: vertical and horizontal FDI. The vertical FDI is an investment in which an investor from industrialized economy relocates the production process in a low-wage economy in order to lower its production cost. On the other hand, in the horizontal FDI, the investors intend to produce the same products in the host country as they are producing in the source economy, aiming at expanding their markets. Although the vertical and horizontal FDI were considered two distinct strands of the FDI but in 2002, Markusen and Maskus [56] integrated them and developed a new framework named knowledge–capital model (E-C model).

For over two years, the sudden outbreak of the novel Coronavirus (shortly called "COVID-19") has deteriorated the economic activities along with worsening the public health of developed as well developing economies. On account of COVID-19 outbreak, the global authorities had to set up several unprecedented containment measures such as, including but not limited, the travel restrictions, international trade restrictions, school, workplace and business closing, and no movement from one to another place [5, 6]. All such steps hindered the local and global economic activities, and consequently, it is observed that the global economies had to face a speedy and an alarming decline in annual GDP growth rate that might lead to a global recession [66, 63].

More importantly, all containment measures taken by the global economies resulted in economic disruption as well as uprooting the globalization that eventually deteriorated the FDI flows, specifically in the developing and emerging economies and the same thing happened in the economy of Pakistan. According to a report by UN Conference on Trade and Development (UNCTAD) [75], it is estimated that FDI flows would tend to decline by 30–40%. It is also expected that the more FDI flows to developing economies would shrink as compared to the developed economies since the primary manufacturing sectors having the major share of FDI flows are in the developing nations and these economies are experiencing the more crisis [63]. For example, Table 1 highlights the effects of COVID-19 on FDI inflows in developing, emerging, developed economies and at global level. Further, in developing, emerging, developed economies and at global level, FDI inflows tended to shrink by 72.1 billion, 82.4 billion, 467.2 billion and 531.3 billion dollars, respectively, from 2019 to 2020. Also, Fig. 1 shows the same scenario of decrease in FDI inflows in developing, emerging, developed economies and at global level. In addition, Fig. 2 also indicates that FDI inflows are observed falling in most of top ten host economies of the world.

Pakistan's economy, FDI and COVID-19

Like other economies, the Pakistan's economy also demonstrates the adverse effects of COVID-19 on FDI inflows and outflows of FDI and this economy is the main concerned country of the current study. Pakistan has been facing the adverse effects of outbreak of COVID-19 on the many macroeconomic variables. According to the Ministry of National Health Services Regulations & Coordination Pakistan [58], the total cases were 1,522,862, total deaths were 30,333, total recoveries were 1,484,496, and active cases were 8033 till March 23, 2022 from February 25, 2020 as Fig. 3 reports. Due to COVID-19, the economy of Pakistan had to experience devastative decline in the macroeconomic indicators. As Fig. 4 exhibits that due to COVID-19, the major economic sectors of Pakistan including services, and industrial sectors have shown a significant down fall. Consequently, the GDP growth rate was recorded by

Table 1 FDI inflows (Billions $).

Year	Economics	FDI inflows (Billions $)	Change
2019	Developing economies	593.1647	−72.155
2020		521.0097	
2019	Emerging markets	713.4538	−82.4609
2020		630.9928	
2019	Developed regions	795.8379	−467.298
2020		328.5397	
2019	World	1530.228	−531.336
2020		998.8914	

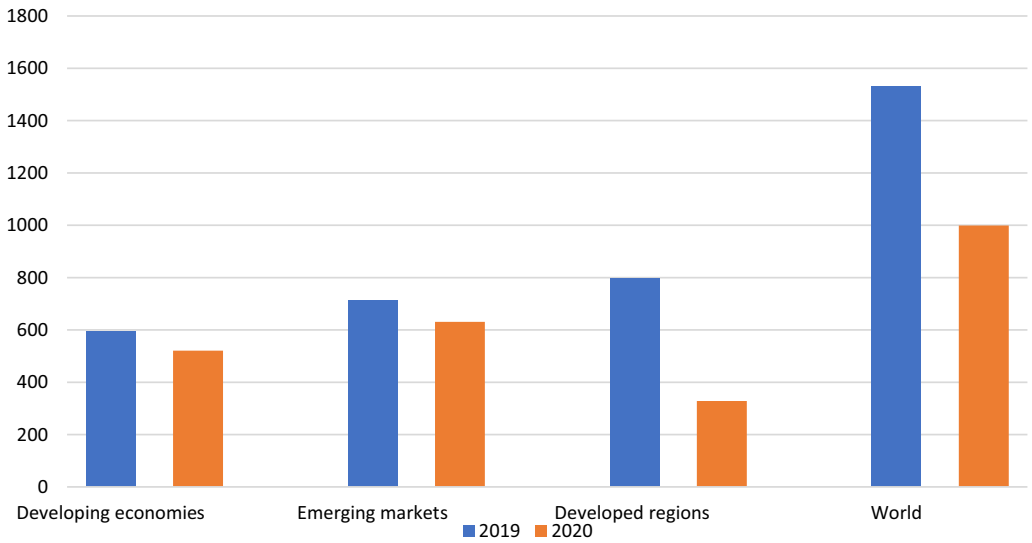


Fig. 1 FDI inflows (Billions $).

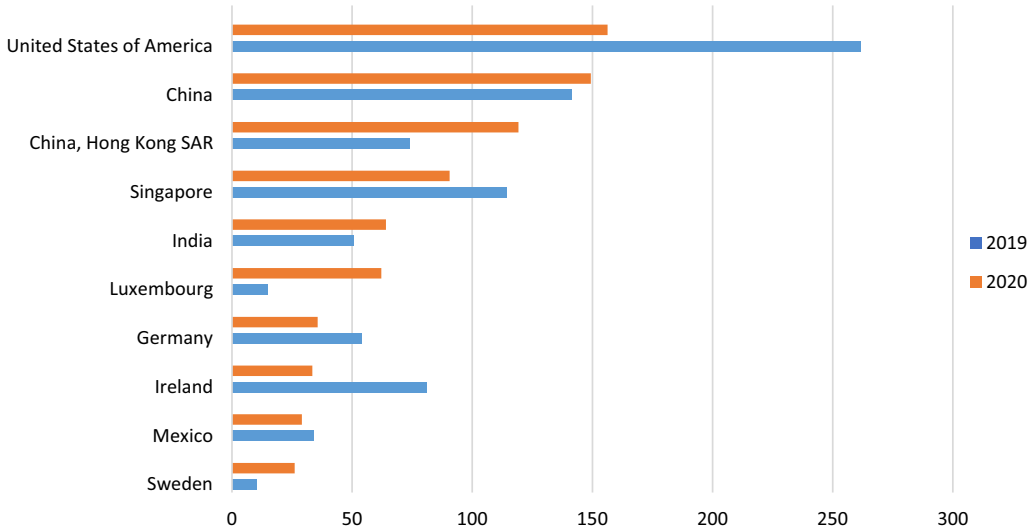


Fig. 2 FDI inflows (Billions $) in top ten host economies.

−0.38%. In a similar vein, the pattern of FDI inflows in Pakistan also has indicated a downfall such as the FDI inflow was 2597.5 million dollars in June 2020 and it declined to 1862.8 million dollars in June 2021. Hence, the FDI inflow in Pakistan was decreased by 734.7 million dollars due to COVID-19 [64].

Although there are some studies that put the attention on exploring the effects of COVID-19 on FDI flows, however, a limited attention is paid to this area. Also, this is not a single study that explores the effects of COVID-19 in the context of Pakistan. Hence, this literature gap induces to analyze following research question.

Research Question How do the FDI inflows respond to the COVID-19 in Pakistan?

Thus, the current article contributes to the extant literature in the following ways. Firstly, majority of the prior studies focuses on the developed world in order to analyze harmful effects of COVID-19 on the economic activities. This is first study, to the best of our knowledge, that empirically divulges the nonlinear effects of COVID-19 on FDI inflows in Pakistan. Secondly, the entire existing literature relies on the single proxy while exploring the detrimental effects of COVID-19. Unlike the previous

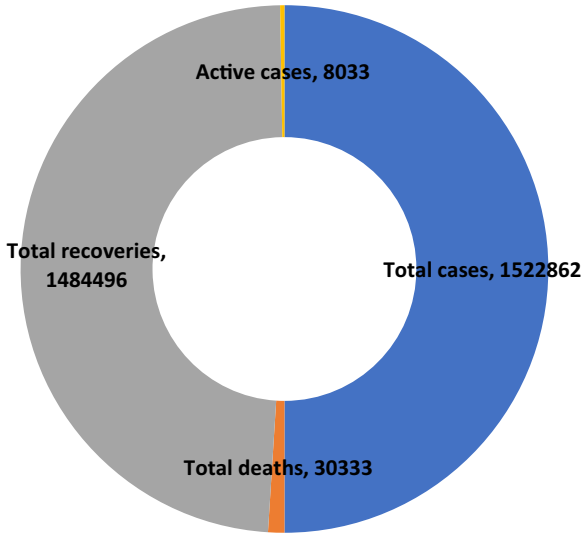


Fig. 3 Overall scenario of COVID-19 in Pakistan. *Source*: Ministry of National Health Services Regulations & Coordination [58] Pakistan

literature, the current study deploys the two proxies (total new cases and total new deaths) for COVID-19 to obtain the robust findings. Thirdly, the available literature estimates the on average effects of COVID-19 while ignoring the plausible asymmetries in the proxies for COVID-19. Hence, we use the advanced econometric (QARDL) technique to explore the quantile-wise findings to capture possible asymmetries and to recommend the more suitable policies. Finally, we also apply time-varying and quantile causality tests to check the robustness our results.

