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Ateeb Akhter Shah Syed
State Bank of Pakistan

Kaneez Fatima
University of Balochistan

Mannan Zaheer
State Bank of Pakistan

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The Impact of COVID-19 on Stock Market and Exchange Rate Uncertainty in Pakistan

Dr. Syed Ateeb Akhter Shah · Dr.
Kaneez, Fatima · Mannan Zaheer

Abstract This paper examines the impact of coronavirus (COVID-19) on exchange rate (EXU) and stock market uncertainty (SMU) in Pakistan while controlling for the effects of interest rate and policy interventions by the Government and the Central bank to combat the pandemic. We employ the vector autoregressive (VAR) model over a sample period ranging from February 25, 2020 to May 6, 2021. We find that a shock to total daily coronavirus cases in Pakistan has a positive and significant impact on both the EXU and SMU. However, this impact is short-lived which may be attributed to a timely policy response and risk-averse nature of investors in Pakistan. This result is aligned with a vast literature on pandemics and investors uncertainty and remains robust to several robustness check exercises.

Keywords COVID-19, Stock Market Uncertainty, Exchange Rate Uncertainty, VAR, Pakistan

1 Introduction

The economies of the globe are hit hard by the outbreak of the novel coronavirus disease and Pakistan is not an exception. This paper aims to investigate the impact of COVID-19 on EXU and SMU in Pakistan by controlling the effect of interest rate which is an important policy variable to influence the performance of foreign exchange and stock markets. In Pakistan, the first COVID case appeared on February 25, 2020 and three weeks later the government imposed a strict lock down. The Pakistani stock market posted record losses due to jerks

Dr. Syed Ateeb Akhter Shah
State Bank of Pakistan (SBP)
E-mail: ateeb@fulbrightmail.org

Dr. Kaneez Fatima
University of Balochistan, Quetta

Mannan Zaheer
State Bank of Pakistan (SBP),
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to the sentiments of investors facing the lowest six-year intra-day value, that is, a reduction by 28 percent this year (Jawad and Salah 2020). Similarly, the Pakistani rupee depreciated by about 14 and 16 percent on a year-on-year basis against the US Dollar during March and April 2020, respectively.

To mitigate the impact of the pandemic, the government of Pakistan approved a fiscal stimulus (a package of Rs. 1.2 trillion and Supplementary Grant of Rs.100 billion for the "Residual/Emergency Relief Fund" in relation to provision of funds). In addition, the State Bank of Pakistan (SBP) took several measures to combat the damage to the economy caused by the pandemic. These measures include reduction of policy rate by 625 basis point, extension of time for settlement of foreign currency loans, and several subsidized financing schemes¹. SBP drastically reduced the policy rate to nearly half (from 13.25 percent to 7.00 percent) over the period of three months and 425 basis points in the period of four weeks. This reduction in policy rate helped the credit market; however, it led to an outflow of hot money from Pakistan thereby exerting immense pressure on exchange rate and resultantly increased the EXU.

Theoretically, the strong effect of pandemic on stock market is due to efficient market hypothesis which implies that news and macroeconomic conditions shape investors sentiments regarding the level of uncertainty in financial markets which affects stock prices, returns and volatility (Fama 1970). Since COVID-19 pandemic is a recent phenomenon, literature on this subject is emerging and evolving. However, a few studies explained the relation of COVID-19 cases and capital or forex markets. During pandemics, wars, natural disasters and financial crises, the level of uncertainty in the markets is exceptionally high and so is the level of risk aversion among investors (Baker et al 2020; Eichenbaum et al 2021).

Historically, the stock markets had been responsive to epidemics (Wang et al 2013). The stock markets around the globe reacted forcefully to the COVID-19 which was an unprecedented event for many of these markets (Baker et al 2020). Research shows that instability caused by COVID-19 crashed the markets which transmitted to the rest of the world from China (Contessi and De Pace 2021; Mzoughi et al 2020; Onali 2020; Zaremba et al 2020. Haroon and Rizvi (2020) and ? examined the effect of COVID-19 on stock volatility at industry level and found that stock volatility increases significantly due to COVID-19 and the increase in volatility varies substantially across industries. Exchange rate has also found to be more volatile during the pandemic as shown by Benzid and Chebbi (2020). They document that the change in the number of cases and deaths in the US has a positive impact on USD/EUR, USD/Yuan and USD LivreSterling volatility.

