SOUTH ASIAN JOURNAL OF SOCIAL SCIENCES & HUMANITIES

ISSN: 2582-7065 (Online) SAJSSH, VOL 2, ISSUE 3, PP. 222-247

# Supply Chain Sustainability in the Context of COVID-19 Pandemic in Pakistan's Economy: Using Computable General Equilibrium (CGE) Model

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**Received:** 19th January 2021 **Accepted:** 20th May 2021 **Published:** 3rd June 2021

## ABSTRACT

The COVID 19 pandemic has had tremendous economic impacts and continues to wreak havoc around the world. This research work has been conducted to analyze the macroeconomic effects of the COVID 19 in the context of Pakistan. The impact ECON Supply Chain (IESC) Computable general equilibrium (CGE) Model which was formulated by Walmsley and Minor (2016) has been employed so that the supply chain effects of many of Pakistan's government policies in response to the coronavirus pandemic can be assessed. An 8% shock was given to 11 sectors of the economy and a 5% shock was given to electricity. Lastly, the impact of these shocks on all 31 sectors of the economy that are included in the model was assessed. Results discovered that there was a decline in real GDP, real exports, real imports, and per capita utility from private expenditure, meanwhile, terms of trade and regional household income increased. This study also illuminated that during pandemic goods market prices increased for 16 sectors while supply price of commodities decreased for 15 sectors. Based on the empirical findings, some relevant policy implications are suggested to overcome the pandemic.

## KEYWORDS

COVID 19 Pandemic, Supply Chain, Economic Losses, Computable General Equilibrium Model, Pakistan



DOI: http://doi.org/10.48165/sajssh.2021.2314

## INTRODUCTION

The coronavirus pandemic has had tremendous economic impacts and continues to wreak havoc around the world. This research work has been conducted to analyze the macroeconomic effects of the coronavirus in the context of Pakistan. There exists great uncertainty about how long this infection will last, and how severe it will be; hence three scenarios have been analyzed, starting from moderate events to disastrous circumstances. To be specific, this research work takes into account an 8% shock to 12 different sectors of the economy including oil, extraction, textile, wearing apparel, light manufacturing, heavy manufacturing, electricity, natural gas, tourism and accommodation, utility consumption, transport and communication, as well as services. After this, we seek to understand the effect of this 8% shock in terms of the 31 sectors of the economy that have been included in the model. The value of 8% was obtained through division of one by a total of twelve (months in a year) and further multiplication by hundred to get percentage of loss if a lockdown is put in place for one month. A table was formulated whereby we checked whether growth rate have increased or decreased for each sector. According to the positive or negative value of each of the sectors, a positive or negative shock of 8% was given. In case of electricity, a negative 5% shock was given, as much less electricity was used in the country because of closure of offices as well as educational institutes. This is demonstrated in the table below:

**Table 1:** ***Affected Sectors***

| Variable | Shock |
|---|---|
| Textile | -8% |
| Wearing Apparel | -8% |
| Light manufacturing | -8% |
| Heavy manufacturing | -8% |
| Tourism | -8% |
| Electricity | -5% |
| Natural gases | 8% |
| Utility Consumption | -8% |
| Transportation and communication | -8% |
| Services | -8% |
| Oil | -8% |
| Extraction | -8% |

**(Author Simulations)**

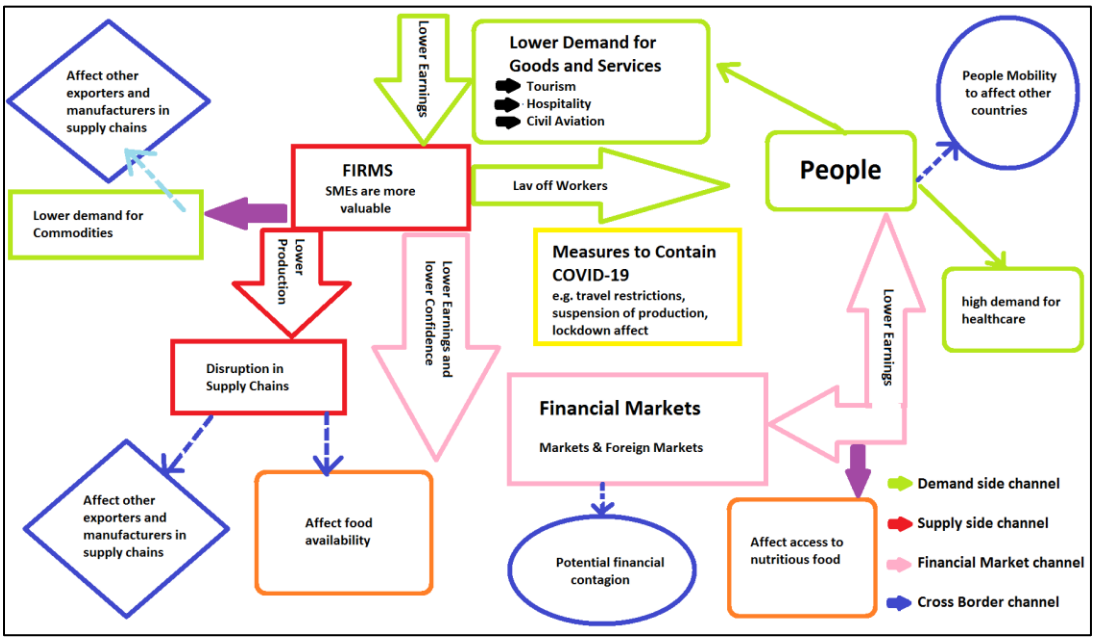
Analysis has been carried out using computable general equilibrium (CGE model), which is a novel economy wide technique used for modeling. This model may also be called a multi-market model that considers behavioral responses with regard to consumers and producers alike, considering the fluctuating prices, regulations as well as different conditions relevant to markets that are interconnected, also taking into account constraints with regard to resources. CGE models characterize an economy based on their interconnectedness in terms of supply chains. CGE models have been used in previous literature to analyze the economic impacts of threats to health for example influenza (Dixon et al. 2010, 2020; Prager et al. 2017; Walmsley et al. 2020). We have employed the Impact ECON Supply Chain Model which has been adapted from the GTAP model which is one of the most commonly used CGE model, and has the capacity to further analyze supply chain effects that are connected to economic activities as well as policies around the globe.



