



Least-Square Models with Structural Breaks for Price-Demand Relationship of Prevention-Commodities to Covid-19 Disease: Evidence from Pooled Weekly Data of Hand Sanitizers, Face-Masks and Vitamin-C Supplements

Aziz Ahmed *

Nagina Gul †

Muhammad Shakeel ‡

Vol. V, No. III (Summer 2020)

Pages: 166 – 182

p-ISSN: 2616-955X

e-ISSN: 2663-7030

ISSN-L: 2616-955X



Abstract

The present study employs log-log models and comparatively estimates the price-demand relationship of hand sanitizers, face-masks and vitamin-c supplements as COVID-19 prevention-commodities both before and after the exponential spread of the current pandemic. A novel weekly data is collected and generated by a two-stage stratified sampling technique in a field survey from five capital and most populous cities of Pakistan. The least-square methods with structural breaks are employed for city-wise assessment, while fully modified ordinary least square methods are employed for the pooled panel of Pakistan. The structural breaks are assessed using a priori information via graphical analysis as well as employing the global information criterion of structural breaks. The findings suggest demands and prices structurally surged exponentially after the spread of COVID-19 disease in Pakistan. Thus, implying; i) immediate policy check to stabilize the prices of COVID-19 prevention-commodities for the poor and lower-income groups of people and ii) importing the commodities to fill the existing demand-supply gap to mitigate the spread of the current pandemic as per the World Health Organization benchmark for public prepared-ness to combat COVID-19 disease.

Key Words: Price-Demand Relationship; Public Health Management; World Health Organization, Pandemic Prevention-Pharmacy-Commodities; COVID-19 Structural Breaks; Weekly Pooled Data

Introduction

The pandemic outbreak of novel COVID-19 disease began in December 2019 in the Wuhan province of China. It spread to many countries of the world and caused thousands of death casualties by its accelerated form of spread-ness. On January 30 this year, the World Health Organization (WHO) announced that COVID-19 is a public health emergency of international concern (PHEIC). The WHO reports mention that, “Globally, as of 26 May 2020, at 05:00 GMT+5, there have been 5,406,282 confirmed cases of COVID-19 disease, including 343,562 confirmed deaths, reported to WHO”, in a total of 216 countries/areas/territories throughout the world. The coronavirus updates in Pakistan show that “coronavirus confirmed cases in Pakistan are 58,864, out of which death cases are 1,225, and recovered cases are 19,142 reported as of LAST UPDATED AT 27 May 2020 - 08:59 am”. The positive cases of the current pandemics are adding day by day ([WHO, 2020](#); [Government of Pakistan, 2020](#)).

The WHO benchmark of six-point action plan in its new Global Humanitarian Response Plan (nGHRP) include public prepared-ness to combat it by social distancing, ramp up surveillance and lab testing, prioritizing treatment for the highest risk of severe illness, pre-emptive measures to reduce the burden on health care facilities by using hand sanitizer, use face masks, eating Vitamin-C supplements and other measures, capacity building and sharing of learning and innovation by research and development (R&D) for improving surveillance, prevention,

* PhD Scholar/Lecturer, Department of Economics, Baluchistan University of Information Technology Engineering and Management Science (BUITMS), Quetta, Baluchistan, Pakistan.

† Assistant Professor, Faculty of Management Sciences, Balochistan University of Information Technology Engineering & Management Sciences, (BUITEMS), Quetta, Baluchistan, Pakistan. Email: nagina.gul@buitms.edu.pk

‡ PhD Scholar, Federal Urdu University of Arts, Science & Technology (FUUAST), Islamabad Campus, Islamabad, Pakistan.

and treatment of COVID-19, and to protect the health and humanitarian supply chain for frontline workers to give life-saving care to the global community. It is considered one of the most disastrous crises faced by humans on global earth ([WHO, 2020](#); UN, 2020; [Kannan, Ali, Sheeza and Hemalatha, 2020](#)).

The International Monetary Fund (IMF) reports that the COVID-19 pandemic will shutter the highest costs to humans and economies of the world in the coming years. The mega economic activities of global supply chains, industrial productivities across the countries, contracting national economic growths of major economies, labor force activities across the global labor markets, stock exchange and financial crises will emerge due to the catastrophic impacts of the current pandemic. It is estimated that the global economy is projected to contract sharply by -3 percent in 2020, much worse than during the 2008–09 financial crisis. The report highlights briefly the preliminary estimates for hampering economic growths, low rates and higher national debts policies, projecting financial constraints probably face by global economies and some of the policy measures of economic prudence and public health policies to depict world economic outlook in the context of the COVID-19 pandemic (IMF, 2020).

Similarly, in the context of public health scenarios across the globe and for achieving the targets of nGHRP of WHO, most of the countries around the world have launched COVID-19 combating aid not only for their own countries but also for developing countries to combat the pandemic corona-virus disease. For evidence, the United Nations issues \$ 2 billion to combat COVID-19 on 25th March 2020 for countries at high risk. Similarly, the United States of America has announced US\$ 2.2 billion for its citizens and US\$ 174 million in financial assistance to 64 of the most at-risk countries facing the threat of COVID-19. The governments throughout the world facing the COVID-19 threats are continuously engaged in mitigating the impacts of the pandemic crisis by generating and allocating public funds within their financial limitations ([WHO, 2020](#); [US State Department, 2020](#); [USAID, 2020](#)).

The public health guidelines mention that the usage of face-masks, washing hands with soaps and hand-sanitizers and taking vitamin-C supplements are recommended as preventive measures to appease the widespread of Coronavirus disease in public ([CDC, 2020](#); State Council China, 2020; WHO, 2020). However, the market response to demand and prices of prevention-commodities to COVID-19 has got a new trend of exponentially increasing in most of the developing countries like Pakistan, Indonesia, India and the even United States these days. For instance, the prices of hand-sanitizer, face masks and vitamin-C supplements show negligible rising trends before mid-January 2020, and the prices got substantial increase after the COVID-19 disease cases reported on media. The contrast of rising prices, before and after the coronavirus disease, show a phenomenon the economists have different opinions. Some economists consider rising prices and higher demand good signs for more productions of the commodities in demand by businesses and producers. A group of other economists strongly discourage rising prices and suggest government prices regulatory policies to respond (the Economist, 2020; [Kannan, Ali, Sheeza and Hemalatha, 2020](#)).

The prices and demand of hand-sanitizer, face masks and vitamin-C supplements as prevention-commodities to COVID-19 disease show an exponential surge in prices after the outbreak of the contemporary pandemic disease. This is alarming as per the opinions of the second class of economists who are not in favor of abnormal profiteering by the businesses and who advocate non-excludability of the people with lower income echelons (i.e. 50 to 65% of the whole population of Pakistan that is approximately equal to 100+ million population) that cannot afford to purchase COVID-19 prevention-commodities at exponentially increasing prices (Figure, 1-10) to combating the disease (Population Census, 2017; Government of Pakistan, 2020; the Economist, 2020).

For Pakistan, it is estimated that 20 million people would probably get COVID-19 disease if social distancing, tight regulatory policies, following the six-point agenda of nGHRP of WHO, and most importantly, the price stability and imports of COVID-19 prevention-commodities are not intact and implemented as per tight government policy regulations in contemporary times of probable/expected coronavirus pandemic (Geo News, 2020; DAWN News, 2020; The Economic Times, 2020).