The remaining part of the document has the following order. The second section covers the pertinent literature review. In the third section, we discuss the econometric model development, data sources and the techniques. The fourth section underlines the results discussion. The last section contains on conclusion and policy recommendations.

Literature review

This section reviews the pertinent literature that is classified into two strands. The first strand covers the studies that analyze effects of COVID-19 on macroeconomic variables. The second strand consists of the studies that endeavor to explore the impact of COVID-19 on FDI that is main concern of the recent research document.

Macroeconomic variables and COVID-19 nexus

For over two years, the outbreak of the novel COVID-19 has deteriorated the economic activities developed as well developing economies. On account of COVID-19 outbreak, the global authorities had to set up several unprecedented containment measures such as, including but not limited, the travel restrictions, international trade restrictions, school, workplace and business closing, and no movement from one to another place. All such steps hindered the local and global economic

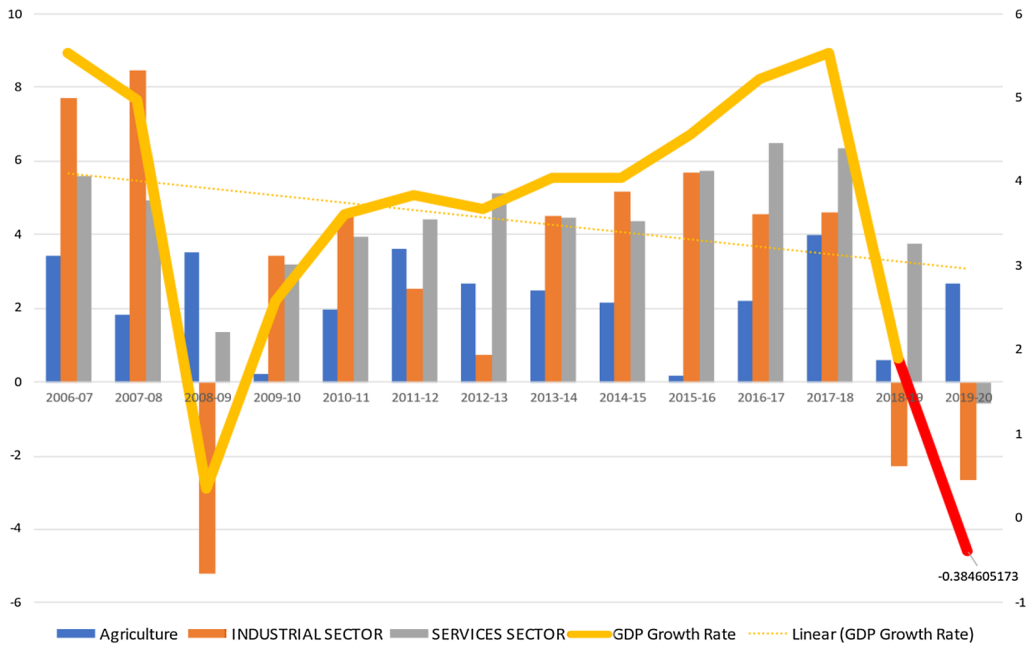


Fig. 4 Overall scenario of Pakistan's economy before and after COVID-19. *Source*: Pakistan Economic Survey [64]

activities, and consequently, it is observed that the global economies had to face a speedy and an alarming decline in annual GDP growth rate that might lead to a global recession [66, 63].

In this context, several scientists have investigated the likely effects of COVID-19 on various macroeconomic variables in order to suggest suitable policies to tackle the adverse impacts of the pandemic [17]. For example, Apergis and Apergis [7] assess the effects of COVID-19 on economic growth in OECD economies and deploy the Bayesian Panel Vector Autoregressive technique. The results exert that OECD economies' GDP growth tends to fall due to outbreak of the pandemic. Also, Vitenu-Sackey and Barfi [76] apply OLS and robust OLS methods and deduce that the rising rate of cases and deaths due to corona demonstrate the negative association with global GDP level. Likewise, König and Winkler [49] investigate the effects of the outbreak at global level and conclude that the rise in pandemic deteriorates the global GDP rate. However, the good governance may decrease the negative effects of the outbreak. Another study by Alam et al. [4] checks the effects for the economy of Bangladesh and considers the different sectors of the economy. The outcome suggests that the Bangladesh's economy had to face the significant adverse effects of the outbreak. Besides, the reports by IMF [44] and OECD [63] also indicate the deteriorating impact of COVID-19 on the global economic growth.

The scholars also explore the nexus between COVID-19 and aggregate consumption level and the results exhibit that aggregate consumption level shows a falling trend due to increase in the adverse effects of the outbreak [10, 33]. It is also evident that labor supply and global value chain tend to decline on account of COVID-19 [15, 16, 34, 35]. Whereas as the nexus between COVID-19 and employment is concerned, Gupta et al. [40], Kahn et al. [47], Kahn et al. [47], Rojas et al. [67] and Su et al. [73] observed that the outbreak shows the adverse effects such that employment rate rapidly falls at the global level.

Similarly, the scholars also seek for the devastating effects of the pandemic on the health. Béland et al. [14], Goldstein and Lee [39] and Lin and Meissner [51] reported that the global health sector has to face severe adverse impacts of the outbreak. Since majority of the major economic indicators demonstrate the adverse effects due to the pandemic, it can be inferred that inequality of income and poverty are also deteriorated. Hence, Adams-Prassl et al. [1], Bartos and Yannopoulos [12], Couch et al. [31] and Forsythe et al. [38] concluded that COVID-19 causes to trigger the income inequality and poverty across the nations. To recapitulate, it can be inferred that COVID-19 severely negatively affected the global economies by deteriorating the macroeconomic economic variables.

The determinants of FDI

Before highlighting the impacts of COVID-19 on FDI flows, it is logical to underline the prior studies' outcome regarding the determinants of FDI. In this context, the previous literature indicates the mixed and inconclusive results. For instance, Adhikary [2] and Kumari and Sharma [50] find that trade openness, interest rate, human capital and market size are vital factor of FDI inflows in the Asian economies. For China, Zhang [80] finds that tax rate, geography, market size and labor cost attract the FDI inflows at regional level and market size, exchange rate, employment and wage rate are the important indicators for sectoral level FDI. Gurshev [41] concludes that market size and tax rate are the pivotal factors of FDI and trade tends to hinder the FDI in Russia. Another study on Brazil confirms that the trade liberalization and domestic market dimension are the vital determinants of FDI [13].

In addition, Maryam & Mittal [57], Asongu et al. [8] are of view that infrastructure facilities, gross capital formation, market size, exchange rate and trade play a key role in attracting the FDI inflows in BRICS nations. Based on two important motives of FDI, viz., horizontal and vertical FDI, Nguyen and Cieślik [60] deployed K-C model and argued that the labor skills' disparity between Europe and Asia leads to promote vertical FDI while similarity in market size between both regions tends to boost the horizontal FDI in Asia. In the context of Pakistan, Shafiq et al. [70] explored the determinants of FDI inflows and trade openness, interest rate, exchange rate, GDP and tax rate are listed as the important attracting factors. Whereas the various economic crises are concerned, the global crises in 2008 have exhibited the adverse impacts on vertical and horizontal FDI [72]. Likewise, Liu [52] has observed that banking crises have significantly contracted the volume of FDI flows. During the Asian financial crisis, Moon et al. [59] argued that FDI flows play a significant role in enhancing the economic stability in Asian region.