This paper aims to investigate the impact of COVID-19 on EXU and SMU in Pakistan by considering other major factors that influence the performance of stock markets such as interest rate and exchange rate. Most importantly, we consider the measures taken by government in early response to the pandemic such as closure of business activities and implementing smart lock down later by relaxing the restrictions. Several economic measures such as fiscal stimulus

¹ For details of the measures taken by the SBP, visit: <https://www.sbp.org.pk/COVID/index.html>

and easing of monetary policy to mitigate the slowdown in economic activities are also taken into account.

The literature on response of financial markets in Pakistan is however, limited. [Waheed et al \(2020\)](#) tested the impact of COVID-19 on Karachi Stock Exchange (KSE). They provide evidence of positive impact on performance of KSE attributing it to timely response of the Government. However, they do not control for the measures taken by the government and other fundamental economic variables which affected the performance of stock market. [Ahmed \(2020\)](#) attempts to determine the performance of stock market in response to daily positive cases of the COVID-19 fatalities and recoveries. The author finds insignificant impact of positive cases and fatalities on the stock market. This evidence is in contradiction to what is observed globally. This may be due to ignoring the other important factors that influenced the stock market during pandemic such as government interventions which mitigated the impact of COVID-19. Similar, study on foreign exchange markets of Pakistan has been conducted but it does not investigate the impact of daily COVID-19 cases on exchange rate ([Aslam et al 2020](#)). The response of EXU and SMU in Pakistan to COVID-19 by controlling the effects of monetary, fiscal measures and other measures is not investigated in the literature yet. Therefore, this paper contributes to the literature by investigating the response of volatility of the US Dollar to Pakistani Rupee nominal exchange rate (E) and KSE to COVID-19.

2 Data and methodology

We use the daily coronavirus cases (C) as a measure of COVID-19 pandemic, SBP general index of shares price/KSE all shares (S) as a measure of stock market², weighted average overnight repo rate (R) is the interest rate³. Moreover, Pakistani Rupee to US Dollar nominal exchange rate (E) is used as a measure of exchange rate (US Dollar is the reserve currency of Pakistan), while stringency index (SI) is used to account for governments lockdown. EXU and SMU are computed from first difference of log of S and E. There are two reasons for selecting these variables; first, on account of their availability on daily basis, providing us enough observations to carry out a meaningful analysis, and second on the basis of economic relevance to our study. To account for monetary and fiscal measures taken during the pandemic, we add a dummy variable (D)⁴. The data spans from February 25, 2020 to May 6, 2021.

The data on C and SI is available for all seven days of the week whereas data on all other variables is available on working days only. To match the data of C and SI with other variables in the study, the value of the last working day of the other variables is carried forward for the missing days, that is, the weekends

² We also used the KSE-100 index as a measure of stock market; however, the results of the paper qualitatively remained the same

³ We also used the SBP policy rate as a measure of interest rate. The results of the model with SBP policy rate qualitatively remained the same.

⁴ The dummy variable D is coded to take on value of 1 at March 17, 2020 and April 1, 2020 and 0 otherwise. It is because the SBP started to lower the policy rate from March 17, 2020 and an emergency cash program was launched by the government on April 1, 2020

and holidays. Data of C and SI is taken from www.ourworldindata.org and data on all other variables is taken from SBP. All the variables except the interest rate, EXU and SMU are in logged form.

2.1 Measuring the volatility (uncertainty) of the stock market and exchange rate:

Volatility of the exchange rate is measured using the conditional variance of the first difference of log of E (DE) and volatility of stock market is measured using the conditional variance of the first difference of the log of S (DS). The mean model specified using the [Geurts \(1977\)](#) methodology and both the EXU and SMU is obtained from a generalized autoregressive conditional heteroskedastic (GARCH) model [Bollerslev \(1986\)](#). If the mean model is chosen correctly, the residuals from the model should be serially uncorrelated. First, we discuss the volatility of the exchange rate. Table 1 contains the mean and the variance equations. The mean model is an AR(2). Analysis of the Q-statistic in Table 1 show that the autoregressive model of DE produces white noise residuals. To determine if the GARCH model is adequate, [Chowdhury and Wheeler \(2008\)](#) suggest testing the residuals from the GARCH model for serial correlation.