The literature related to containing the spread of COVID-19 also suggests the use of COVID-19 prevention-commodities along with the following six-point agenda of nGHRP of WHO and nationally approved health care tips announced by the government of Pakistan (WHO, 2020; Government of Pakistan, 2020). Yet, there are different but not effective remedies identified by the scientists to cure COVID-19 disease promptly. To save the

accelerated spread-ness and mitigate the increase in confirmed cases, experts are of the view that pre-emptive measures like using Vitamin-C supplements, washing hands with sanitizer and soap and using face masks to stop squeezing and cough droplets are effective ([Thevarajan et al., 2020](#); Wang and Wang, 2020; [Feng et al., 2020](#); Nkangasong et al., 2020; Nature News, 2020; NIH, 2020; ([CDC, 2020](#); State Council China, 2020; WHO, 2020).

This paper highlights preliminary estimates of the price-demand relationship of prevention-commodities of hand sanitizers, Vitamin-C supplements, and face masks to combating the COVID-19 disease. The selection of the mentioned three prevention-commodities is based on wide literature, guidelines and recommendations of [CDC \(2020\)](#), State Council China (2020) and WHO (2020). For doing so, a least-square model with structural breaks is employed for pooled weekly data of prices and quantity demanded of the prevention-commodities before and after the pandemic outbreak in Pakistan.

The scientific contributions of the study may touch on the scope of health economics, economical prices of treatment commodities during the global epidemics amid the slack government regulatory policies to stabilize markets in developing countries (like Pakistan), statistical contributions to add COVID-19 factor into prevention-commodities price-demand function, data generation of prices and demand of prevention-commodities to coronavirus disease before and after pandemic disease outbreak in the perspective of Pakistan, higher profiteering behavior of the medical/pharmacy stores/retailers/sellers amid pandemic disease. The study may also support the R&D innovation and sharing appeal of point Also, guideline suggested to the academicals supporting the appeal of nGHRP of WHO in the perspective of a developing country located in the most populous South Asia.

Research Methodology and Data Collection

It is a field survey study conducted in the five most populous cities of Pakistan. Two stages of stratified sampling technique are used for primary data about the prices and quantity demanded of the three prevention-commodities to COVID-19. In the first stage of the sampling technique, five cities are selected, including twin cities of national capital (Islamabad and Rawalpindi) and four provincial capitals and the most populous cities (Karachi, Lahore, Peshawar and Quetta) of the four provinces of Pakistan. The selected most populous and capital cities are included in the survey, where approximately 25% of the national population reside. In the second stage, each city is distributed into four different and demographically distinct locations to generate and collect data. The data of quantity demanded is collected from invoices records and on counter prices charged per units of the prevention-commodities in selected medical/pharmacy stores located in each of the four locations of each city. The data is collected from those medical/pharmacy stores that only deal in drugs selling to final customers as per the licenses approved by the drugs inspection directorates of the provinces concerned ([Government of Pakistan, 2020](#); Population Census, 2017; Election Commission of Pakistan, 2020).

The data of prices and quantity demanded of each commodity is pooled over 39 weeks of time intervals, starting from the first week of July-2019 to the last week of March-2020, and across five selected cities for analysis of this study. A total number of observations reached weekly pooled data of 195 (39*5) for graphical and statistical/econometric analysis of this study (e.g. see [Thalanany, 2008](#); Population Census, 2017; [Leman, 2010](#); Finance Ministry, 2019).

This study uses data about three COVID-19 prevention-commodities of hand sanitizers, face-masks and Vitamin-C supplement approved by most of the medical and healthcare practitioners, scientific professionals and virologists/microbiologists as pre-emptive measuring tools to stop the spread-ness of COVID-19 disease further ([CDC, 2020](#); [Government of Pakistan, 2020](#); NIH, 2020; WHO, 2020). These commodities are generally available in medical stores, and both their quantity demanded and prices have increased many folds after the outbreak of COVID-19 pandemic disease in Pakistan (Figures 1-10). The number of face-masks is measured in a pack of 50 pieces of face masks, the quantity of Vitamin-C supplements is measured in a bottle of 1000 gram in the shape of tablets, and the unit of hand sanitizer is measured in a 1000/ml pump bottle. The prices are measured in local Pakistani currency of rupees at current nominal values as a unit of measure for this study. These units of measurement are in-line with most of the available stuff and purchasing records of retail, medical/pharmacy stores for the commodities. The following table show data collection cities and their locations of the two-stage stratified sampling technique employed in this study (Table 1; Pakistan Bureau of Statistics, 2020). Therefore,

the researchers use the calculated averages of each variable of quantities demanded and prices charged of the selected three COVID-19 prevention-commodities for each city, and it is nevertheless somewhat unambiguous that those averages are almost close to the true value in each location of the same city (Table 1; Figures 1-10).

Table 1. Data Collection Cities and Locations by two Stages of Sampling Technique

S. No.	Cities (Stage-1)	Location in Cities (Stage-2)	No. of Observations for units of Quantities and Prices on a weekly basis
1	Islamabad (Federal capital city)	1. Sector G-6 (Aabpara market) 2. Sector G-7 (Blue area)	39 observations from each location
2	Lahore (Provincial capital & highest populous city of Punjab)	1. Anarkali Bazar 2. Model town 3. Gwalmandi 4. Shahdra	39 observations from each location
3	Peshawar (Provincial capital & highest populous city of K-Pashtonkhwa)	1. Hayatabad 2. Bara Gali 3. Dispensary road Wadpga	39 observations from each location
4	Quetta (Provincial capital & highest populous city of Balochistan)	1. Kakar colony 2. Saryab road 3. Dr Bano road	39 observations from each location
5	Karachi (Provincial capital & highest populous city of Sindh)	1. Clifton area 2. Behria colony 3. Saddar Karachi 4. Shershah	38 observations from each location

Source: Survey design & data collection sampling by authors

Graphical Analysis of Price-Demand Relationship

Utilizing the given data set, the researchers have analyzed graphical trends in the prices charged and quantities demanded (variables) of the three precautionary commodities for preventing COVID-19, i.e. hand sanitizer, face-masks, vitamin-C supplements. The trends in these values are absolute and not in log-form. Since the objective is to empirically estimate the price-demand relationship for the selected three prevention-commodities of COVID-19, the graphs show that the price trends are relatively different before and after the outbreak in the capital cities of the country. It is, therefore, plausible in formulating the modeling framework for general analysis.

Specifically elaborating the graphs of each city, it is shown that the demand-price relationship is stable, and there are somewhat similar movements in direction-wise context and a standard increase in price before the COVID-19 spread (before the first week of February 2020), and there is almost negligible change in the quantity demanded shown for face-masks, vitamin-C supplements and hand sanitizers in Islamabad. It is, nonetheless, intriguingly clear that this demand-price relationship breaks and the trends are shown on the rise exponentially between the prices charged and quantities demanded of COVID-19 prevention-commodities after the spread of COVID-19 in Islamabad (Figures 1 & 2).

In a similar way, the trends before the COVID-19 spread (before February) in Lahore corroborates somewhat similar patterns like that of Islamabad. A notable difference between graphical analysis of Lahore from Islamabad is that the prices charged in Lahore for face-masks and hand sanitizers are shown double than those shown for Islamabad after the outbreak of the COVID-19 epidemic (Figures 3 & 4).