COVID-19, being a recent issue, caught the less attention of researchers to investigate its effects on FDI inflows. Agarwal et al. [3] checked the impacts of pandemic on FDI inflows in India and inferred that COVID-19 declines the FDI inflows by 59% in India. Later, the Indian government took the serious step and implemented the suitable policies that triggered the FDI inflows by 16% in coming months. Another study by Chaudhary et al. [19] for Nepal shows the deleterious effects of the pandemic on FDI inflows. However, Chattopadhyay et al. [18] analyzed how FDI inflows respond

to the COVID-19 in BRICS economies. To this end, the study applies GMM and pooled mean group techniques. The results indicate the insignificant effects of COVID-19 on FDI. The review of the prior literature demonstrates the two considerable loopholes. Firstly, while addressing the effects of any economic crises on FDI, less attention is paid to this side as the FDI is predominant predictors of the economy. Secondly, the scholars try to divulge the effects of recently emerged global, viz., COVID-19; however, less attention is paid to the developing world in order to suggest suitable policies to handle the global pandemic. More specifically, the scholars did not pay the attention toward exploring how COVID-19 may affect FDI inflows in Pakistan. Hence, such loopholes in the existing literature induce the recent study to divulge the dynamic impacts of COVID-19 on Pakistan's FDI inflows to suggest the suitable policies to handle the plausible adverse effects of COVID-19.

Data and econometric methodology

Data

The recent document aims at divulging the effects of COVID-19 on FDI inflows in Pakistan. To this end, we retrieve the monthly data for FDI inflows (FDI) from the State Bank of Pakistan (https://www.sbp.org.pk/). Also, the daily data for new deaths (ND & NC) and new cases due to COVID-19 as a proxy for COVID-19 are taken from the Ministry of National Health Services Regulations & Coordination Pakistan (https://covid.gov.pk/). Besides, the data for energy prices index (EPI) and real exchange rates (EXR) as the control variables are retrieved from the pink sheet of World Bank (https://www.worldbank.org/en/research/commodity-markets) and State Bank of Pakistan (https://www.sbp.org.pk/ecodata/index2.asp), respectively. The data for all-modeled series cover the period from 1st week of March, 2020 to last week of February, 2022. The data for all series are converted into weekly frequency, applying the quadratic sum method [65, 71, 69] in order to make the all-modeled series at the same frequency. Besides, Fig. 5 indicates the overall trends in the selected series.

Theoretical underpinning

The recent study aims at exploring the dynamic effects of COVID-19, energy prices and exchange rate on the FDI inflows in Pakistan. In this context, the study argues that the above independent series are the vital determinants of the FDI. This section presents the theoretical

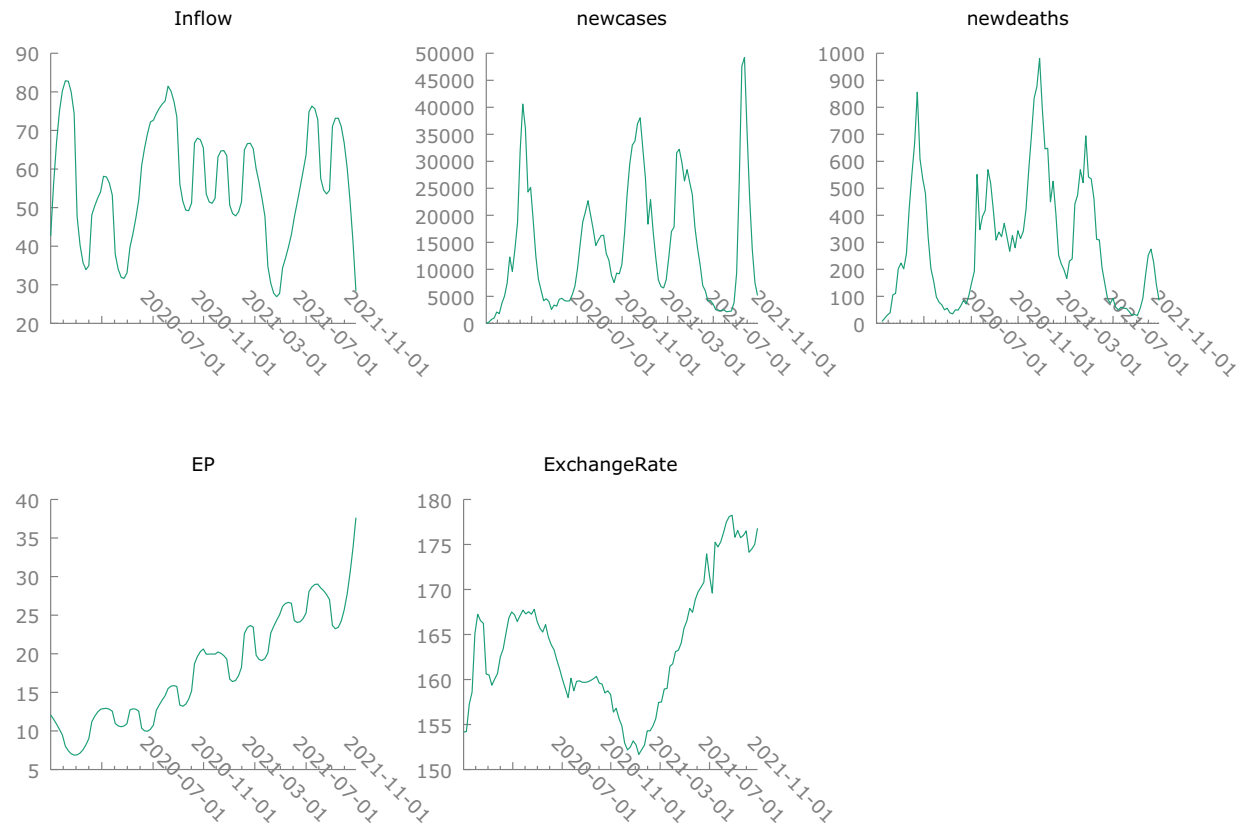


Fig. 5 Overall trends in the selected series

and logical channels through which independent series affect the dependent series. Whereas the logical effects of COVID-19 on the FDI, there are various likely reason by which FDI has face the significant impacts of COVID-19. The outbreak and the subsequent shutdowns and travel restrictions that were implemented to slow its spread have led to a sharp decline in economic activity and a decrease in global trade and investment. Many companies have put their investment plans on hold as they focus on dealing with the crisis, and the uncertainty and unpredictability of the pandemic has made it difficult for them to make long-term investment decisions. Additionally, the economic downturn caused by the pandemic has led to a decrease in demand for goods and services, which has led to a decrease in revenue for many companies, making them less able to invest in foreign markets. Sectors like tourism and hospitality, retail, manufacturing and energy are the most affected by this pandemic, and thus their FDI also declines drastically. The uncertain political and economic environment caused by the pandemic has also made it more difficult for companies to predict the future and assess the risks and opportunities of investing in foreign markets [66, 63].

More importantly, all containment measures taken by the global economies resulted in economic disruption as well as uprooting the globalization that eventually deteriorated the FDI flows, specifically in the developing and emerging economies. More broadly, the inflow of FDI, predominantly, relies on the home nations' supply capacity, host nation's demand, production & fixed costs for FDI in host nation, business freedom ratio, monetary and fiscal policies of host nation [42]. Any change in the aforementioned determinants tends to alter the FDI inflow ratio. Due to COVID-19, the global authorities had to set up several unprecedented containment measures such as, including but not limited, the travel restrictions, international trade restrictions, school, workplace and business closing, and no movement from one to another place. Hence, unprecedented containment measures affected the main divers of FDI inflow. For instance, the travel restrictions, international trade restrictions and closing of factories significantly discouraged the home notions to commence any new business in any other economy. Similarly, such unprecedented containment measures also impeded the host economies to allow the foreign investment to enter in the territory. Likewise, the closing of the local industries and consumers' demand during the COVID period put an enormous pressure on the supply side. It resulted in high inflation rate; eventually, this process increased the production cost and fixed cost of FDI. Also, different kinds of uncertainties also played a critical role in discouraging the FDI inflows in specifically developing nations like Pakistan. Since many studies [30, 9] indicate the detrimental influence of COVID on the essential drivers of FDI, it is rational of assumes the likely but comprehensive effects of COVID on FDI inflows.

Similarly, energy prices can affect foreign direct investment (FDI) in several ways. High energy prices can increase the cost of production for firms, which can make a country less attractive for foreign investment. Additionally, countries that are heavily dependent on the export of natural resources, such as oil and gas, may see fluctuations in FDI based on global commodity prices. If a country has lower energy prices, it can make the country more attractive to foreign investors, as it can lower production costs and increase competitiveness. However, countries with lower energy prices may also have less of a comparative advantage in the production of energy-intensive goods and may not be able to attract as much FDI in these sectors.