Table 1: Mean and Conditional Volatility Estimation Results for the PKR/USD Exchange Rate (Estimation period: February 28, 2020 – May 6, 2021)

Mean model:			
<hr/>			
$(DS_t - DS_{t-1}) = 0.325398(DS_{t-1} - DS_{t-2}) - 0.095454(DS_{t-2} - DS_{t-3}) + e_t$			
	(2.09)	(3.41)	(1)
<hr/>			
Variance model:			
<hr/>			
$SMV_t = 0.000003 + 0.13040e_{t-1}^2 + 0.44381SMV_{t-1}$			
	(4.90)	(3.24)	(4.43)
<hr/>			
Q-statistic(12) = 8.14, Q ² -statistic(12) = 8.14			
<hr/>			

Note: Q-statistic is the Ljung-Box Q-statistic for the residuals from the mean equation, while Q²-statistic is the Ljung-Box Q-statistic for the residuals from the variance equation. Parenthesis contain the absolute value of t-statistics.

Therefore, we test the residuals from the GARCH (1,1) model for serial correlation using the [Ljung and Box \(1978\)](#). Analysis of Q²-statistic in Table 1 show that the residuals obtained from the GARCH (1,1) model are white noise. Table 1 shows that there is significant ARCH and GARCH effects in S at 5% level of significance. In case of the stock market uncertainty, AR(1,2,4,6) model is chosen as the mean model. The volatility is modelled using the GARCH (1,1). Table 2 shows that there is significant ARCH and GARCH effects in S at 5%

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level of significance. As earlier, same diagnostic tests were applied for checking adequacy of the mean and variance equations. Table 2 shows that the Q and Q2-statistic points towards adequacy of models, respectively.

Table 2: 2 Mean and conditional volatility estimation results for the Stock Price Index (Estimation period: March 9, 2020–May 6, 2020)

Mean model:	
$(DE_t - DE_{t-1}) = 0.100446(DE_{t-1} - DE_{t-2}) + 0.125266(DE_{t-2} - DE_{t-3}) -$	
(2.14)	(2.64)
$0.135876(DE_{t-4} - DE_{t-5}) + 0.153262(DE_{t-6} - DE_{t-7}) + e_t;$	(3)
(2.88)	(3.25)
Variance model:	
$EXU_t = 0.000003 + 0.106293e_{t-1}^+ 0.863466EXU_{t-1}$	(4)
(2.71) (4.50) (34.09)	
Q-statistic(12) = 15.15, Q ² -statistic(12) = 15.18	

Notes: Q-statistic is the Ljung-Box Q-statistic for the residuals from the mean equation, while Q²-statistic is the Ljung-Box Q-statistic for the residuals from the variance equation. Parenthesis contain the t-statistic in absolute terms.

In order to gain an idea of how the volatility of the stock market and exchange rate reacted to the COVID-19 in Pakistan, we plot EXU and log of C, and SMU and log of C in Figure 1 and Figure 2, respectively. Both figures show that EXU and SMU behave almost identically, in response to C; they show that the uncertainty is not constant throughout the period and increases substantially starting end of March to early June 2020 when the coronavirus cases rise sharply.

Both the EXU and SMU dampens from about mid-May to October 2020 which may be attributed to the risk averse behaviour of the equity market and stock market investors and the strict lock down imposed by the Government of Pakistan.

Fig. 1: EXU (Left-hand side) against log of C from March 3, 2020 to May 6, 2021

However, as the second and third wave of COVID-19 started to affect Pakistan around November 2020 and February 2021 respectively, both the uncertainty measures once again experienced a rise (SMU more than EXU) responding to an increase in daily COVID-19 cases in Pakistan. A decreased impact of rising COVID-19 cases may be attributed to the well-known concept of rational expectations, especially for the third wave. Investors already have taken any adverse effects of the rising cases in mind and have adjusted accordingly. Furthermore, the availability of vaccines, which to some extent has already normalized life in Pakistan and elsewhere, may also have contributed to lesser spikes in investors uncertainty.

To empirically investigate the response of EXU and SMU to COVID-19 as

Fig. 2: SMU (Left-hand side) against C from March 3, 2020 to May 6, 2020

shown in the Figures 1 and 2, we use the VAR model for estimation, introduced by Sims (1980). All the variables are tested for stationarity using a series of augmented Dickey-Fuller (ADF) (Dickey and Fuller 1981) tests and found stationary in log-levels/levels. Therefore, we estimate the model in log-levels/levels. The lag length of the variables for the ADF tests is chosen using the Bayesian Information Criteria (BIC)(Schwarz 1978).