Similarly, the trends of prices charged by the medical store retailers and quantities demanded by customers in the most populous city (Karachi) of Pakistan show almost the same pattern of trends for a demand-price

relationship as that shown for the second populous city of Lahore. It implies that the two most populous cities of Pakistan show somewhat similar behavior in market estimates for the demand-price relationship for the prevention-commodities of COVID-19 disease in Pakistan (Figures 5 & 6).

The trends of price-demand relationship for prevention-commodities of COVID-19 disease in both Quetta and Peshawar also demonstrate that before the spread of COVID-19, there is a somewhat stable relationship between the variables of prices charged and quantities demanded face-masks, vitamin-C supplements and hand sanitizers. This relationship between demand and prices of life-saving preventing-commodities change in similar ways as shown for other capital and most populous cities after the spread of COVID-19 disease in Pakistan (Figures 7 & 8 for Peshawar; Figures 9 & 10 for Quetta).

Graphical analysis of the price-demand relationship (Tables: 1-10): City-wise

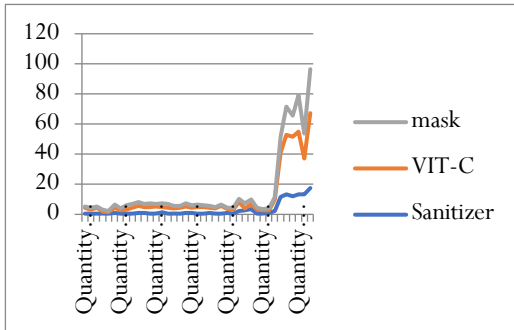


Figure 1: Prices Charged City: Islamabad

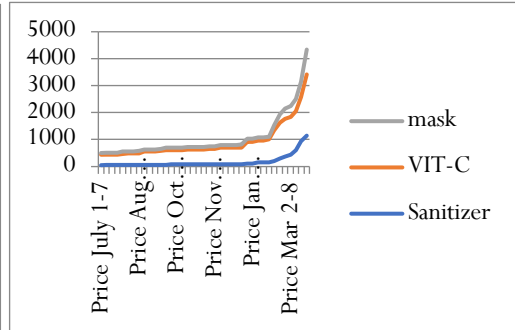


Figure 2: Quantities Demanded City: Islamabad

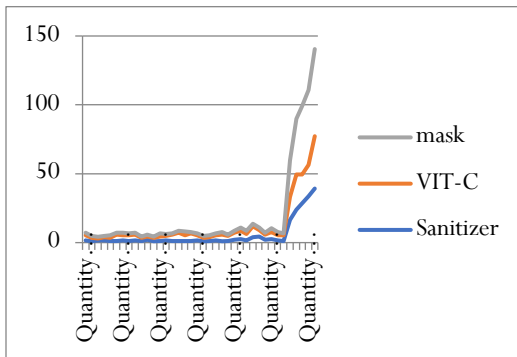


Figure 3: Prices Charged in City: Lahore

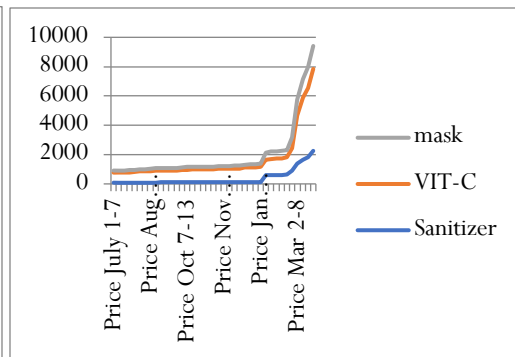


Figure 4: Quantities Demanded in City: Lahore

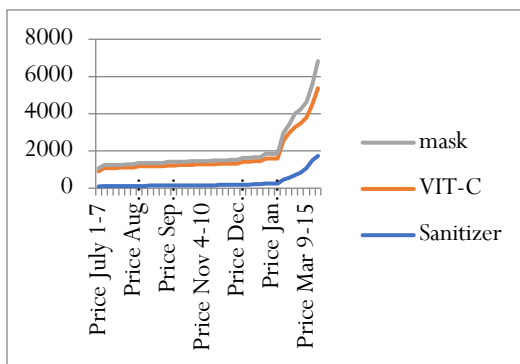


Figure 5: Prices charged in City: Karachi

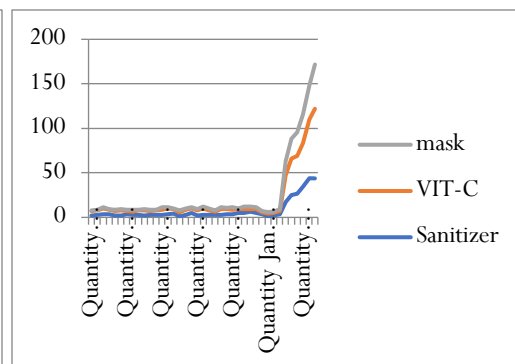


Figure 6: Quantities Demanded City: Karachi

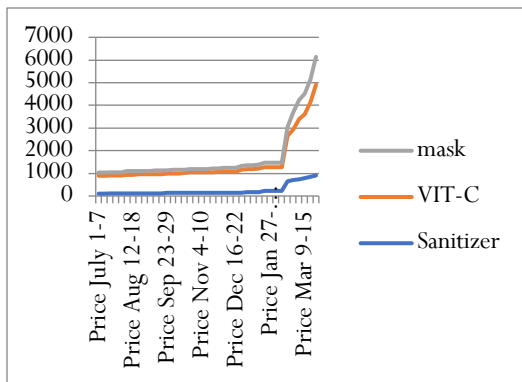


Figure 7: Prices Charged in City: Peshawar

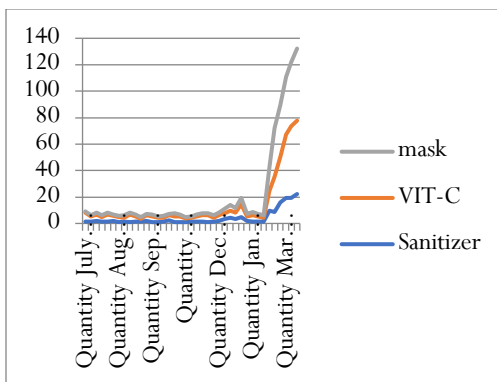


Figure 8: Quantities Demanded City: Peshawar

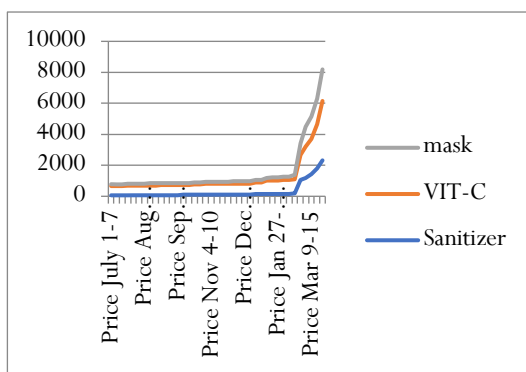


Figure 9: Prices Charged in City: Quetta

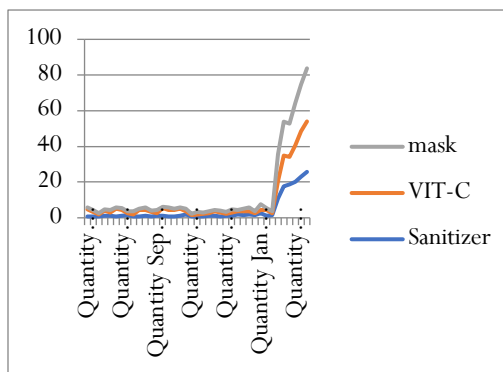


Figure 10: Quantities Demanded City: Quetta

Notwithstanding, the spread of the COVID-19 disease leads to an increase in the demand for these products many-fold and therein corroborates a surge in both the quantities demanded and prices of this product, *ceteris paribus*, in major cities of Pakistan. The graphical analysis of weekly average data implies that price increase does not reduce the demand for these life-saving products in major cities of Pakistan. Nonetheless, the existing scenario amid COVID-19 spread will increase the demand manifold for prevention-commodities of COVID-19 disease, *ceteris paribus*, in a demand-price relationship in the context of weekly collected from the records of the price charged at counter and quantity demanded by customers in major cities of Pakistan.