On the other hand, if a country has higher energy prices, and it is not abundant in natural resources, it may discourage the foreign investment in energy-intensive industries and decrease the country's competitiveness. Furthermore, countries that have greater access to renewable energy sources may be more attractive to foreign investors who are interested in investing in sustainable energy production [37, 54]. Overall, it can be said that energy prices are one of many factors that can influence FDI decisions and can have both positive and negative effects depending on a country's energy resources and industry structure.

In addition, exchange rates can have a significant impact on foreign direct investment (FDI). A stronger domestic currency can make a country's exports more expensive and less competitive in foreign markets, which can make investing in a foreign country more attractive for companies. On the other hand, a weaker domestic currency can make a country's exports cheaper and more competitive in foreign markets, which can make investing in a domestic company more attractive.

Exchange rate also has an impact on the company's currency-related risks. For instance, if a company is earning revenues in a foreign currency and has to pay expenses in its domestic currency, a depreciation of domestic currency will reduce the value of the company's revenues in domestic currency terms [11]. Additionally, changes in exchange rates can also affect the cost of borrowing for companies and the value of any existing debt they may have, which can also affect their investment decisions. Overall, exchange rate movements can affect the relative costs and benefits of foreign investment, which can lead to changes in the level of foreign direct investment flowing into a country.

Based on the above discussion, we infer that COVID-19, energy prices, exchange rate may deteriorate the FDI inflows in Pakistan as Fig. 6 depicts the expected results.

Model and methodology

Based on the above theoretical discussion, the study claims that COVID-19, energy process and exchange rate are the likely important drivers of FDI inflows. Hence, this tends to formulate the following model which is in the line with Choi et al. [30], Azzimonti [9], Chattopadhyay et al. [18], Chaudhary et al. [19] and Agarwal et al. [3]:

$$\mathrm{FDI}_t = \alpha_0 + a_1\mathrm{COVID}_t + a_2\mathrm{EPI}_t + a_3\mathrm{EXR}_t + u_t \tag{1}$$

where FDI, COVID, EPI, EXR and u_t represent foreign direct investment inflows in Pakistan, novel Coronavirus, energy price index, exchange rate and error term. We use two proxies for COVID-19, i.e., new deaths and new cases due to COVID-19. Hence, the extended form of Eq. 1 after including EPI & EXR can be expressed as:

$$\begin{aligned}\mathrm{FDI}_t =& \alpha_0 + a_1\mathrm{ND}_t + a_2\mathrm{EPI}_t \\ &+ a_3\mathrm{EXR}_t + u_t\end{aligned} \tag{2}$$

$$\mathrm{FDI}_t = \alpha_0 + a_1\mathrm{NC}_t + a_2\mathrm{EPI}_t + a_3\mathrm{EXR}_t + u_t \tag{3}$$

Since the current article aims at investigating the nonlinear effects of COVID-19 with the consort of EPI and EXR on FDI inflows in Pakistan, we tend to deploy QARDL technique propounded by Cho et al. [29]. The QARDL technique has ability to check the long-run quantile-wise effects of COVID-19 and energy prices on FDI inflows that provide the more information while tackling the plausible nonlinearity among the selected series. Also, the QARDL is the extended form of traditional ARDL method; hence, the basic ARDL equation can be expressed as:

$$\begin{aligned}\mathrm{FDI}_t =& \alpha_0 + \sum_i^p a_1\mathrm{FDI}_{t-i} + \sum_i^q a_2\mathrm{COVID}_{t-i} \\ &+ \sum_i^n a_3\mathrm{EPI}_{t-i} + \sum_i^n a_4\mathrm{EXR}_{t-i} + u_t\end{aligned} \tag{4}$$

The above equation represents the ARDL form of our basic model where the lagged variable of dependent series is included in the left hand-side [21, 24–26].

Next, we move toward our proposed model (i.e., QARDL). To this end, we include quantiles of each independent series and the final form of QARDL technique can be written as:

$$\begin{aligned}Q_{\mathrm{FDI}_t} =& \alpha_0(\tau) + \sum_i^p a_1(\tau)\mathrm{FDI}_{t-i} + \sum_i^q a_2(\tau)\mathrm{COVID}_{t-i} \\ &+ \sum_i^n a_3(\tau)\mathrm{EPI}_{t-i} + \sum_i^n a_4(\tau)\mathrm{EXR}_{t-i} + e_t(\tau)\end{aligned} \tag{5}$$

Equation 4 is the final form of QARDL method that represents the long-run estimates. Besides, $e_t(\tau) = \mathrm{FDI}_t - Q_{\mathrm{FDI}_t}(\frac{\tau}{e_{t-1}})$ and $0<\tau<1$ indicates the quantile. In addition, the subsequent pair quantiles τ that belong to 0.10, 0.20,..., 0.90 are deployed to compute the results. The final equation of QARDL that includes short-run estimators can be written as:

$$\begin{aligned}Q_{\mathrm{FDI}_t} =& a(\tau) + \rho_1(\tau)(\mathrm{FDI}_{t-i} - w_1(\tau)\mathrm{FDI}_{t-i} \\ &- w_2(\tau)\mathrm{COVID}_{t-i} - w_3(\tau)\mathrm{EPI}_{t-i} \\ &- w_4(\tau)\mathrm{EXR}_{t-i}) + \sum_{i=1}^{p-1} a_1(\tau)\Delta\mathrm{FDI}_{t-i} \\ &+ \sum_{i=0}^{q-1} a_2(\tau)\Delta\mathrm{COVID}_{t-i} + \sum_{i=0}^{n-1} a_3(\tau)\Delta\mathrm{EPI}_{t-i} \\ &+ \sum_{i=0}^{n-1} a_4(\tau)\Delta\mathrm{EXR}_{t-i} + e_t(\tau)\end{aligned} \tag{6}$$

The above equation exhibits the short-run and long-run effects of COVID-19 and energy prices on FDI inflows in Pakistan.

Since the main purpose of the current document is to explore the long-run effects, we mainly focus on only long-run estimates. Also, we apply Wald test to confirm

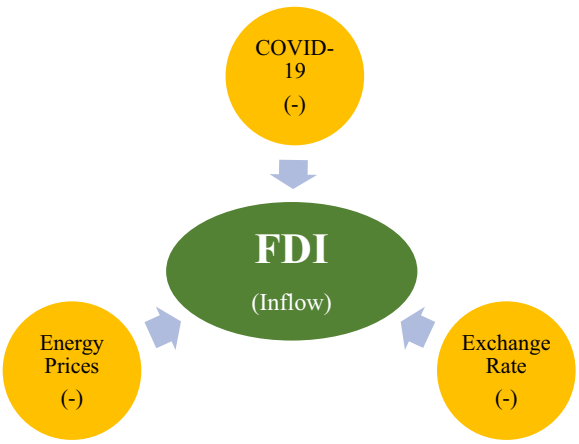


Fig. 6 Theoretical effects of independent series on FDI inflows in Pakistan

the long-run asymmetries among FDI, COVID and EPI [20, 23, 45]. Besides, we deploy quantile unit root test and quantile cointegration tests to affirm the stationarity and long-run association across the series to avoid the spurious results. The notable benefit of the quantile cointegration test [46, 22, 28, 27] is that it considers the nonlinearity while computing quantile cointegration. To confirm the robustness of the results, we rely on two methods. Firstly, we apply quantile Granger causality to confirm the causal nexus in different quantiles. Secondly, the time-varying causality test is used.

Results and discussion

This section moves toward the discussion of the results. In Table 2, the descriptive statistics are reported. The outcome demonstrates that the series of NC possesses the largest mean value (i.e., 14847.25), followed by ND (296.80), EXR (I63.72), FDI (53.72) and EPI (18.08). In addition, all the modeled series have the significant difference among their minimum and maximum values, implying the nonlinear behavior of the series. Besides, the Jarque–Bera test also exhibits the asymmetries across the selected variables. These characteristics induce to deploy the QARDL method to divulge the asymmetric associations among the variables.