DOI: http://doi.org/10.48165/sajssh.2021.2314

We have used the assumptions, the variables as well as the parameters for analysis that have been explained in detail later. These assumptions have been used so that the analysis can be carried out without difficulty. Sensitivity tests were carried out regarding some major assumptions as well as parameters to ensure the robustness of the results. However, the mix of assumptions allows our results to be taken as upper bound estimates. The main factor that has an impact on the results about each of the three scenarios is a mix of closures and business reopening. The 2nd most important factor is pent up demand which arose because of restrictions on spending owing to closures as well as reopening that was partial. Asian Development Bank predicted in initial March that the economy of Pakistan would face a loss of nearly 16 million US$ in case of best scenario, while standing at 61 million US$ in the case of worst scenario. In case there was a significant outbreak, this would lead to an approximate loss of 5 billion US dollars, a 1.57% contraction in GDP as well as loss of jobs for about a million people. Near the end of March, the Asian Development Bank provided revised estimates standing at 415 million US dollars in the case of best scenario and a loss of 6.6-17 billion US dollars if the outbreak was significant. Employment loss was expected to range between 1.2-3.2 million jobs while GDP growth was expected to contract from 2-5%.

***Figure 1:*** **Channels through which COVID-19 affects the Economy**




Other studies have found that there is a presence of stress points and goes on to identify points that can be helped the most through interventions of policy. Individuals and businesses adapt rapidly, as shown by a rise in telework, and so the adverse economic effects of the pandemic are being reduced through individual motivations. Together with this, considering that uncertainty still exists with regard to the main drivers, studies have taken into account this uncertainty by considering 3 different scenarios, emphasizing on the time duration, the level of severity, as well as the course of the outbreak, that allows us to bound the extent of potential effects. The scenarios that have



DOI: http://doi.org/10.48165/sajssh.2021.2314

been considered, as well as the decomposition analysis about specific factors allow the discovery of further differences in driving forces through combination of components in terms of analysis.

We intend to carry out an analysis explaining the macroeconomic effects of the coronavirus pandemic with regard to a given set of factors that cause it. This makes our research work comprehensive. Through this study, we aim to add to available literature, and provide information to policymakers through decomposition with respect to the relative impacts of different causal factors.

## GENERAL CGE METHODOLOGY

The impact ECON Supply Chain (IESC) CGE Model which was formulated by Walmsley and Minor (2016), Footnotel has been employed so that the supply chain effects of many of Pakistan's government policies in response to the coronavirus pandemic can be assessed. The model has its basis in the GTAP model which is widely used, and also possesses all of its characteristics (Hertel and Tsigas 1997; Corong et al. 2017). The model is taken to be a benchmark when it comes to analysis related to policy issues as well as global trade. The database which underlies it, consists of input output tables as well as trading relations with respect to one hundred and forty one countries and sixty five commodities taken from the database of GTAP (Aguiar et al. 2019), together with more detail related to the source of intermediate as well as final products. So that the model can be calibrated, many substitution and demand elasticities are taken in combination with this data. The GTAP model is adapted by the IESC model so that detail with respect to tariff and trade data regarding sources of imported goods (intermediate and final) can be included, thus adding to the analysis with respect to effects on global supply chains. For this case, we had information regarding the sectors that were affected most by the lockdown imposed due to the situation of the pandemic, which enables us to find out how disruptions or delays. In this case, information is available about how the hindrance or delay in the import of intermediate goods from foreign countries has negatively affected Pakistan's ability related to production or export of commodities. A comparative static CGE model is called the IESC model which gives a method that is consistent theoretically, to analyze effects of global shocks on Pakistan's economy. The model incorporates demand by households, firms, government as well as for purposes of investment. It also incorporates supply related to 8 factors of production by households including five categories of labor, land, natural resources and capital. To capture the effect of mandatory closures, the production of affected sectors is reduced by 8 percent and as a result, final demand falls. Some iterations have been run on the basis of this so the indirect effects regarding closure of these sectors may be considered in relation with rest of the sectors. An advantage of these models lies in the fact that indirect effects that business closures done within one sector have on the rest of the sectors, can be captured. An example of this is that as restaurants close down, demand related to vegetables and fruits also decreases as they are no longer used to produce meals in restaurants. Sometimes, indirect effects turn out to be even larger compared to the sector which has been closed down, and thus these indirect impacts are allowed to become dominant. Sectorial production may decrease more as compared to the sector's share which has been closed down. Resultantly, a decrease in production must be imposed in case of those sectors only where direct effects of mandatory closures are higher compared to indirect impacts that are the result of closure of other sectors particularly recreation related services as well as construction. Mandatory closures cause production to decrease, while pent up demand and avoidance are likely to increase and reduce



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private consumers' final demand respectively. When it comes to avoidance in terms of education, a decrease in government demand is also likely.

## EMPIRICAL FINDINGS

**Table 3:** ***Impact on Macroeconomic variables***

| Pakistan | Simulation |
|---|---|
| Real GDP | -5.04336 |
| Real Exports | -13.544453 |
| Real Import | -4.178948 |
| Terms of Trade | 2.793341 |
| Per capita utility from Private expend | -3.565721 |
| Regional household income | 2.634635 |

**(Author Simulations)**

As a result of lockdown, an 8% shock was given to 11 sectors of the economy including oil production, extraction, textile, wearing apparel, light manufacturing, heavy manufacturing, tourism, natural gas, utility consumption, transport, and communication, as well as services. In addition, a 5% shock was given to electricity. The results are as follows: An 8% shock to the 11 selected sectors and a 5% shock to electricity caused a 5.04336 million USD decline in Real GDP, 13.544453 million USD decline in real exports, 4.178948 million USD decline in real imports, a 2.793341 million UD rise in terms of trade, 3.565721 million USD decline in per capita utility from private expenditure, and a 2.634635 million USD rise in regional household income.