The abnormal/expedient surge mostly in prices of these preventing of COVID-19 commodities implies for effective and price regulatory role of government in major medicine and life-saving drugs markets in Pakistan to support its national agenda for preventing of this epidemic disease and practically abide by the six-point agenda of nGHRP of WHO for slowing and vanishing the novel corona-virus epidemic for sustainable national health preservation of the Pakistani public at large. Since the higher prices for the selected commodities to preventing COVID-19 fast spread-ness among the poor are beyond the scope of purchasing power of the poor people and people with lower income echelons in populous cities of Pakistan. Thus, the existing trends are shown in the price-demand relationship suggest for quarantine practising, social distancing, the lockdown of social congregations, keeping good hygiene, and using of natural products as alternate to the studied three prevention-commodities of COVID-19 disease as precautionary health care measures and tools to control the adverse effects of COVID-19 (WHO, 2020; [Government of Pakistan, 2020](#), NIH, 2020).

Empirical Model and Estimation Methodology

For strengthening scientifically and statistically further the authenticity of the above-graphed demand-price relationship, the following two sections are devoted to; a) elaborating the empirical model of the price-demand relationship as the theoretical background of this study and b) empirically estimating the relationship by applying least square methods with structural breaks for city-wise assessment and fully-modified ordinary least square methods with structural breaks for the pooled panel data of Pakistan.

An Empirical Model for the Demand-Price Relationship of Prevention-Commodities to Combat COVID-19 Disease

This study employs the standard log-log model of demand-price relationship for the selected three prevention-commodities to COVID-19 disease, and it is specified in the following equation (1) as;

$$\log D(Q_i) = a + b \cdot \log(P_i) + \mu \quad (1)$$

In equation (1); Q_i is used to show quantities demanded prevention-commodities to COVID-19 disease, and i stands for three commodities of hand-sanitizers, face-mask and Vitamin-C supplements demand by the customers; P_i indicates respective price charged of the commodities at counters of medical stores in five cities of Pakistan, a is a constant term, and b represents the elasticity of demand (% change in quantity demanded due to % change in price) of each prevention-commodity. The last term μ is used to show the random term of the model shown by equation (1).

Assumptions of equation (1) include no other factors influencing the equilibrium quantities and prices of the three commodities taken for in this study. The substitution and complementary effects are held constant. Similarly, other factors of demand and supply of the three commodities discussed in this study are also held constant. The quantities demanded are equilibrium quantities that are equal to quantities supplied at equilibrium prices (charged at counter prices) by the medical/pharmacy stores where the data of prices and quantities demanded are collected for this study. It is confined to keeping the effects of all other related variables fixed, like the price of other related goods and the income of the customers. These are plausible assumptions because economic theory/insights to-date guide us clearly that consumers have no close substitute(s) of life-saving commodities, especially in the short run. And patients consume relatively a small and fixed share of their income on life-saving commodities to purchase ([Adler, 1995](#); among others). Nonetheless, this specification is reliable with the existing scenario of the COVID-19 spread in the country wherein the quantity demanded, and prices of these three commodities are mounting in Pakistan. Also, this study has analyzed two estimates with respect to the modeling framework; one before the spread and the second after the spread of COVID-19. Thus, focusing inter alia on the COVID-19 preventive commodities will be insightful as the usage of these commodities mitigate the expected risks/death-toll of the disease at individual and aggregate levels simultaneously (Godey and Huitfeldt, 2020; [Van den Berg et al., 2017](#)) as well as of COVID-19 spread specifically (WHO, 2020).

In short, equation (1) is designed to empirically assess the own-price effects of the commodities discussed, both before and after the pandemic COVID-19 spread, therein discussing the current scenario both for public and government awareness to combat the disease as per the WHO and nationally prescribed guidelines in Pakistan.

Estimation Methodology for Estimating the Demand-Price Relationship of Prevention-Commodities to Combat COVID-19 Disease

In the first instance, the econometric methodology of least square with structural breaks has been employed to assess the city-wise models. This methodology uses global information criteria of a structural break with using Shawaraz Information Criterion (SIC) to select the multiple break date (see [Bai and Perron, 1998](#); [Bai and Perron, 2003](#); for details). The econometric properties of this global M-break optimizer are the set of breakpoints and corresponding to consistent least square estimates that minimize the sum of squared residuals across all possible sets of M-break partitions using the information criterion method ([Nunes et al., 1995](#); [Liu et al., 1997](#)).

Next, the fully modified ordinary least square (FMOLS) methodology has been employed to estimate the pooled-panel of Pakistan. FMOLS has been shown to provide consistent and robust estimates due to controlling the nuisance parameter wherein autocorrelation, and potential endogeneity is tackled with non-parametric adjustments. Moreover, the global M-breaks criteria are also employed to assess the structural break of the data by utilizing a priori information from the graphical analyses shown in the previous section of this study ([Pedroni, 2000; 2001](#)).

Nevertheless, both estimations are robust as heteroskedastic autocorrection (HAC) corrected errors and covariance have been considered for city-wise regressions, and panel corrected standard error has been considered for the panel of Pakistan based regression ([Pedroni, 2000; 2001](#)). Therefore, the researcher provides robust estimates of the price-demand relationship of the COVID-19 preventive commodities selected for this study.

Results and Discussion

For empirical estimation of the demand-price relationship for prevention-commodities to combat COVID-19 disease, the estimation procedures have employed HAC standard error, and covariance robust ordinary least square methods with structural breaks wherein provide robust estimates of the demand-price relationship for pandemic COVID-19 prevention-commodities in Pakistan. The structural breaks are computed using global breaks determination using Schwarz Information Criteria (SIC), as mentioned earlier. Thus, these results are consistently providing the estimates both before and after the pandemic of COVID-19 in the context of a developing country like Pakistan. The next two sub-sections elaborate the results for each five capital cities selected and vis-à-vis, combining these five cities into one panel, indicating the overall country findings considering the main objectives of the study.

City-Wise Discussion on Prevention-Commodities of COVID-19 Disease

The present city-wise discussion attempts to highlight the incidence of the outbreak of COVID-19 on the market demand and prices and estimates of own prices of hand sanitizer, face-masks and vitamin-C supplements in each of the capital and highly populous city of Pakistan. It is nonetheless stated that the demand-price relationship employs global information criteria to empirically assess the structural breaks for each city. Nevertheless, the graphical analysis is previously shown in the 2nd section also guides us about the month of a surge in the prices/demands of these products, indicating the structural break date on a priori basis amid the second to the third week of February 2020. The discussion on each of the three commodities is elaborated on separately.