Next, we prefer to utilize the quantile unit root (i.e., QAR) test to confirm the stationarity among the modeled variables since the unit test is mandatory to confirm that there is not a single series in the model which is I(2) to avoid the spurious results [32, 62, 68, 74, 77, 78]. The main reason to apply QAR and neglecting the traditional unit root (viz., ADF and PP) tests is that the selected series are not normally distributed and the traditional tests may produce spurious results. Therefore, we prefer to use QAR unit root test in order to obtain robust findings [48]. Table 3 reports the QAR test's outcome and the results indicate that NC is stationary at level from quantile 5th to 9th, ND is stationary at level from quantile 5th to 7th, and EPI is stationary at level from quantile 5th to 7th. The remaining quantiles are stationary at

Table 2 Descriptive statistics

	FDI INFLOWF (FDI)	NEW_CASES (NC)	NEW_DEATHS (ND)	EXR	EPI
Mean	53.72508	14847.25	296.8039	163.7233	18.08372
Median	54.75620	12238.00	252.0000	163.1000	18.48617
Maximum	66.10719	49214.00	981.0000	178.2500	37.64171
Minimum	44.62157	966.0000	19.00000	151.6800	6.865740
Std. Dev	6.500345	11494.32	231.2320	7.200367	7.005058
Skewness	0.115854	0.902966	0.806133	0.346031	0.288340
Kurtosis	1.525617	3.045143	2.937678	2.214823	2.245688
Jarque–Bera	9.466854	13.86957	11.06397	4.792607	3.831577
Probability	0.008796	0.000973	0.003958	0.091054	0.147226

Table 3 QAR unit root test

Quantiles	FDI		New cases		New deaths		EXR		EPI	
	CV	t-stats	CV	t-stats	CV	t-stats	CV	t-test	CV	t-stats
0.10	− 2.25	3.00	− 3.07	1.11	0.993	− 0.70	1.034	− 1.70	− 3.80	− 1.20
0.20	− 2.49	0.49	− 3.61	0.89	0.994	− 0.97	1.420	− 1.77	− 3.81	− 0.37
0.30	− 3.21	− 1.55	− 3.61	0.07	0.994	− 1.20	1.443	− 1.10	− 3.81	− 0.41
0.40	− 3.21	− 1.90	− 3.61	− 0.78	0.995	− 1.60	1.447	− 1.70	− 3.81	− 0.36
0.50	− 3.21	− 2.20	− 3.61	**− 4.90**	0.998	**− 7.39**	1.448	**− 5.09**	− 3.81	**− 4.81**
0.60	− 3.21	− 1.60	− 3.61	**− 5.08**	0.999	**− 6.24**	4.213	**− 5.44**	− 3.81	**− 5.03**
0.70	− 3.21	− 1.80	− 3.61	**− 4.40**	0.997	**− 5.55**	4.662	**− 6.03**	− 3.81	**− 6.40**
0.80	− 3.07	− 1.13	− 3.55	**− 6.77**	0.993	− 1.00	4.662	**− 6.10**	− 3.88	− 1.60
0.90	− 2.97	− 1.68	− 3.50	**− 7.93**	1.012	− 0.09	4.662	**− 6.22**	− 3.89	− 2.12

CV critical values, bold values assert the presence of stationarity, rejecting H_0 of unit root

Table 4 Quantile cointegration estimates

	τ								
	0.10	**0.20**	**0.30**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**
Model 1	13.22***	10.12***	1.40	2.00	2.883***	2.24 ***	2.63***	3.00	7.11***
Model 2	8.17***	5.20***	5.80***	4.10***	3.00***	1.33	5.04***	4.53***	0.92

***Indicate the significance level at 1%

Table 5 QARDL estimates

	Panel A: Dependent variable = New deaths					**Panel B: Dependent variable = New cases**				
Part A										
Quantiles	**Constant**	**ECM**	**Long-run estimates**			**Constant**	**ECM**	**Long-run estimates**		
	$a(\tau)$	$\rho(\tau)$	$a_{ND}(\tau)$	$a_{EPI}(\tau)$	$a_{EXR}(\tau)$	$a(\tau)$	$\rho(\tau)$	$a_{NC}(\tau)$	$a_{EPI}(\tau)$	$a_{EXR}(\tau)$
0.10	3.00***	0.01	0.001	−0.01	−0.001	1.20***	0.03	0.02	0.002	0.001
0.20	2.09*	0.06	0.03	−0.04**	0.003	1.59***	0.06	0.01	−0.003*	0.002
0.30	5.01***	−0.10***	−0.06	−0.04*	0.003	2.00*	−0.10*	−0.03	0.04	−0.005
0.40	1.67	−0.10	−0.10***	0.06	0.006	1.88	−0.02	−0.06	0.07	−0.007
0.50	0.63*	0.13*	−0.13***	0.03	−0.009*	0.97**	0.13**	−0.17**	0.10	0.008
0.60	2.06***	−0.28***	−0.19*	−0.10	−0.01	1.61*	−0.14	−0.13**	0.10	−0.02***
0.70	1.00**	−0.21**	−0.25***	−0.11	−0.03**	3.19**	−0.34**	−0.08**	0.12	−0.04
0.80	2.25*	−0.34***	−0.14**	−0.20**	−0.03***	2.10***	−0.37**	−0.03	−0.15**	−0.06***
0.90	1.88	−0.55***	−0.10	0.27***	0.04*	3.08*	−0.49***	−0.04	−0.35***	−0.08***
Part B: Diagnostic tests										
Adj. R^2	0.82					0.85				
Reset test	0.600					0.721				
CUSUM	Stable					Stable				
CUSUMQ	Stable					Stable				
LM	0.711					0.803				
Durbin–Watson test	d = 2.10					d = 2.14				

***, **, & *Indicate the significance level at 1%, 5% and 10%, respectively

I(1), and similarly, FDI and EXR become stationary after taking first difference. The dissimilar integration orders of the modeled series justify the application of QARDL technique.

Once confirming that not a single series in the model is I(2), we move toward computing the long-run association among the selected variables, applying quantile cointegration test propounded. Table 4 documents that quantile cointegration test affirms the long-run association in both models, implying that the estimation of long-run coefficients will be meaningful and reliable.

Since both models have the cointegration, we confidently compute the long-run coefficients by applying QARDL as reported in Table 5. Hence, we start the interpretation of the results. Firstly, we discuss the results given in panel A in which new deaths due to coronavirus are used as a proxy for COVID-19. The estimated parameters of $\rho(\tau)$ are negative and significant in 3rd, and 5th to 9th quantile in model 1, implying that there is significant evidence of speed of adjustment from short-run disequilibrium to the long-run equilibrium in these quantiles between FDI, ND, EXR and EPI.

Table 5 reports the main findings of the study. Further, Part A documents the coefficients estimations' results, while Part B documents the diagnostic tests. Whereas the effects of ND on FDI are concerned, the coefficients of ND are significantly negative from 4 to 8th quantiles. It implies that the new deaths due to COVID-19 tend to deteriorate FDI inflow level in Pakistan. The reason being, Pakistan's government also follows the instructions of World Health Organization (WHO) just like other economies to handle issue of COVID-19 and to minimize its adverse effects on the economy. On account of COVID-19 outbreak, the Pakistan's government had to set up several unprecedented containment measures such as, including but not limited, the travel restrictions,

international trade restrictions, school, workplace and business closing, and no movement from one to another place. All containment measures taken by the authorities resulted in economic disruption as well as uprooting the globalization that eventually deteriorated the FDI flows in Pakistan. Therefore, the pattern of FDI inflows in Pakistan has indicated a downfall such as the FDI inflow was 2597.5 million dollars in June 2020 and it declined to 1862.8 million dollars in June 2021. Hence, the FDI inflow in Pakistan was decreased by 734.7 million dollars due to COVID-19 [64]. Also, international authorities strictly followed the instructions by WHO in order to handle issue of COVID-19. The same thing also is practiced by the economies who invest in Pakistan. Such process, on the one hand, helped in reducing the harmful effects of COVID-19. On the other hand, this process temporarily also disrupted the economic activities across the economies along with uprooting the globalization. It, ultimately, resulted in curtailing the FDI inflows in Pakistan. This piece of research falls in the line with Agarwal et al. [3] and Chaudhary et al. [19] that deduce the same findings for India and Nepal, respectively. Another notable point is that the middle to higher quantiles (i.e., 4th to 8th) show the significant effects on FDI, indicating that the COVID-19 did not suddenly affect the FDI inflow; however, the loss due to COVID-19 came into account after a time period.

As for as the effects of EPI are concerned, the QARDL estimates determine that 2nd, 3rd, 8th and 9th quantiles exhibit the significantly negative link with the FDI. It indicates that the rise in energy prices tends to shrink the FDI inflow ratio in Pakistan. Generally, the variations in the energy prices lead to create the uncertainty. The uncertainty leads to imbalance the supply and demand markets. It tends to cause the inflation in the economy; this process increases the production cost and decreases the profit ratio. Eventually, this situation discourages the local as well as foreign investment. Hence, FDI tends to decline due to fluctuations in energy prices. In the context of Pakistan, the logical reason behind the fall in FDI is that Pakistan economy suddenly reacts to the international energy prices since it is highly dependent on the imports of oil, gas and petroleum products. The rise in energy prices leads to create the inflation that brings uncertainty. Consequently, it leads to discourage the investment process, and therefore, the FDI inflows also decrease. We can observe that the middle quantiles (i.e., 4th, 5th, 6th and 7th) do not significantly affect the FDI inflow. The reason is that during the first wave of COVID-19, the prices of the energy products tend to decline. Therefore, it shows insignificant effects on FDI inflows.