**Table: 4 Changes in Sectorial Output**

| Pakistan | Simulation | Pre value | Post value | Change divided by %change | Percentage Change |
|---|---|---|---|---|---|
| Land | 0 | 27875.93359 | 27875.93359 | 0 | 0% |
| Technical and Professionals | 0 | 9093.148438 | 9093.148438 | 0 | 0% |
| Clerks | 0 | 2007.170166 | 2007.170166 | 0 | 0% |
| Service shop | 0 | 3214.049561 | 3214.049561 | 0 | 0% |
| Officers & Managers | 0 | 18731.67383 | 18731.67383 | 0 | 0% |
| Agriculture low skilled workers | 0 | 33031.14453 | 33031.14453 | 0 | 0% |
| Capital | 0 | 138996.5781 | 138996.5781 | 0 | 0% |
| Natural Resources | 0 | 1601.953613 | 1601.953613 | 0 | 0% |
| Grains Crops | 0 | 53926.51563 | 53926.51563 | 0 | 0% |
| Veg & Fruit | 0 | 12235.91699 | 12235.91699 | 0 | 0% |
| Meat Livestock | 0 | 30750.04297 | 30750.04297 | 0 | 0% |



DOI: http://doi.org/10.48165/sajssh.2021.2314

| | | | | | |
|---|---|---|---|---|---|
| Oil | -8 | 12228.98731 | 11250.66797 | -978.3193 | -8% |
| Extraction | -8 | 6421.147949 | 5907.456055 | -513.6918 | -8% |
| Processed Food | 0 | 31708.95703 | 31708.95703 | 0 | 0% |
| Textile | -8 | 30188.59961 | 27773.51172 | -2415.087 | -7.999% |
| Wearing apparel | -8 | 7143.508789 | 6572.02832 | -571.4804 | -7.999% |
| Leather | 0 | 2046.386719 | 2046.386719 | 0 | 0% |
| Chemical & Rubber | 0 | 10598.76563 | 10598.76563 | 0 | 0% |
| Light manufacturing | -8 | 11838.89258 | 10891.78125 | -947.1113 | -7.999% |
| Pharma | 0 | 4572.857422 | 4572.857422 | 0 | 0% |
| Metals | 0 | 4315.233398 | 4315.233398 | 0 | 0% |
| Heavy manufacturing | -8 | 9532.223633 | 8769.645508 | -762.5781 | -8% |
| Tourism | -8 | 44313.17188 | 40768.11719 | -3545.054 | -8% |
| Motor parts | 0 | 4610.384277 | 4610.384277 | 0 | 0% |
| Electricity | 5 | 15558.05859 | 16335.96191 | 777.90332 | 5% |
| Natural Gas | 8 | 1866.584839 | 2015.911621 | 149.32678 | 7.999% |
| Utility Consumption | -8 | 22451.59766 | 20655.4707 | -1796.126 | -7.999% |
| Financial Business | 0 | 6317.706543 | 6317.706543 | 0 | 0% |
| Transportation & Communication | -8 | 102020.8281 | 93859.16406 | -8161.664 | -7.999% |
| Services | -8 | 38568.29688 | 35482.83203 | -3085.464 | -8% |
| CGDS | -3.610926 | 34584.12891 | 33335.32031 | -1248.808 | -3.610% |

**(Author Simulations)**

Table 4 shows changes in sectorial output following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows: Sectorial output for land, technical and professional, clerks, service shops, officer and manager shops, agriculture low skilled labor, capital, natural resources, grain crops, vegetables and fruits, meat and livestock, processed food, pharma, metals, motor parts, chemicals and rubber, leather and financial business remained unchanged. On the other hand, sectorial output increased by 777.90 million USD for electricity, 149.326 million USD for natural gas, whereas sectorial output declined by 978.3193 million USD for oil production, 513.6918 million USD for extraction, 2415.0878 million USD for textile, 571.48046 million USD for Wearing apparel, 947.11132 million USD for light manufacturing, 762.57812 million USD for heavy manufacturing, 3545.0546 million USD for tourism, 1796.1269 million USD for utility consumption, 8161.6640 million USD for transport and communication, 3085.4648 million USD for services and 1248.8085 million USD for CGDS.



DOI: http://doi.org/10.48165/sajssh.2021.2314

***Figure 2:*** **Changes in Sectoral Output**

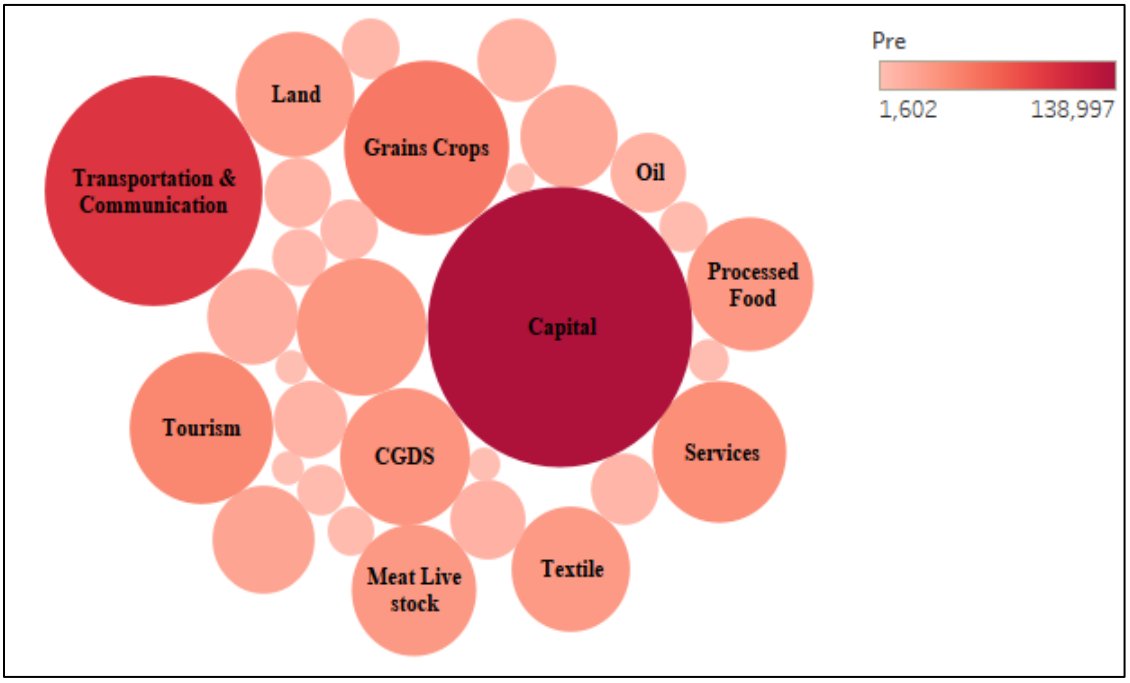


Figure 2 show the change in sectorial output base year value.