Hand Sanitizers

The estimates of the quantity demanded of sanitizer is initially insignificant before the date of a first break (i.e. December 30, 2019), and then onwards, it becomes highly elastic till the outbreak of the COVID-19 in the second week of February in capital twin cities of Islamabad and Rawalpindi (Table 2). The estimates after the 3rd break from February 10, 2020, indicates that the demand becomes positive and inelastic, implying that people in the capital city of Pakistan are less concerned about the exponential rising prices of the hand sanitizer due to the spread of COVID-19 disease and people are compelled to purchase at higher prices to save their lives from the epidemic disease of corona-virus.

In a similar way, the findings for own-price effects of the quantity demanded of hand-sanitizer in Lahore city is initially insignificant before the date of the first break; December 16, 2019, and then onwards, it becomes highly negative elastic till the outbreak of the COVID-19 in the second week of February 2020. The estimates after the 3rd break from February 17, 2020, indicates that the quantity demanded by consumers becomes positive and inelastic (value, 0.80) to price rise, implying that people in Lahore are less concerned about the rising prices of the hand-sanitizer due to the spread of COVID-19 disease (Table 3).

The findings of own-price effects of the commodity of hand-sanitizers for the data of most populous and the most hit-city of COVID-19 in Pakistan (Karachi) demonstrate the demand is initially insignificant before the date of the outbreak of COVID-19 disease. After the COVID-19 outbreak in the city of Karachi, the own-price effects

become highly positive and inelastic the outbreak of the COVID-19 disease in Karachi. The estimate indicates that its demand becomes positive and inelastic (value, 0.82) to its price rise, implying that people in Karachi are not priced sensitive for the purchasing of hand-sanitizers, *ceteris paribus*, amid the COVID-19 in Karachi. The consumers want more quantities of hand-sanitizers, even at a higher price, to save their lives from the infection of corona-virus expected inflicting after its outbreak (Table 4).

In a similar way, the finding for own-price effects of the demand of hand-sanitizer in Peshawar city is initially significant and inelastic (value, -0.47) before the date of the first break; December 16, 2019, of the pandemic. The estimates then become insignificant till the outbreak of the COVID-19 in the second week of February (Table 5). The estimate after the 3rd break from February 17, 2020, indicates that the quantity demanded of hand-sanitizers becomes positive and elastic (value, 1.80) to price rise, implying that people in Peshawar are less concerned about the price surge of hand-sanitizers and people give more weight to their health to protect after the spread of COVID-19 disease.

The case of city Quetta is the same about the demand-price relationship and its least square estimates of hand-sanitizers with structural breaks. The estimates after the 3rd break from February 17, 2020, indicates that the demand becomes positive and more inelastic (value, 0.34) to price rise. This indicates that people in Quetta are less concerned about the price surge of hand-sanitizers and more conscious about their health after the spread of COVID-19 disease in the city (Table 6).

In such scenarios of a surge in prices of hand-sanitizers as one of the preventing-commodities of COVID-19 disease has the likelihood to exclude people of lower-income groups from getting hand sanitizers as a pre-emptive cleaning tool, thus resulting the low-income group to face more chances of inflicting upon the coronavirus disease and accelerate COVID-19 spread in the vicinity of Islamabad, Lahore, Karachi, Peshawar and Quetta respectively (Tables 2-6). The globally set efforts to combat COVID-19 disease may also be hampered, and the contemporary epidemic spread of COVID-19 may not be contained as mentioned in the six-point agenda of nGHRP of WHO. The reported positive cases of COVID-19 in all the major cities are evidence of the spreadness of the pandemic.

Face Masks

Likely, the findings for own-price effects of face-masks demonstrate that, in Islamabad, its demand is shown highly elastic before the date of 1st break on October 10, 2020, and then it becomes relatively insignificant till the outbreak of COVID-19 after the second week of February 2020 (Table 2). The estimate of the own-price effect becomes relatively positive and inelastic due to the pandemic spread in February 2020, thus implying that consumers care less about the price-rise of face-masks and instead to purchase the masks as preventing-commodity to COVID-19 disease in the capital twin cities of Pakistan.

Similarly, the findings for own-price effects of the commodity, face-masks, demonstrate that its demand is shown highly inelastic (value, 0.28) before the date of 1st break, and it becomes relatively less inelastic (value, 0.82) after the outbreak of COVID-19 in the third week of February 2020, in Lahore (Table 3). The estimates become relatively positive and less inelastic that imply the same consumer behavior due to the coronavirus spread in Lahore as that implied in the case of Islamabad.

The case of demand-price estimates in the most populous city of Pakistan is not different. The findings for the own-price effects of face-masks are shown highly elastic (value, 1.27) before the 1st break. It then becomes relatively less more elastic and shown negatively (value, -1.97) after the 1st break on December 30, 2019, and lastly, after the outbreak of COVID-19 on February 17, 2020, in Karachi, the quantity demanded the COVID-19 preventing face-masks becomes positive yet inelastic (value, 0.97) as compared to before the COVID-19 outbreak in Karachi (Table 4, see Appendix-B). The findings imply that people prefer it inclined toward more demanding face-masks as COVID-19 preventing commodity at comparatively higher prices in Karachi. Since Karachi has 30% of its population living on or below the line of poverty and the price surge of face-masks may exclude the lower echelons of income groups to purchasing the face-masks as COVID-19 preventing commodity. The widespread poverty of the people may be one of the reasons that a maximum number of positive cases and its fatalities of COVID-19 are reported in Karachi in Pakistan.

Not differently, the findings for own-price effects of face-masks demonstrate, in Peshawar, that the demand of face-masks is positive elastic (value, 1.58) before the date of 1st break then becomes relatively less more elastic (value, -6.8) on December 23, 2019. Then, after the outbreak of Covid-19 in the third week of February 17, 2020, the demand-price estimate becomes relatively positive and less elastic, implying the same outcomes as implied for other cities of Pakistan after the spread of COVID-19 disease in Peshawar city. (Table 5). Likewise, the findings for own-price effects of face-masks in Quetta show that the demand for face-masks is positive and relatively inelastic (value, 0.81) before the date of 1st break; it then becomes relatively more inelastic (value, 0.30) after the outbreak of Covid-19 in the third week of February 17, 2020. It implies that consumers are likely less concerned about the price-rise of masks due to the pandemic spread in Quetta city (Table 6).

The findings of price rise and higher demand of face-masks in all the capital and populous cities of Pakistan show that the demand of face-masks, as preventive-commodity to COVID-19, has surged many-fold after the outbreak of COVID-19 disease. The findings of this demand-price behavior of face-masks in different cities of Pakistan may likely to imply alarming situations for the poor and low-income groups of people to be likely excluded from the use of face-masks as preventing-commodity to COVID-19 and may place the excluded groups of people to be at high-risk to inflicting upon the coronavirus disease in major cities of Pakistan. The daily increase in positive cases of coronavirus disease in all the major cities of Pakistan provides empirical evidence to the stated implications of this study (CORONA UPDATE NIH, 2020).

Vitamin-C Supplements

Notwithstanding, the findings of own-price calculations for Vitamin-C, as a precautionary measure to improve immune system demonstrate against COVID-19 infliction upon people, shows that demand for Vitamin-C supplement has corroborated just one structural break on February 17, 2020 (Table 2). Before this date, there is an insignificant relationship between the price and quantity demanded of the supplement, albeit the relationship becomes significant statistically with a value of 0.54 after the spread of COVID-19 in twin capital cities of Pakistan. This implies that demand for Vitamin-C rises, and the estimated value indicates that it is inelastic with respect to its price, *ceteris paribus*, implying more consumption at higher prices as preventing-commodity to combat coronavirus disease in the capital city of Pakistan.