Furthermore, the findings suggest that EXR's 5th, and 7th to 9th quantile possesses the negative link with FDI, implying that FDI endures the loss on account of an increase in EXR. These findings support the outcome of Balaban et al. [11] who argues that rise in the EXR tends to make the local production expensive which eventually discourages the foreign investors to invest in the host economy. Consequently, this process impedes the FDI inflows.

Moving toward the results of second model as given in Panel B, Table 5, the estimated parameters of $\rho(\tau)$ are negative and significant during 3rd, 5th and 7th to 9th quantile in model 2, implying that there is significant evidence of speed of adjustment from short-run disequilibrium to the long-run equilibrium in these quantiles between FDI, NC, EXR and EPI. Whereas the effects of NC on FDI are concerned, the coefficients of NC are significantly negative from 5 to 7th quantiles. It implies that the new cases of COVID-19 tend to deteriorate FDI inflow level in Pakistan, supporting the results of Panel A. In a similar vein, the QARDL estimates determine that 2nd, 8th, and 9th quantiles of EPI exhibit the significantly negative link with the FDI. It indicates that the rise in energy prices tend to shrink the FDI inflow ratio in Pakistan, supporting results of energy prices given in Panel A. Likewise, the 6th, 8th and 9th quantile of EXR has the adverse association with the FDI, again supporting the outcome of model 1. Hence, it can be inferred that rise in the EXR significantly disrupts the inflow of FDI in host nation.

After discussing the main results, next, we report the several diagnostic tests' outcome in order to assure the reliability of the coefficients estimation. To this end, several diagnostic tests are utilized as Part B in Table 5 indicates. Firstly, the values of adjusted R squired for both models (0.82 for Model 1, and 0.85 for model 2) confirm that the variations in FDI are well explained by modeled independent variables, assuring the goodness of fit of the model. Similarly, the t-statistics of Reset test are insignificant both models, affirming that the models are not misspecified. Also, the stability of CUSUM and CUSUMQ tests shows that the estimated parameters are stable. Further, the outcome of LM tests indicates the models are pure from the issue of autocorrelation. Finally, the Durbin–Watson d-test's statistics are near to 2, implying that again both models are correctly specified. To recapitulate, the diagnostic tests for models affirm that both econometric models are correctly specified and the findings are robust and reliable.

Robustness check

To confirm the robustness of our estimates, we rely on two methods, i.e., quantile Granger causality (QGC) and

Table 6 Quantile Granger causality (QGC) test

Quantiles	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
Model 1									
$ND_t toFDI_t$	12.43***	19.55***	9.64***	11.64***	13.08***	15.14***	18.07***	13.55***	10.64***
$EXR_t toFDI_t$	18.12***	7.76***	8.64***	2.65	1.76	1.05	1.00	12.46***	19.63***
$EPI_t toFDI_t$	15.64***	17.06***	13.77***	14.88***	18.45***	9.54***	17.32***	22.70***	24.02***
Model 2									
$NC_t toFDI_t$	13.00***	10.11***	8.03***	8.60***	12.02***	15.55***	17.12***	9.55***	15.23***
$EXR_t toFDI_t$	2.21	2.04	0.88	1.08	1.60	6.90***	12.30***	12.81***	16.56***
$EPI_t toFDI_t$	10.04***	11.23***	13.43***	15.45***	11.40***	14.63***	20.06***	19.50***	24.14***

***, **, & *Indicate the significance level at 1%, 5%, and 10%, respectively

time-varying Granger causality tests. Firstly, we discuss the outcome of QGC test as Table 6 reports. The results determine that there is a significant unidirectional causal association between ND & NC and FDI that runs from ND & NC to FDI in both models. It implies that any policy shocks to control ND & NC create significant casual effects on FDI. Similarly, we find that there exists a unilateral causal nexus between EPI, EXR and FDI that runs from EPI & EXR to FDI, implying that any policy shocks to EPI and EXR lead to cause the FDI in both models.

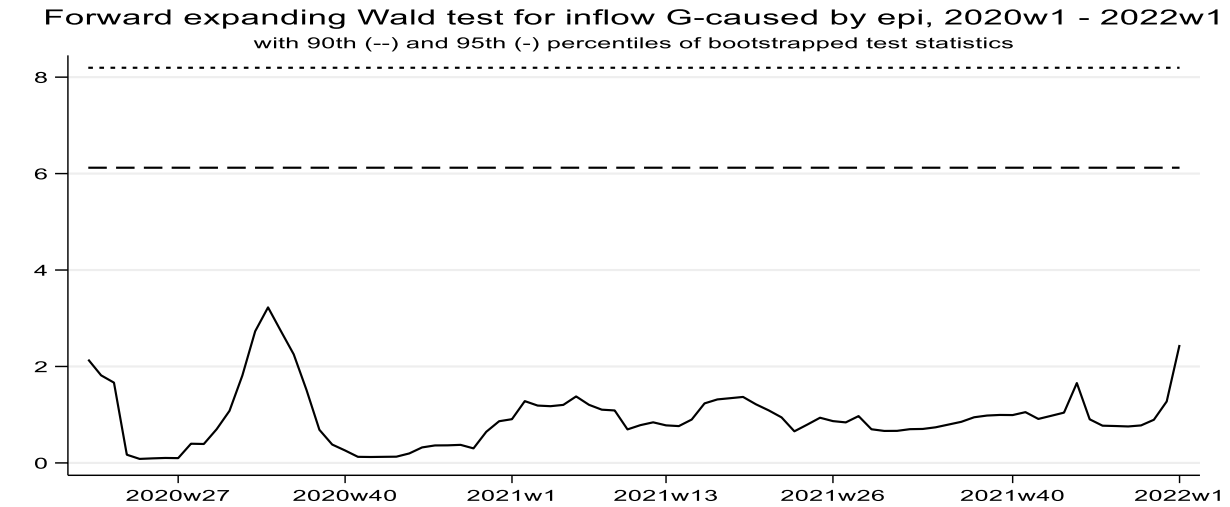
Whereas the second test to check robustness is concerned, we apply time-varying Granger causality (TVGC). Starting from the casual nexus from EPI to FDI as Fig. 7 depicts, the rolling and recursive window tests suggest that EPI significantly causes the FDI. This evidence supports estimates of QARDL. In a similar vein, the results of forward, rolling and recursive window tests presented in Fig. 8 show that ND significantly causes the FDI inflows in majority of the time period, supporting the findings of QARDL for the ND coefficients. Besides, the rolling and recursive window tests indicate that FDI shows a significant response to any change in NC as Fig. 9 indicates. In addition, the rolling and recursive window tests suggest the causal nexus that runs from EXR to FDI, indicating that any policy change regarding EXR tends to affect the FDI inflow in Pakistan (as reported in Fig. 10). Overall, we infer that TVGC test indicates the more significant results when ND is used as a proxy for COVID-19 as compared to NC.

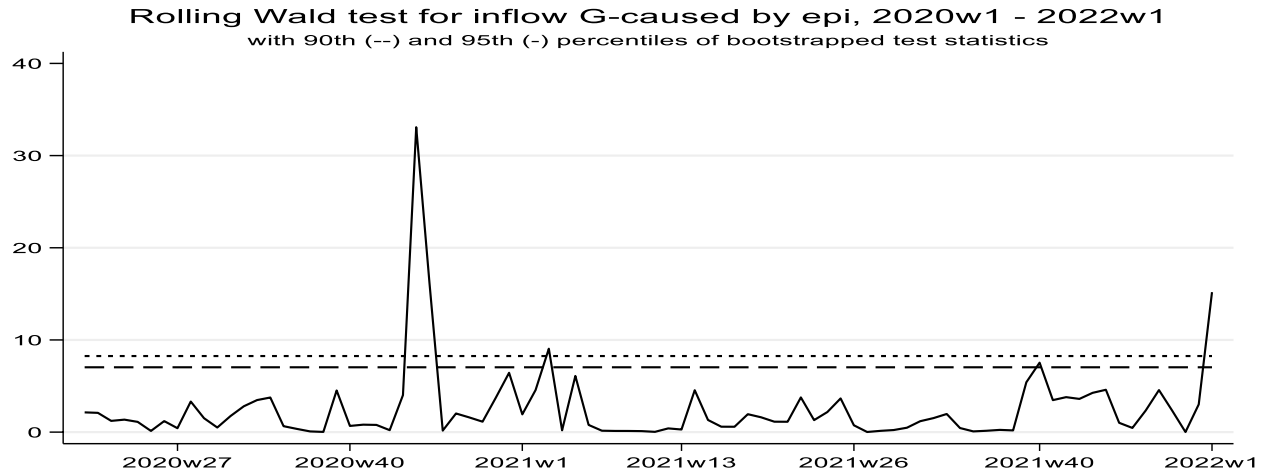
Conclusion

The recent study extends the literature by exploring the dynamic effects of a recent global macroeconomic shock (viz., COVID-19) with the consort of EXR and EP on the FDI inflows in Pakistan. To this end, two proxies (viz., new deaths and new cases) for COVID-19 are deployed to find the reliable and more directional results. For analysis purpose, we use several advanced econometric techniques including QAR test, quantile cointegration test, QARDL technique, quantile Granger causality test and TVGC test. The results of QARDL suggest that COVID-19 significantly reduces the FDI inflows in Pakistan when both proxies are used. However, based on the results, we suggest that the variable of new deaths is more reliable proxy to capture the effects of COVID-19. Similarly, we infer that EPI and EXR also lead to decease the FDI inflows in both models. Besides, the quantile Granger causality and TVGC tests also support our results by confirming the casual nexus from COVID-19 and EPI to FDI.