***Figure 3:*** **Changes in Sectorial Output**

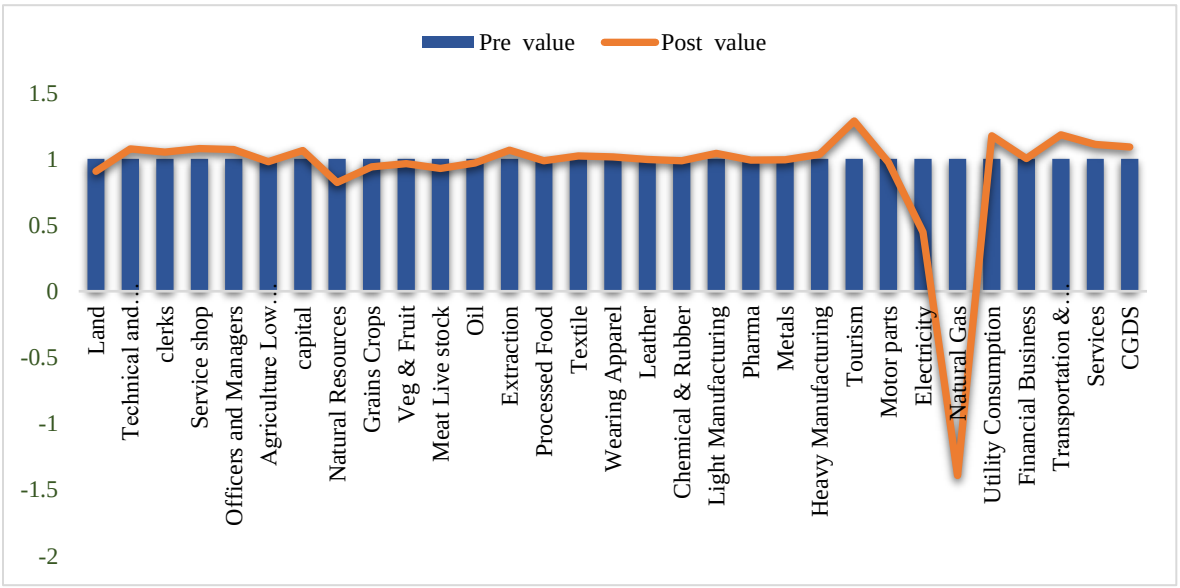


Figure 3 shows changes in sectorial output for 31 sectors, providing a comparison of the pre and post pandemic values for each. We can see that sectorial output has remained unchanged for some of the sectors including land, technical and professionals, clerks, service shops, officers and managers, capital, natural resources, grain crops, vegetables and fruits, meat and livestock, processed food, textile, and financial business. Sectorial output increased for electricity and natural



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gas, while showing a declining trend for oil production, extraction, wearing apparel, light manufacturing, heavy manufacturing, tourism, utility and communication, services and CGDS.

**Table 5:** ***Changes in Trade***

| Pakistan | Export Simulation | Import Simulation |
|---|---|---|
| Grains Crops | 28.961859 | -18.105747 |
| Veg Fruit | 9.98332 | -6.445256 |
| Meat Livestock | 50.695343 | -20.033518 |
| Oil | 20.662312 | -16.552246 |
| Extraction | -94.013359 | 24.202847 |
| Processed Food | 4.557422 | -3.198928 |
| Textile | -15.338026 | 5.023653 |
| Wearing apparel | -10.764565 | 3.783638 |
| Leather | 2.547421 | -2.690473 |
| Chemical & Rubber | 7.498234 | -5.48635 |
| Light Manufacturing | -29.898874 | 8.496936 |
| Pharma | 4.904866 | -2.692274 |
| Metals | 4.77454 | -3.576883 |
| Heavy Manufacturing | -23.334627 | 3.637676 |
| Tourism | -109.100014 | 46.449661 |
| Motor parts | 13.764881 | -7.372762 |
| Electricity | 310.151337 | -147.611008 |
| Natural Gas | 1339.592285 | -645.556702 |
| Utility Consumption | -68.501411 | 25.471931 |
| Financial Business | -0.979082 | 0.894565 |
| Transport & Communication | -63.68824 | 28.811188 |
| Services | -41.318729 | 15.717152 |

**(Author Simulations)**

Table 5 shows changes in trade following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows: Exports increased by 28.961859 million USD for grain crops, 9.98332 million USD for vegetables and fruits, 50.695343 million USD for meat and livestock, 4.904866 million USD for pharma, 4.77454 million USD for metals, 13.764881 million USD for motor parts, 310.151337 million USD for electricity, 4.557422 million USD for processed food, 7.498234 million USD for chemicals, 2.547421 million USD for leather and 1339.592285 million USD for natural gas. In contrast, exports decreased by 20.662312 million USD for oil production, 94.013359 million USD for extraction, 15.338026 million USD for textile, 10.764565



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million USD for wearing apparel, 29.898874 million USD for light manufacturing, 23.334627 million USD for heavy manufacturing, 109.100014 million USD for tourism, 68.501411 million USD for utility consumption, 0.979082 million USD for financial business, 63.68824 million USD for transport and communication and 41.318729 million USD for services.

Imports increased by million 24.202847 USD for extraction, 5.023653 million USD for textile, 3.783638 million USD for wearing apparel, 8.496936 million USD for light manufacturing, 3.637676 million USD for heavy manufacturing, 46.449661 million USD for tourism, 147.611008 million USD for electricity, 25.471931 million USD for utility consumption, 0.894565 million USD for financial business, 28.811188 million USD for transport and communication and 15.717152 million USD for services. On the contrary, imports decreased by 18.105747 million USD for grain crops, 5.48635 million USD for chemicals, 2.690473 million USD for leather, 6.445256 million USD for vegetable and fruit, 20.033518 million USD for meat and livestock, 3.198928 million USD for processed food, 2.692274 million USD for pharma, 16.552246 million USD for oil production, 3.576883 million USD for metals, 7.372762 million USD for motor parts and 645.556702 million USD for natural gas.