The result from the base model is reported in form of an impulse response function (IRF). To compute the IRF, the residuals from the VAR model must be orthogonalized. One technique to compute orthogonalized residuals is Choleski decomposition of contemporaneous relationships. Under the Choleski decomposition, variables in the system are required to be ordered in a particular manner. Variables higher in the ordering contemporaneously influence the variables lower in the ordering and not vice versa.

2.2 Exchange rate uncertainty model

The ordering for our base model is C, R, S, EXU. This ordering is consistent⁵ with the hypothesis we are testing: C is a health crisis driven by the pandemic and is assumed to be exogenous. R is placed next to control for the monetary policy response to the pandemic. A change in interest rate leads to a change in stock market investments, this places S after R. Finally, assuming markets are efficient and financial variables reflect all the available information quickly, EXU is placed last in the ordering. A series of robustness check exercises⁶ have been conducted to ensure robustness of our findings.

2.3 Stock Market Uncertainty Model

In case of the stock market volatility, the ordering for our base model is C, R, E, SMV. This ordering is once again consistent⁷ with the hypothesis we are testing: C is a health crisis driven by the pandemic and is assumed to be exogenous. R is placed next to control for the monetary policy response to the pandemic. A change in interest rate leads to a change in the exchange rate, this places E after R. Finally, assuming markets are efficient and financial variables reflect all the available information quickly, SMU is placed last in the ordering. A series of robustness check exercises⁸ have been conducted to ensure robustness of our findings.

⁵ Our baseline VAR for the exchange rate uncertainty model contains variables C, R, S, EXU and D and it is estimated using 25 lags. The estimation period is from March 22, 2020 to May 6, 2021. For adequacy of the VAR model, the residuals from each VAR equation are required to be white noise. At 25th lag the residuals became white noise. We also tested for serial correlation among the residuals from each VAR equation via a series of [Ljung and Box \(1978\)](#) tests with the null hypothesis of no autocorrelation. The Q-statistics showed that the residuals from each VAR equation in the model are white noise.

⁶ We performed several robustness checks for the exchange rate uncertainty model: First, we added the stringency index as a measure of government intervention (closure of business activities, schools, universities, and other social distancing measures) and placed it after the interest rate variable. Second, we estimated the model by removing the stock market variable. We also estimated a bi-variate VAR (C and EXU) with reverse ordering. All these robustness exercises revealed that the results qualitatively remain the same.

⁷ Our baseline VAR model for the stock market uncertainty model contains variables C, R, E, SMU and D and it is estimated using 31 lags. The estimation period is from April 5, 2020 to May 6, 2021. For adequacy of the VAR model, the residuals from each VAR equation are required to be white noise. At 19th lag the residuals became white noise. We also tested for serial correlation among the residuals from each VAR equation via a series of [Ljung and Box \(1978\)](#) tests with the null hypothesis of no autocorrelation. The Q-statistics showed that the residuals from each VAR equation in the model are white noise.

⁸ We performed several robustness checks for the stock market uncertainty model: First, we added the stringency index as a measure of government intervention (closure of business activities, schools, universities, and other social distancing measures) and placed it after the interest rate variable. Second, we estimated the model by removing the exchange rate variable. We also estimated a bi-variate VAR (C and SMU) with reverse ordering. As China and US are the top two trading partners of Pakistan. Hence, we also used Pakistani Rupee to Chinese Yuan (CNY) as a measure of exchange rate. All these robustness exercises revealed that the results qualitatively remain the same

3 Results and discussion

We start discussion of our results by reporting the results of the ADF tests. Table 3 contains the results of the ADF tests. According to both variants of the ADF test, the variables R, E, C and SI are found to be stationary in log-levels/levels. The variable S is found to be stationary with ADF test containing both the trend and drift but not with the ADF test with drift only. In such a situation [Enders \(2008\)](#), on page 208 suggests performing a joint significance test on coefficient of the first lag of the variable of interest and the trend term. Therefore, we performed a joint significance test on the first lag of S and the trend term. We found these to be statistically significant at 5 percent level of significance. Hence, the variable S is trend stationary in log-levels. Furthermore, both variants of the ADF tests show that all the variables are stationary in first differences.