Likely, the findings of own-price calculations for Vitamin-C supplements has also corroborated just one structural break on February 17, 2020 (Table 3). Before this date, there is a significant elastic relationship between the price and demand of the product, albeit the relationship becomes inelastic (value, 0.35) and significant statistically after the spread of COVID-19 in the capital city of the province Punjab. The implications of the findings are not different for consumers of Vitamin-C supplements as that shown for consumers in the capital city of Pakistan.

Similarly, the findings of own-price calculations of Vitamin-C supplements have also corroborated two structural breaks on January 6, 2020, and February 17, 2020 (Table 4) in the case of the most populous and business city of Karachi. Before the mentioned two structural breaks, there is an insignificant relationship between the price and quantity demanded vitamin-C supplements, albeit the relationship becomes more elastic (value, 4.9) in January 2020 and becomes relatively half elastic (value, 2.2) after the spread of COVID-19 in Karachi. This implies that demand for Vitamin-C supplements rises, and estimated values indicate that consumers are likely to relatively care less about price surge after the outbreak of the corona-virus disease in Karachi, *ceteris paribus*.

Not differently, the findings of own-price calculations for Vitamin-C in Peshawar as a precautionary measure to COVID-19 disease show that quantity demanded Vitamin-C supplement has also corroborated one structural break in mid-February 2019 (Table 5). There is a significant elastic relationship between the price and quantity demanded of the product, albeit the relationship becomes elastic (value, 4.94) and significant statistically after the spread of COVID-19 in the capital city of Pakhtunkhwa.

Notwithstanding, the findings of own-price calculations for Vitamin-C has demonstrated that its demand has also corroborated just one structural break on February 17, 2020 (Table 6). Before this date, there is a significant negative, and elastic relationship (values, -1.34) between the price and quantity demanded of the product, albeit the relationship becomes relatively inelastic (value, 0.73) and significant statistically after the

spread of Covid-19. This implies that the quantity demanded Vitamin-C rises, and the estimated value indicates that consumers care less about price surge after the outbreak of corona-virus due to probable religious tourists came from Iran to the capital city Quetta, *ceteris paribus*. This pattern of the demand in Quetta city is consistent with the patterns of the demand-price relationship shown for the other four capital and most populous cities of Pakistan for Vitamin-C supplement as a preventive-commodity to combat COVID-19.

Thus, the above findings likely imply for strict government price regulatory rules of law to contain prices within the purchasing limits of low-income groups and subsidies providing for vitamin-C supplements to low-income groups to raise the purchasing power of low-income groups so that they could also buy COVID-19 preventing-commodities to combat COVID-19 disease (Table 2-6).

Regression results of the log-log model for the three preventive-commodities to covid-19 disease (Tables: 2-6): City-wise

Table 2. Log-Log Models of Demand-Islamabad

Variable	P	P at the first break	P at second break
Sanitizer	0.29	-3.63	0.81
t-value	0.85	-6.62	2.76
Break-Date		12/30/2019	2/10/2020
Dw-stats	2.31	S.E of regression	0.38
Masks	2.51	-0.09	0.74
t-value	5.84	-0.12	5.67
Break-Date		10/14/2019	2/17/2020
Dw-stats	1.91	S.E of regression	0.37
Vitamin-C	0.25	0.54	N/A
t-value	0.62	2.38	N/A
Break-Date		2/17/2020	N/A
Dw-stats	1.9	S.E of regression	0.44

P=Price, DW= Durbin Watson, S.E= standard error, N/A= Not applicable, Constant term added in OLS regression, Break type: compare information criteria for o to M globally determined breaks.

Selection: Schwarz criterion, trimming 0.15, HAC standard error and covariance

Table 3. Log-Log Models of Demand-Lahore

Variable	P	P at the first break	P at second break
Sanitizer	0.28	-0.20	0.80
t-value	1.51	-2.06	22.0
Break-Date		12/16/2019	2/17/2020
Dw-stats	2.63	S.E of regression	0.22
Masks	0.28	0.82	N/A
t-value	4.04	17.1	N/A
Break-Date		2/17/2020	N/A
Dw-stats	2.56	S.E of regression	0.28
Vitamin-C	1.43	0.35	N/A
t-value	3.21	3.82	N/A
Break-Date		2/17/2020	N/A
Dw-stats	1.31	S.E of regression	0.30

P=Price, DW= Durbin Watson, S.E= standard error, N/A= Not applicable, Constant term added in OLS regression, Break type: compare information criteria for o to M globally determined breaks.

Selection: Schwarz criterion, trimming 0.15, HAC standard error and covariance

Table 4. Log-Log Models of Demand-Karachi

Variable	P	P at the First Break	P at Second Break
Sanitizer	0.20	0.81	N/A
t-value	0.79	15.9	N/A
Break-Date		2/17/2020	N/A
Dw-stats	1.45	S.E of regression	0.34
Masks	1.27	-1.97	0.97
t-value	2.56	-2.29	46.6
Break-Date		12/30/2019	2/17/2020
Dw-stats	2.66	S.E of regression	0.26
Vitamin-C	0.04	4.94	2.22
t-value	0.14	2.35	6.86
Break-Date		1/6/2020	2/17/2020
Dw-stats	2.27	S.E of regression	0.27

P=Price, DW= Durbin Watson, S.E= standard error, N/A= Not applicable, Constant term added in OLS regression, Break type: compare information criteria for o to M globally determined breaks.

Selection: Schwarz criterion, trimming 0.15, HAC standard error and covariance

Table 5. Log-Log Models of Demand-Peshawar

Variable	P	P at the First Break	P at Second Break
Sanitizer	-0.47	2.21	1.80
t-value	-2.09	1.13	26.9
Break-Date		12/16/2019	1/20/2020
Dw-stats	2.25	S.E of regression	0.33
Masks	1.58	-6.46	1.01
t-value	2.99	-6.53	29.6
Break-Date		12/23/2019	2/17/2020
Dw-stats	2.76	S.E of regression	0.20
Vitamin-C	-3.70	4.94	N/A
t-value	-1.93	2.35	N/A
Break-Date		9/9/2019	N/A
Dw-stats	2.08	S.E of regression	0.26

P=Price, DW= Durbin Watson, S.E= standard error, N/A= Not applicable, Constant term added in OLS regression, Break type: compare information criteria for o to M globally determined breaks.

Selection: Schwarz criterion, trimming 0.15, HAC standard error and covariance

Table 6. Log-Log Models of Demand-Quetta

Variable	P	P at the First Break	P at Second Break
Sanitizer	0.86	0.34	N/A
t-value	6.64	17.1	N/A
Break-Date		2/17/2020	N/A
Dw-stats	1.94	S.E of regression	0.24
Masks	0.81	0.30	N/A
t-value	2.48	6.05	N/A
Break-Date		2/17/2020	N/A
Dw-stats	2.97	S.E of regression	0.33
Vitamin-C	-1.34	0.73	N/A
t-value	-3.09	1.82	N/A
Break-Date		2/17/2020	N/A

Dw-stats	2.08	S.E of regression	0.26
----------	------	-------------------	------

P=Price, DW= Durbin Watson, S.E= standard error, N/A= Not applicable, Constant term added in OLS regression, Break type: compare information criteria for o to M globally determined breaks.