Based on the computed results, we infer the following policies for recommendation. Firstly, we find that the both proxies for COVID-19 confirm the deteriorating effects of the pandemic on the FDI inflows in Pakistan as some other studies also find the same findings for other global economies. In this context, we suggest the following policies. The phenomena like COVID occur at the global level and these macro-level shocks affect the global economies. Hence, global authorities should encourage the globalization across the economies, while discouraging the anti-globalization propaganda since the globalized economies can help each other to deal with the dilemmas like COVID-19. Also, the policy-makers in developed and developing economies should focus on opening the international borders through free trade agreements in order to trigger the pace of world globalization. The globalization can help in transferring the new technologies and scientific methods in order to handle the all-uncertain shocks like COVID-19 more easily and effectively. Besides, the global authorities should establish a global level forum in order to finance the needy economies during the global crisis due to any macro-level shock.

Secondly, the results indicate that energy prices and EXR also negatively affect the FDI inflows. However, the fluctuations in EPI and EXR lead to create the uncertainty in the local market that bring inflation. Ultimately, it leads to increase the production cost and decrease the





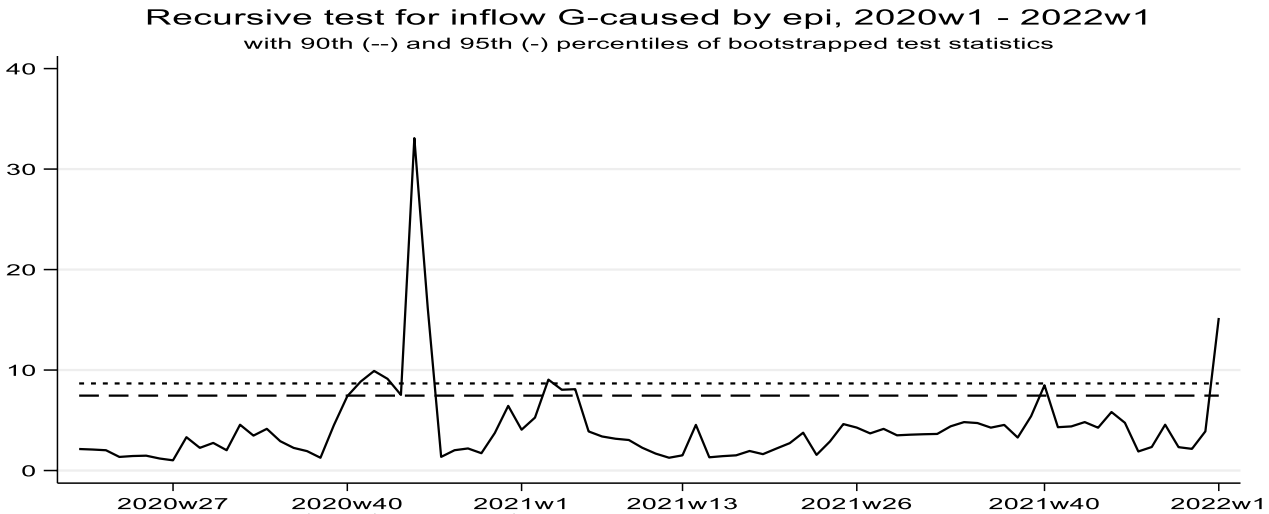


Fig. 7 Time-varying Granger causality test between EPI and FDI

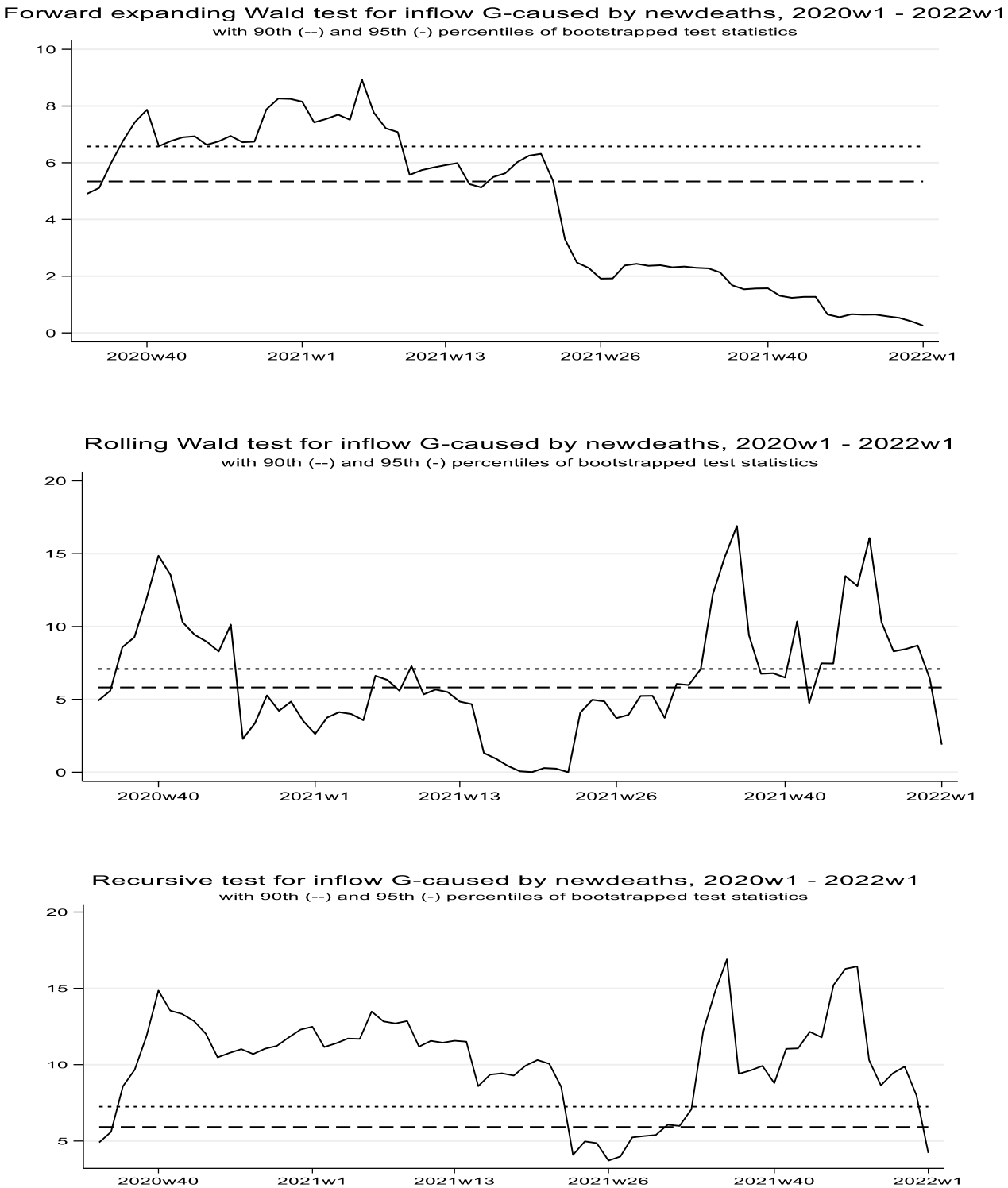


Fig. 8 Time-varying Granger causality test between ND and FDI

profits and this discourages the foreign investors. Hence, FDI inflows tend to fall. To deal with such exigency, the local government can use option of subsidies in order to tackle the uncertainty. Also, the investors can do the hedging to minimize the loss on account of uncertainty. Ultimately, this process can ameliorate the decrease in FDI inflows.