Table 3: Results of Augmented Dickey Fuller Tests
Augmented Dickey Fuller Test with Drift

Variable	Log-Levels/levels	No of Augmenting Lags (Log-Levels/Levels)	First Difference	No of Augmenting Lags (First Difference)	Critical Value*
S	-0.84	1	-12.38	1	-2.87
C	-13.65	12	-6.37	12	-2.87
R	-3.72	1	-17.28	1	-2.87
E	-1.23	4	-13.87	2	-2.87
SI	-3.42	1	-14.04	1	-2.87

Augmented Dickey Fuller Test with Drift and Trend					
Variable	Log-Levels/levels	No of Augmenting Lags (Log-Levels/Levels)	First Difference	No of Augmenting Lags (First Difference)	Critical Value*
S	-3.48	1	-12.37	1	-3.42
C	-15.99	12	-6.38	12	-3.42
R	-3.49	1	-17.42	1	-3.42
E	-3.56	4	-14.08	2	-3.42
SI	-3.97	1	-14.05	1	-3.42

S: KSE general index of all shares price index, C: Daily total coronavirus cases, R: Weighted average overnight repurchase rate, E: Pakistani Rupee to US Dollar nominal exchange rate, SI: Stringency Index. * denotes critical value reported in the table at 5% level of significance and are taken from Table A in the supplementary material of Enders (2015) at <http://www.time-series.net>; The values in bold shows that the variable is stationary in log-levels/levels or first differences

Second, we report the result⁹ of our estimated VAR models. Figures 3 and 4 shows the response of EXU and SMU to a one standard deviation shock in C from the base model. Figure 3 shows that the shock to C produces a significant and positive impact on EXU for forecast horizons 1 and 2, 8, 23, 27 and 30. At forecast horizons 6, 7, 10, 11 and 18, the impact is significant and negative, while it remained insignificant otherwise. As we can see that, at the earliest horizon the uncertainty was increased by a COVID-19 shock. This is followed by a negative response and it can be attributed to the risk averse nature of investors during the period of high uncertainty about high-risk and return assets once they observe an increased uncertainty due to financial crisis/pandemic. The riskiness of the foreign exchange market is evident from outflow of hot money from Pakistan during mid-2020. Similarly, Figure 4 shows that the response of SMU to a one standard deviation shock in C from the base model.

Shock to C produces a significant and positive impact on SMU for the first 3 forecast horizons, while it remained insignificant thereafter. As the positive and significant impact remained longer than the negative one on EXU, and there is only a significant and positive impact on SMU, our result in line with Onali (2020) and Zaremba et al (2020) among others and indicates that during pandemics, investors uncertainty rises.

Fig. 3: Impact of C on EXU (base model). The figure show VAR-estimated impulse response functions (60 days) for EXU to COVID-19 innovations (solid black line) with confidence bands (dotted black lines)

It is important to emphasize that the experiences of economic crisis such as the great depression of the 1930s and especially the great recession of 2007-09 and the policy responses thereto in the information kit of the economists enabled the policy makers at both the central bank and the ministry of finance to respond with adequate monetary and fiscal policy measures in a timely manner, respectively.

This strong policy responses from the key macroeconomic institutions/offices may explain as to why the impact of COVID-19 on exchange rate and stock market uncertainty in Pakistan is not very strong and as prolonged as it could

⁹ The confidence intervals for the IRFs in Figure 3 and 4 are computed via ten thousand Monte Carlo draws. Following Tillmann et al. (2019), we report the bootstrapped confidence bands indicate the 0.16 and 0.84 percentiles of the draws.

Fig. 4: Impact of C on SMU (base model). The figure show VAR-estimated impulse response functions (60 days) for SMU to COVID-19 innovations (solid black line) with confidence bands (dotted black lines)

have been otherwise. Our claims above are very well supported by the facts shown in figures 5 and 6 below. An analysis of Figure 5 shows that the SBP, supporting the stance of governments austerity measures, maintained a high interest rate of 13.25 percent during the first half of fiscal year 2020 (H1-FY20) and resultantly the stock returns remained low. Due to this consistent policy stance, the exchange market also showed a low level of uncertainty. However, as COVID-19 cases started to appear at the start of February 2020, and to counter the expected adverse impact of COVID-19 on economic activity, SBP sharply lowered the key policy interest rate; Resultantly, flight of capital took place from Pakistan. The stock market returns started to tumble and this outflow of foreign investment triggered the sharp increase in the exchange rate uncertainty around June-August 2020.