Selection: Schwarz criterion, trimming 0.15, HAC standard error and covariance

Panel-Wise Discussion on Prevention-Commodities of COVID-19 Disease

The present panel-wise estimates attempt to highlight the incidence of the outbreak of COVID-19 on the selected prevention-commodities as precautionary medical/health-preserving products since the month of February 2020 in Pakistan. Specifically elaborating, the findings of the results for own-price effects of these life savings preventing-commodities to COVID-19 disease demonstrate that quantity demanded of hand sanitizers in five cities pooled-panel of Pakistan is initially less inelastic (value, 0.77) before the date of a first structural break (Table 7). And then onwards, the estimate after the 3rd break from February 17, 2020, indicates that the quantity demanded of hand sanitizers are shown positive and more inelastic (value, 0.50). This implies that people in Pakistan are less concerned about the exponential rising in the prices of hand sanitizers due to the spread of COVID-19 disease, and people are compelled to purchase it at higher prices to save their lives from the pandemic disease of corona-virus.

Likely, the findings for own-price effects of face-masks demonstrate that its demand is shown highly inelastic (value, 0.07) before the date of 1st break, and then it becomes relatively inelastic (value, 0.51) after the outbreak of COVID-19 on February 17, 2020 (Table 7). Thus, implying that consumers care less about the price-rise of face-masks due to the pandemic spread in February 2020 in Pakistan. It also means that face-masks demand has surged many-fold after the outbreak of COVID-19, and more face-masks are needed than before in the country.

Panel-wise regression results of the log-log model for the three preventive-commodities to covid-19 disease (Tables: 2-6): Pakistan

Table 7. Log-Log Models of Demand-Pakistan

Variable	P	P at the First Break
Sanitizer	0.77	0.50
t-value	8.15	5.37
Break-Date		2/17/2020
S.E of regression	0.47	0.21
Masks	0.07	0.51
t-value	7.44	35.3
Break-Date		2/17/2020
S.E of regression	0.57	0.36
Vitamin-C	0.18	0.41
t-value	22.0	19.4
Break-Date		2/17/2020
S.E of regression	0.46	0.82

Notwithstanding, the findings of own-price calculations for Vitamin-C supplements as a precautionary measure to improve the immune system demonstrate that its demand has substantiated just one structural break on February 17, 2020 (Table 2, see Appendix-B). Before this date, there is an inelastic (value, 0.18) relationship between the price and quantity demanded of the preventing-medical commodity, albeit the relationship becomes significant statistically with relatively inelastic (value, 0.41) after the spread of COVID-19.

In such scenarios of a surge in prices of preventing-commodities to COVID-19 disease have a likelihood of excluding people of low-income groups to get the studied medical commodities as a pre-emptive measure to combat COVID-19 disease. Thus, resulting in the low-income group to face more chances of inflicting the corona-virus disease and accelerate COVID-19 spread in Pakistan. The implication of this pooled-data-based demand-price behavior of the preventing commodities shows likely alarming situations for low-income groups

and the poor people of Pakistan. The findings for Pakistan may demand regulated price policy and/or subsidies to the probably excluded income groups due to their lower purchasing powers so that they could also purchase COVID-19 preventing commodities at medical/pharmacy store to follow the global safeguard against COVID-19 disease of WHO and nationally proposed public health care protocols of using the studied preventing commodities. The results of this study also resemble the findings of [Cowling and Aiello \(2020\)](#) and [Van Bavel et al. \(2020\)](#), suggesting public health measures inter alia like hand sanitizers, face masks, and vitamin-c supplements are pivotal to slow community spread of COVID-19.

Conclusion and Policy Implications for Combating COVID-19 as Per the six-point Agenda of nGHRP of WHO

This paper is 1st ever study to empirically estimate and assess the price-demand relationship of three COVID-19 prevention-commodities comprising of hand-sanitizers, face-masks and vitamin-C supplements in the context of the current pandemic. This study is theoretically based on the microeconomic framework of the demand function for public health awareness as per the appeal of R&D innovation related to corona-virus disease mentioned in the six-point agenda of nGHRP of WHO. The present analyses disclose that in all the capital and most populous cities of Pakistan, there is a somewhat similar price-demand relationship found for these three critically needed and basic medical-necessities of life-saving and COVID-19 prevention-commodities before as well as after the spread of the global pandemic corona-virus disease, *ceteris paribus*. The structural breaks for these commodities in all the selected cities are reported between the second to the third week of the month of February 2020, wherein conform to the a priori estimate of the break.

The relationship before the spread of COVID-19 disease indicates that there is either an elastic or an insignificant relationship between the prices charged and quantities demanded of all the select commodities, *ceteris paribus*. It is nevertheless obvious that, as the COVID-19 disease starts to spread in the month of February 2020, all the estimates of own-price effects become relatively inelastic for all the selected three commodities mentioned indicating that people care less about the price-rise during the fear of pandemic spread and use precautionary motives and maintaining good-hygiene by purchasing more quantities of COVID-19 prevention-commodities in Pakistan.

The demand for these products has surged in an unprecedented way after the spread of corona-virus disease in Pakistan. This implies detrimental consequences to the lower-income groups and their non-purchasing power for the three selected COVID-19 prevention-commodities at higher prices during the pandemic outbreak. The findings of the study also imply discouraging the slack government regulatory policies to not stabilizing prices and no/zero subsidies provided to the poor and lower-income groups to make the preventing-commodities affordable/purchasable within the income limits of the lower-income population to stop the probable spread of COVID-19 in Pakistan.

The study also implies discouraging abnormal/expedient profiteering behavior, which is common in developing countries of the world during such crises, through constitutional amendments and rules of law as per the convention set for the production and marketing of life-saving drugs. The study may also imply that prices of these commodities are rising due to the demand-supply gap and therein requiring the ingenuity of the government to take action and support businesses and private sector producers of these precautionary commodities via imports/production, tax exemption and/or other economic policy options.