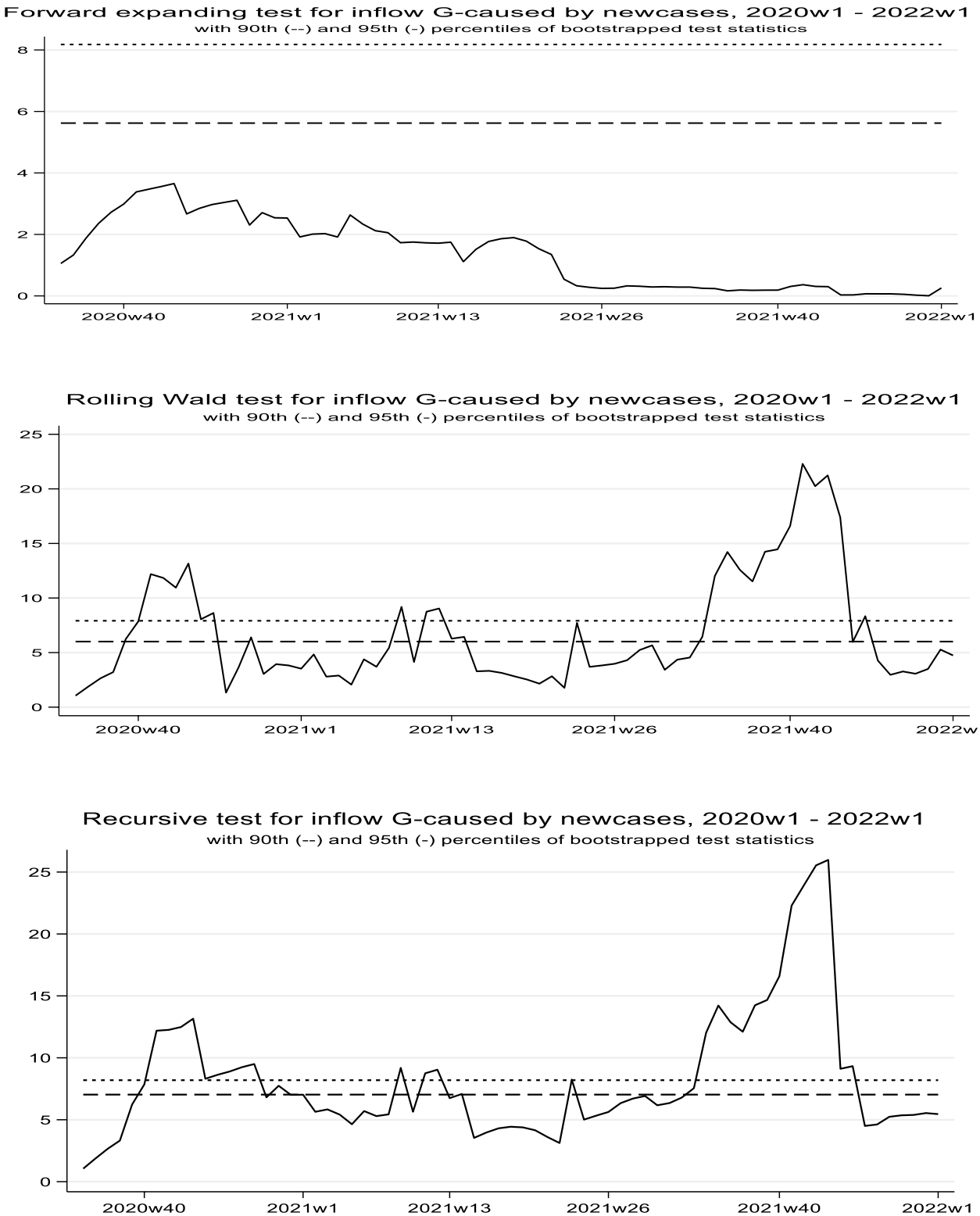


Fig. 9 Time-varying Granger causality test between NC and FDI

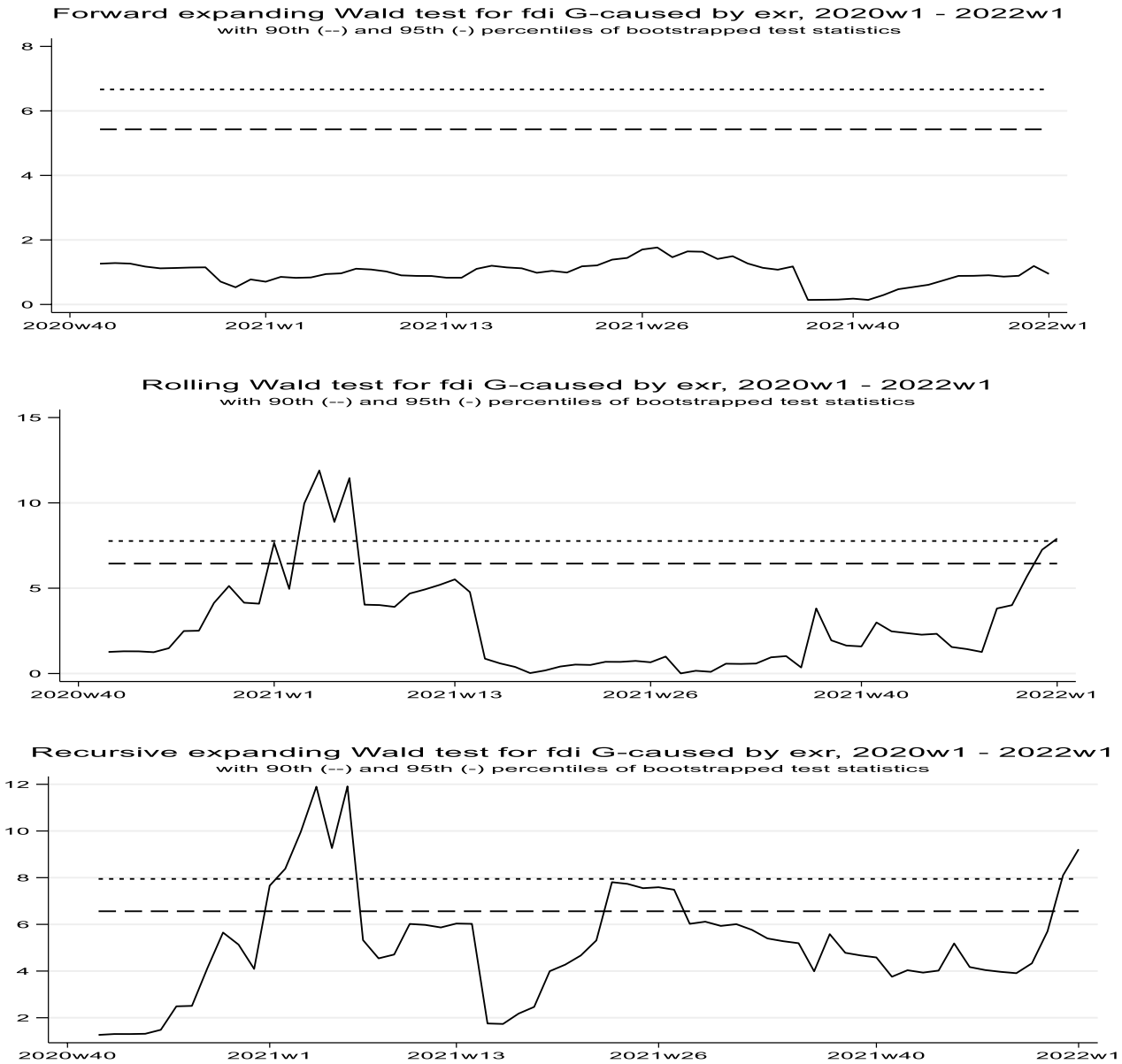


Fig. 10 Time-varying Granger causality test between NC and FDI

Also, the recent study possesses some limitations that can help the future studies to divulge the new sights in the field of economic research. Firstly, the recent document focuses only on Pakistan for the analysis. The researchers are suggested to use the same model for other economies, regions and group of economies such as G-7 and G-20. Secondly, the recent paper applies QARDL technique for analysis. The future studies can use nonlinear QARDL and asymmetric TVGC for more informative results. Lastly, the model of the recent article can be extended by including some other economic variables such as exchange rate, stock exchange assets, oil prices, commodity prices and financial innovation.

Abbreviations

FDI	Foreign direct investment
EPI	Energy price index
EXR	Real exchange rates
ND	New deaths due to COVID-19
NC	New cases due to COVID-19
QARDL	Quantile autoregressive distributed lags
QAR	Quantile autoregressive
TVGC	Time-varying Granger causality

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Author contributions
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