Fig. 5: SBP policy response - (dotted black line), Stock Market Returns - (Grey bars), Coronavirus Total Cases (Black bars), Exchange rate Volatility (solid black line)

Similarly, Figure 6 informs us that the business confidence had already started to show signs of deterioration in January 2020, whereas the volatility of the stock market started to rise in February 2020. This uncertainty peaked in

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Fig. 6: SBP policy response - (black dashes), total coronavirus cases - (grey bars), Business Confidence Index - (dotted black line) and Stock Market Volatility (solid black line)

May 2020. However, the Government of Pakistan provided a stimulus package in April 2020; hence, assisting the monetary easing stance of the central bank, following which the investors confidence turned positive and the SMU declined. Finally, the results of such a fast market supportive moves by both the central bank and the central government are evident from the rise in the business confidence. As market confidence rose, and the policy actions started to work, the volatility of the stock market embarked on a declining path and has remain on it except a mild rise in August 2020.

4 Conclusion

The foreign exchange and stock markets unprecedently responded to the COVID-19 pandemic around the globe by an increased level of volatility and decreased returns. However, preliminary evidence in literature for Pakistan is not in line with the evidence on global stock markets (Waheed et al (2020); Ahmed (2020)). In this paper we investigated the impact of COVID-19 on EXU and SMU using a daily dataset covering the sample period from February 25, 2020 May 6, 2021. We control the effect of economic variables, and policy measures of government and the central bank to mitigate the losses posed by the pandemic. We used a VAR model to estimate the impact of COVID-19 on EXU and SMU. Our baseline model shows that both the EXU and the SMU demonstrate a significant rise in their volatility in response to a COVID-19 shock. These results are robust to numerous specifications, change of variables and lag length of the models. These results are consistent with the results reported in the recent literature. However, the response of volatility in exchange rate and stock market became insignificant after a short period. This may be attributed to measures taken by policy makers to manage the damaging confidence and risk averse behaviour of investors.

At this juncture, two points needs to be clarified. First, it is important to

note that the impact of COVID-19 on economic activity using a daily data base is not possible for a developing country like Pakistan¹⁰. Moreover, the first COVID-19 case appeared on 25th February 2020 in Pakistan; therefore, provision of views on how COVID-19 is going to impact the uncertainty in the foreign exchange and stock market in Pakistan is not possible. Second, COVID-19 hit Pakistan in February 2020 and since then, the vaccination has already been completed for majority of age groups in Pakistan, which may further dampen this impact. Hence, it is hard to comment on the long-run impact of COVID-19 on investors (stock market and exchange market) uncertainty. Maybe, if the efficacy of the vaccines remained low and COVID-19 kept on infecting people, researchers down the road may be able to provide some insights on its long-run affects. We leave this as a topic for future research.

Although positive and significant effects of COVID-19 on EXU and SMU are reported; policies did play a strong role in dampening this impact. This may explain why the impact of COVID-19 on exchange rate and stock market uncertainty in Pakistan is not very strong and as prolonged as it could have been otherwise. Our claims above are very well supported by the facts shown in figures 5 and 6. An analysis of Figure 5 shows that the SBP, supporting the stance of governments austerity measures, maintained a high interest rate of 13.25 percent during the first half of fiscal year 2020 (H1-FY20) and resultant the stock returns remained low. Due to this consistent policy stance, the exchange market also showed a low level of uncertainty.

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¹⁰ Some may argue that our models do not have a variable of price and output. In Pakistan, the GDP numbers are only available at an annual frequency. The prices are available at a weekly frequency (Sensitive Price Index). However, original data series on daily basis for an indicator of economic activity and the price level is not available from any official source including the Pakistan Bureau of Statistics (PBS). Furthermore, conducting analysis on monthly dataset was not possible as we only could find ourselves with 16 observations (February 2020 to May 2020, which is low for any kind of meaningful econometric analysis). Therefore, due to this problem at hand, we do not use a measure of economic activity or the price level in our paper.

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