References

- Adler, R. S. (1995). Redesigning People versus Re-designing Products: The Consumer Product Safety Commission Addresses Misuse. *JL & Pol.*, 11, 79.
- Bai, J., & Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica*, 47-78.
- Bai, J., & Perron, P. (2003). Computation and analysis of multiple structural change models. *Journal of applied econometrics*, 18(1), 1-22.
- CDC. (2020). Coronavirus Disease 2019 (COVID-19): steps to prevent illness. Available Online: <https://www.cdc.gov/coronavirus/2019-ncov/about/prevention-treatment.html> (accessed on 27 May 2020)
- CDC-Centre for Disease Control and Pretension. (2020). CDC Statement for Healthcare Personnel on Hand Hygiene during the Response to the International Emergence of COVID-19. Available Online: <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/hcp-hand-sanitizer.html>. (Access on 12 April 2020)
- CDC-Centre for Disease Control and Pretension. (2020). Show Me the Science – When & How to Use Hand Sanitizer in Community Settings. Available Online: <https://www.cdc.gov/handwashing/show-me-the-science-hand-sanitizer.html>. (Access on 3 April 2020)
- Cowling, B. J., & Aiello, A. (2020). Public health measures to slow community spread of COVID-19. *The Journal of Infectious Diseases*.
- Feng, S., Shen, C., Xia, N., Song, W., Fan, M., & Cowling, B. J. (2020). Rational use of face masks in the COVID-19 pandemic. *The Lancet Respiratory Medicine*.
- Godøy, A., & Huitfeldt, I. (2020). Regional variation in health care utilization and mortality. *Journal of Health Economics*, 71, 102254.
- Government of Pakistan (2020). National Action Plan for Corona virus disease (COVID-19). Ministry of National Health Sciences, *Regulations and Coordination, Islamabad*
- Government of Pakistan (2020). National Action Plan for Corona virus disease (COVID-19). Ministry of National Health Sciences, Regulations and Coordination, Islamabad, Available online: <http://covid.gov.pk/> (Accessed on 21 April 2020)
- Government of Pakistan. (2020). Ministry of National Health Sciences, Regulations and Coordination. Available Online: https://www.nih.org.pk/wp-content/uploads/2020/03/COVID-19-NAP-V2-13-March-2020.pdf?_cf_chl_jschl_tk=__1b5bf656f5473196fc60d159e08c26f78638a4f2-1585293635-0-AX9mqqiU0gqpBB_c4nxz4fv2_zETrX8KAemXBsfyU7taNUx3RkdzMMxdsdmr4uoFgsDvSZ41pMRnhwCCzg0tveHSsBox_oAwCYj9qvTYChKk7trG76xQshAmp_gfy5aCKOscG1AZ4oFYRbZTUh2VWPZDAUgZEY4m5w9xcHnd0vQs0EPrBQI-zkGC1YHu5YMcgRp5QncHc6ehhlhy9YtpHstmT0HVzRRu0lDof4RpuMRTk43VWgNMvOOQ8_s1DFEWKvEjTeX9mmaAZnWlz6MvflZ7lcXqTvkYwpqOtlvXazqleZ85zw_zWHaburNXWO4W0jsq79DCAvb94KCdMGqUEVKZrzGTzmitkZVJJht3406. (access on 27 March 2020)
- Hastie, T. J. (2017). Generalized additive models. In *Statistical models in S* (pp. 249-307). *Routledge*.
- Kannan, S. P. Shaik Syed Ali, A. Sheeza, K. Hemalatha. COVID-19 (Novel Coronavirus 2019) – recent trends, *Eur Rev Med Pharmacol Sci*, Year: 2020, 24(4), Pages: 2006-2011, DOI: 10.26355/eurrev_202002_20378
- Lau, L. J. (1986). Functional forms in econometric model building. *Handbook of econometrics*, 3, 1515-1566.
- Leman, J. (2010). Quantitative data collection. In Dahlberg, L., & McCaig, C. *Practical research and evaluation: A start-to-finish guide for practitioners* (pp. 172-190). London: *SAGE Publications Ltd* doi: 10.4135/9781446268346. Available Online: <https://psyarxiv.com/y38m9> (Accessed on 20 April 2020)
- Liu J, Wu S, Zidek JV. (1997). On segmented multivariate regressions. *Statistica Sinica* 7, 497–525.
- Nkengasong, J. N., & Mankoula, W. (2020). Looming threat of COVID-19 infection in Africa: act collectively, and fast. *The Lancet*, 395(10227), 841-842.

- Novel Coronavirus Disease Named COVID-19. Available online: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen> (accessed on 6 April 2020).
- Nunes, L. C., Kuan, C. M., & Newbold, P. (1995). Spurious break. *Econometric Theory*, 11(4), 736-749.
- PBS-Pakistan Bureau of Statistics. (2020). Government of Pakistan. Ministry of Planning, Development and Special Initiatives PAKISTAN BUREAU OF STATISTICS. PRESS RELEASE ON CONSUMER PRICE INDEX (CPI) INFLATION FOR THE MONTH OF February, 2020 [Base 2015-16=100]. Available Online: http://www.pbs.gov.pk/sites/default/files/press_releases/2020/cpi_press_release_february_2020.pdf. (accessed on 10 April 2020).
- Pedroni, P. (2000). Fully modified OLS for heterogeneous cointegrated panels. *Advances in econometrics*, 15, 93-130.
- Pedroni, P. (2001). Purchasing power parity tests in cointegrated panels. *Review of Economics and statistics*, 83(4), 727-731.
- State Council, China. (2020). Guidelines for the selection and use of different types of masks for preventing new coronavirus infection in different populations 2020 (in Chinese). Available Online: http://www.gov.cn/xinwen/2020-02/05/content_5474774.htm (accessed on 27 May 2020)
- Thalanany, M.M., Mugford, M., Hibbert, C. et al. (2008). Methods of data collection and analysis for the economic evaluation alongside a national, multi-centre trial in the UK: Conventional ventilation or ECMO for Severe Adult Respiratory Failure (CESAR). *BMC Health Serv Res* 8, 94 <https://doi.org/10.1186/1472-6963-8-94>
- The Washington Post (2020). The corona virus threatens all of humanity. All of humanity must fight back. Available online: https://www.washingtonpost.com/opinions/global-opinions/wealthy-nations-pandemic-fight-doesnt-stop-at-their-borders/2020/03/24/94afdae8-6e0c-11ea-b148-e4ce3fbd85b5_story.html. (accessed on 7 April 2020)
- Thevarajan, I., Nguyen, T.H.O., Koutsakos, M. et al. (2020). Breadth of concomitant immune responses prior to patient recovery: a case report of non-severe COVID-19. *Nat Med* <https://doi.org/10.1038/s41591-020-0819-2>
- US State Department. (2020). Coronavirus Disease 2019 (COVID-19). Emergency Alert, Available Online: <https://www.state.gov/coronavirus/> (accessed on 27 May 2020)
- USAID. (2020). United States AID, From the American People. NOVEL CORONAVIRUS (COVID-19), Available Online; <https://www.usaid.gov/coronavirus> (accessed on 27 May 2020)
- Van Bavel, J. J., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crockett, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N. Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, S. A., Jetten, J., Kitayama, S., Mobbs, D., Napper, L. E., Packer, D. J., Pennycook, G., Peters, E., Petty, R. E., Rand, D. G., Reicher, S. D., Schnall, S., Shariff, A., Skitka, L. J., Smith, S. S., Sunstein, C. R., Tabri, N., Tucker, J. A., van der Linden, S., Van Lange, P. A. M., Weeden, K. A., Wohl, M. J. A., Zaki, J., Zion, S. & Willer, R. (in press). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behavior*.
- Van den Berg, G. J., Gerdtham, U. G., von Hinke, S., Lindeboom, M., Lissdaniels, J., Sundquist, J., & Sundquist, K. (2017). Mortality and the business cycle: Evidence from individual and aggregated data. *Journal of health economics*, 56, 61-70.
- WHO. (2020). Coronavirus disease (COVID-19) advice for the public: when and how to use masks. Available Online: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/when-and-how-to-use-masks> (accessed on 27 May 2020)
- World Health Organization (2020). Coronavirus (COVID-19), WHO Health Emergency Dashboard WHO (COVID-19) Homepage, Available Online: <https://covid19.who.int/> (Accessed on 21 April 2020)
- International Monetary Fund. (2020). World Economic Outlook, April 2020: The Great Lockdown, WORLD ECONOMIC OUTLOOK REPORTS, April 2020, Available Online: <https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020> (accessed on 27 May 2020)

World Health Organization (2020). WHO Director General's remarks Launch of Appeal: *Global Humanitarian Response Plan* - 25 March 2020. Available Online: <https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-launch-of-appeal-global-humanitarian-response-plan---25-march-2020> (accessed on 15 April 2020)