***Figure 4:*** **Changes in Terms of Trade**

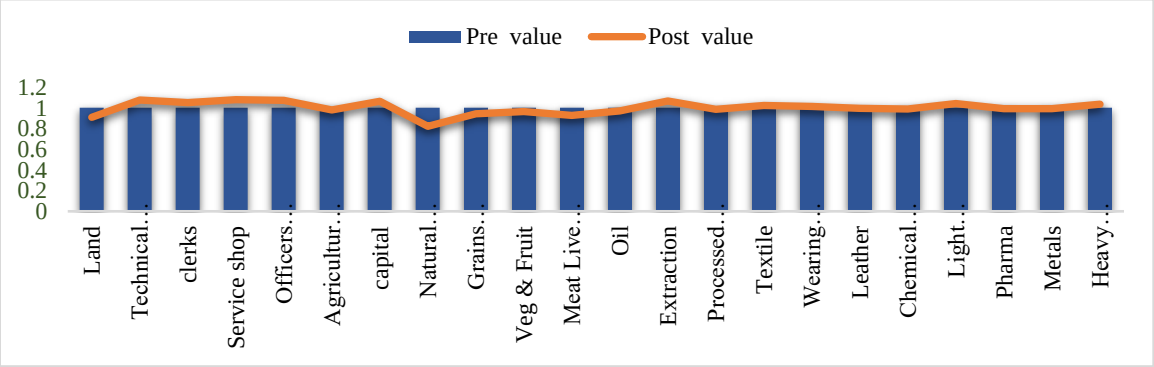


Figure 4 shows changes in terms of trade in 22 sectors post the lockdown owing to the coronavirus pandemic, the brown bars representing exports and the light brown bars representing imports.

**Table 6:** ***Sectorial Prices***

| **Pakistan** | **Simulation** |
|---|---|
| Land | -9.229851 |
| Technical and Professionals | 7.564472 |
| Clerks | 5.229189 |



DOI: http://doi.org/10.48165/sajssh.2021.2314

| | |
|---|---|
| Service shop | 7.879612 |
| Officers and Managers | 7.218318 |
| Agriculture Low Skilled Workers | -2.139667 |
| Capital | 6.429389 |
| Natural Resources | -17.846436 |
| Grains Crops | -5.897249 |
| Vegetable & Fruit | -3.482954 |
| Meat Livestock | -7.263437 |
| Oil | -2.931124 |
| Extraction | 6.689344 |
| Processed Food | -1.360657 |
| Textile | 2.220895 |
| Wearing Apparel | 1.522858 |
| Leather | -0.33472 |
| Chemical & Rubber | -1.247836 |
| Light Manufacturing | 4.162733 |
| Pharma | -0.800068 |
| Metals | -0.691056 |
| Heavy Manufacturing | 3.493718 |
| Tourism | 28.708002 |
| Motor parts | -2.539122 |
| Electricity | -55.402546 |
| Natural Gas | -239.238098 |
| Utility Consumption | 17.552694 |
| Financial Business | 0.244906 |
| Transportation & Communication | 18.268433 |
| Services | 10.947333 |
| CGDS | 9.023763 |

**(Author Simulations)**

Table 6 shows sectorial prices following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows: Sectorial prices rose by 7.564472 million USD for Technical and professionals, 5.229189 million USD for clerks, 7.879612 million USD for service shops, 7.218318 million USD for officers and managers, 6.429389 million USD for capital, 6.689344 million USD for extraction, 2.220895 million USD for textile, 1.522858 million USD for wearing apparel, 4.162733 million USD for light manufacturing, 3.493718 million USD for heavy manufacturing, 28.708002 million USD for tourism, 17.552694 million USD for utility



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consumption, 0.244906 million USD for financial business, 18.268433 million USD for transport and communication, 10.947333 million USD for services, and 9.023763 million USD for CGDS. On the contrary, sectorial prices declined by 1.247836 million USD for chemicals, 0.33472 million USD for leather, 2.139667 million USD for agriculture low skilled labor, 2.931124 million USD for oil production, 9.229851 million USD for land, 17.846436 million USD for natural resources, 0.800068 million USD for Pharma, 5.897249 million USD for grain crops, 3.482954 million USD for vegetables and fruits, 7.263437 million USD for meat and livestock, 1.360657 million USD for processed food, 0.691056 million USD for metals, 2.539122 million USD for motor parts, 55.402546 million USD for electricity and 239.238098 million USD for natural gas.

***Figure 5:*** **Sectorial Prices**

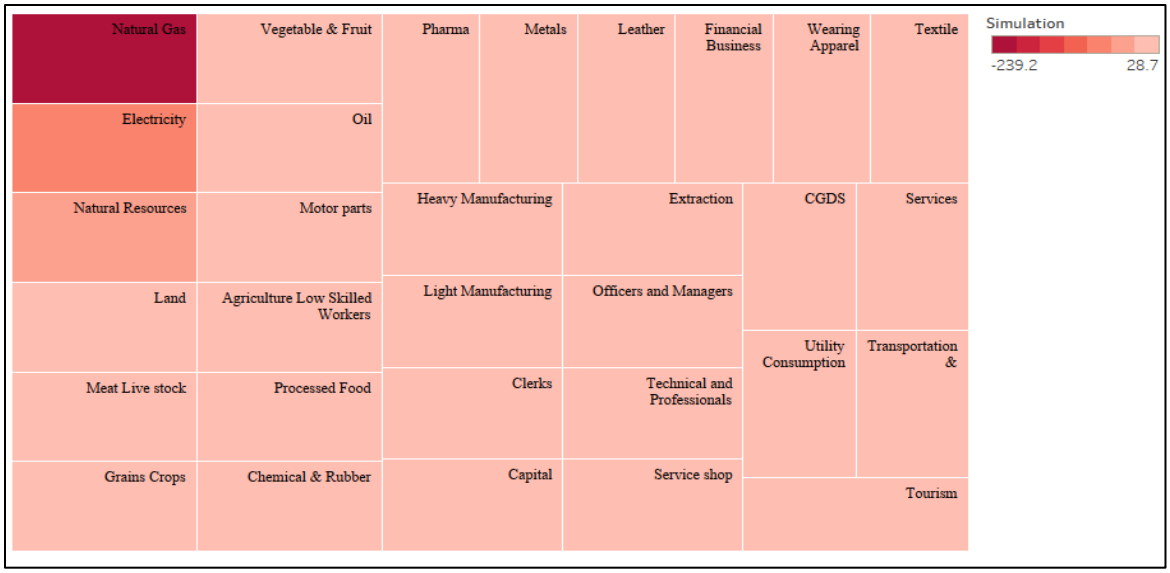


Figure 5: Shows the Sectorial Prices following an 8% shock to the 11 selected sectors and a 5% shock to electricity.

**Table 7:** ***Domestic Sales***

| Pakistan | Simulation | Pre value | Post value | Change divided by %change | Percentage change |
|---|---|---|---|---|---|
| Grains Crops | -1.498227 | 51274.05078 | 50505.84766 | -768.203125 | -1.498% |
| Veg & Fruit | -0.570583 | 11574.39746 | 11508.35547 | -66.041992 | -0.570% |
| Meat Livestock | -0.598134 | 30391.46484 | 30209.68359 | -181.78125 | -0.598% |
| Oil | -9.020271 | 11808.63867 | 10743.46777 | -1065.170898 | -9.020% |
| Extraction | -2.917912 | 6062.749512 | 5885.84375 | -176.905762 | -2.917% |



DOI: http://doi.org/10.48165/sajssh.2021.2314

| | | | | | |
|---|---|---|---|---|---|
| Processed Food | -0.230281 | 30183.80664 | 30114.29883 | -69.507813 | -0.230% |
| Textile | -4.492349 | 20425.16406 | 19507.59375 | -917.570313 | -4.492% |
| Wearing Apparel | -1.841811 | 2213.295898 | 2172.53125 | -40.764648 | -1.841% |
| Leather | -1.364625 | 1332.552979 | 1314.368652 | -18.184326 | -1.364% |
| Chemical & Rubber | -0.787981 | 9590.869141 | 9515.294922 | -75.574219 | -0.787% |
| Light Manufacturing | -6.083907 | 10886.38965 | 10224.07227 | -662.317383 | -6.083% |
| Pharma | -0.211798 | 4383.569824 | 4374.285645 | -9.28418 | -0.211% |
| Metals | -1.130529 | 3489.069092 | 3449.624268 | -39.444824 | -1.130% |
| Heavy Manufacturing | -6.485575 | 8675.330078 | 8112.685059 | -562.64502 | -6.485% |
| Tourism | -7.799738 | 44225.57031 | 40776.08984 | -3449.480469 | -7.799% |
| Motor parts | -0.14989 | 4560.721191 | 4553.885254 | -6.835938 | -0.149% |
| Electricity | 4.999425 | 15558.0293 | 16335.8418 | 777.8125 | 4.999% |
| Natural Gas | 7.985373 | 1866.564331 | 2015.616455 | 149.052124 | 7.985% |
| Utility Consumption | -7.955071 | 22434.9375 | 20650.22266 | -1784.714844 | -7.955% |
| Financial Business | 0.02538 | 6158.077148 | 6159.640137 | 1.562988 | 0.025% |
| Transportation & Communication | -6.816122 | 99897.10938 | 93088 | -6809.109375 | -6.816% |
| Services | -5.527612 | 35904.06641 | 33919.42969 | -1984.636719 | -5.527% |

**(Author Simulations)**

Table 7 shows changes in domestic sales following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows: Domestic sales rose by 777.8125 million USD for electricity, 149.052124 million USD for natural gas and 1.562988 million USD for financial business. On the hand, domestic sales declined by 75.574219 million USD for chemicals, 1984.636719 million USD for services, 18.184326 million USD for leather, 40.764648 million USD for wearing apparel, 917.570313 million USD for textile, 69.507813 million USD for processed food, 181.78125 million USD for meat and livestock, 176.905762 million USD for extraction, 768.203125 million USD for grain crops, 66.041992 million USD for vegetables and fruit, 1065.170898 million USD for oil production, 39.444824 million USD for metals, 562.64502 million USD for heavy manufacturing, 3449.480469 million USD for tourism, 9.28418 million USD for pharma, 6.835938 million USD for motor parts, 1784.714844 million USD for utility consumption and 1784.714844 million USD for transport and communication.



DOI: http://doi.org/10.48165/sajssh.2021.2314

***Figure 6:*** **Changes in Sectoral Sales**

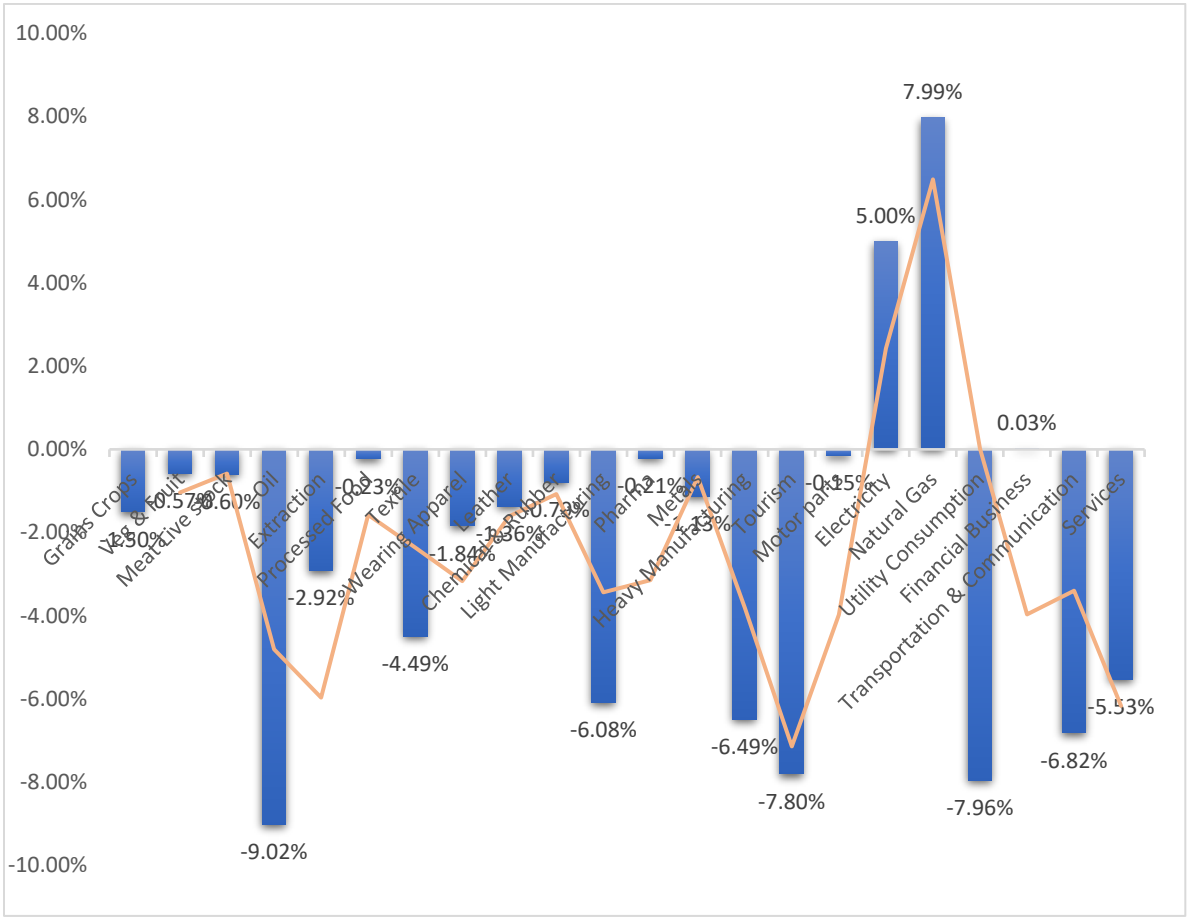


Figure 6 shows Percentage sales in 21 sectors of the economy following an 8% shock to 11 sectors of the economy and a 5% shock to electricity.

**Table 8:** ***Effects on Real Returns to factors***

| Pakistan | Simulation | Pre-Value | Post-Value | Change divided by %Change | Percentage change |
|---|---|---|---|---|---|
| Land | -15.24991 | 1 | 0.847501 | -0.152499 | -15.2499 |
| Technical and Professionals | 1.544412 | 1 | 1.015444 | 0.015444 | 1.5444 |
| Clerks | -0.790871 | 1 | 0.992091 | -0.007909 | -0.7909 |
| Service shop | 1.859553 | 1 | 1.018596 | 0.018596 | 1.8596 |
| Officers and Managers | 1.198258 | 1 | 1.011983 | 0.011983 | 1.1983 |
| Agriculture Low Skilled Workers | -8.159727 | 1 | 0.918403 | -0.081597 | -8.1597 |
| Capital | 0.409329 | 1 | 1.004093 | 0.004093 | 0.4093 |
| Natural Resources | -23.866497 | 1 | 0.761335 | -0.238665 | -23.8665 |

**(Author Simulations)**



DOI: http://doi.org/10.48165/sajssh.2021.2314

Table 8 shows effects on real returns to factors following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows: Real returns increased by 0.015444 million USD for technical and professionals, 0.992091 million USD for clerks, 0.018596 million USD for service shops, 0.011983 million USD for officers and managers and 0.004093 million USD for capital. Conversely, real returns decreased by 0.152499 million USD for land, 0.081597 million USD for agriculture low skilled labor and 0.238665 million USD for natural resources.

***Figure 7:*** **Change in Sectors of the Economy**

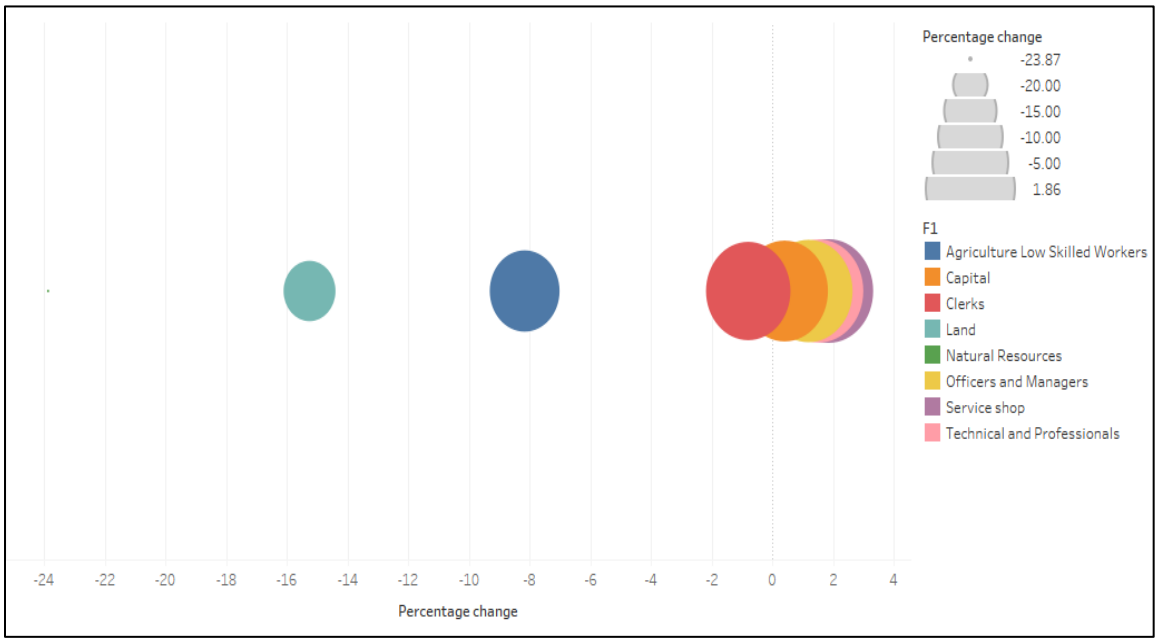


Figure 7 shows Percentage change in 8 sectors of the economy following an 8% shock to 11 sectors of the economy and a 5% shock to electricity.

***Figure 8:*** **Effects on Real Returns to Factors**

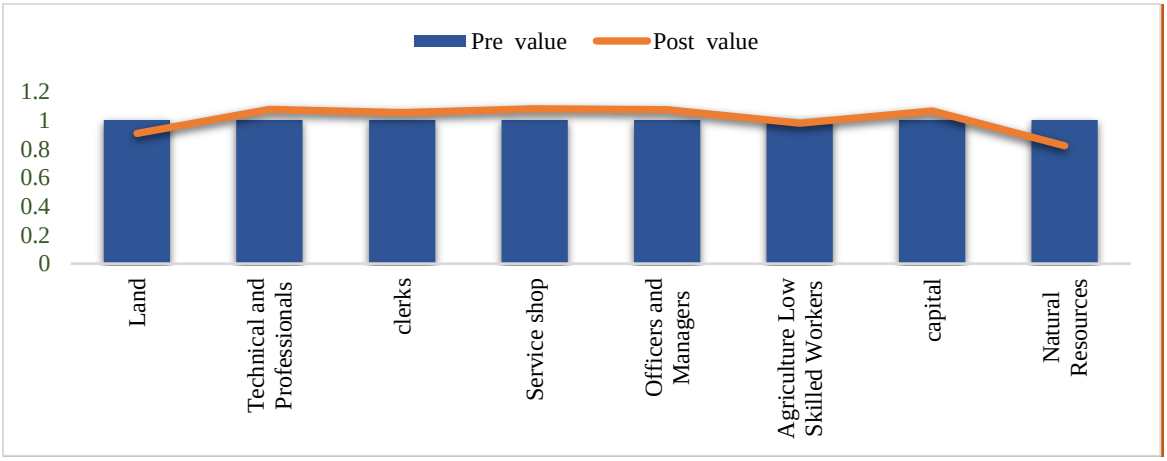




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Figure 8 shows effects on real returns to factors before and after lockdown. The bar graph shows a rise in returns for technical and professionals, clerks, service shops, officers and managers and capital. In contrast, real returns declined for land, agriculture low skilled labor and natural resources.

**Table 9:** ***Market Price of Commodity***

| Pakistan | Simulation | Pre-Value | Post-Value | Change divided by %change | Percentage change |
|---|---|---|---|---|---|
| Land | -9.229851 | 1 | 0.907701 | -0.092299 | -9.2299% |
| Technical and Professionals | 7.564472 | 1 | 1.075645 | 0.075645 | 7.5645% |
| clerks | 5.229189 | 1 | 1.052292 | 0.052292 | 5.2292% |
| Service shop | 7.879612 | 1 | 1.078796 | 0.078796 | 7.8796% |
| Officers and Managers | 7.218318 | 1 | 1.072183 | 0.072183 | 7.2183% |
| Agriculture Low Skilled Workers | -2.139667 | 1 | 0.978603 | -0.021397 | -2.1397% |
| capital | 6.429389 | 1 | 1.064294 | 0.064294 | 6.4294% |
| Natural Resources | -17.846436 | 1 | 0.821536 | -0.178464 | -17.8464% |
| Grains Crops | -5.897249 | 1 | 0.941028 | -0.058972 | -5.8972% |
| Veg & Fruit | -3.482954 | 1 | 0.96517 | -0.03483 | -3.483% |
| Meat Live stock | -7.263437 | 1 | 0.927366 | -0.072634 | -7.2634% |
| Oil | -2.931124 | 1 | 0.970689 | -0.029311 | -2.9311% |
| Extraction | 6.689344 | 1 | 1.066893 | 0.066893 | 6.6893% |
| Processed Food | -1.360657 | 1 | 0.986393 | -0.013607 | -1.3607% |
| Textile | 2.220895 | 1 | 1.022209 | 0.022209 | 2.2209% |
| Wearing Apparel | 1.522858 | 1 | 1.015229 | 0.015229 | 1.5229% |
| Leather | -0.33472 | 1 | 0.996653 | -0.003347 | -0.3347% |
| Chemical & Rubber | -1.247836 | 1 | 0.987522 | -0.012478 | -1.2478% |
| Light Manufacturing | 4.162733 | 1 | 1.041627 | 0.041627 | 4.1627% |
| Pharma | -0.800068 | 1 | 0.991999 | -0.008001 | -0.8001% |
| Metals | -0.691056 | 1 | 0.993089 | -0.006911 | -0.6911% |
| Heavy Manufacturing | 3.493718 | 1 | 1.034937 | 0.034937 | 3.4937% |
| Tourism | 28.708002 | 1 | 1.28708 | 0.28708 | 28.708% |
| Motor parts | -2.539122 | 1 | 0.974609 | -0.025391 | -2.5391% |
| Electricity | -55.402546 | 1 | 0.445975 | -0.554025 | -55.4025% |
| Natural Gas | -239.238098 | 1 | -1.392381 | -2.392381 | -239.2381% |
| Utility Consumption | 17.552694 | 1 | 1.175527 | 0.175527 | 17.5527% |
| Financial Business | 0.244906 | 1 | 1.002449 | 0.002449 | 0.2449% |



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| | | | | | |
|---|---|---|---|---|---|
| Transportation & Communication | 18.268433 | 1 | 1.182684 | 0.182684 | 18.2684% |
| Services | 10.947333 | 1 | 1.109473 | 0.109473 | 10.9473% |
| CGDS | 9.023763 | 1 | 1.090238 | 0.090238 | 9.0238% |

**(Author Simulations)**

Table 9 shows market price of commodity following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows: Market price rose by 0.075645 million USD for technical and professionals, 0.052292 million USD for clerks, 0.078796 million USD for service shops, 0.072183 million USD for officers and mangers, 0.064294 million USD for capital, 0.066893 million USD for extraction, 0.022209 million USD for textile, 0.015229 million USD for wearing apparel, 0.041627 million USD for light manufacturing , 0.034937 million USD for heavy manufacturing, 0.28708 million USD for tourism, 0.175527 million USD for utility consumption, 0.002449 million USD for financial business, 0.182684 million USD for transport and communication, 0.109473 million USD for services and 0.090238 million USD for CGDS. In contrast, market price declined by 0.008001 million USD for pharma, 0.012478 million USD for chemicals, 0.003347 million USD for leather, 0.029311 million USD for oil production, 0.021397 million USD for agriculture low skilled labor, 0.092299 million USD for land, 0.178464 million USD for natural resources, 0.058972 million USD for grain crops, 0.03483 million USD for vegetables and fruits, 0.072634 million USD for meat and livestock, 0.013607 million USD for processed food, 0.006911 million USD for metals, 0.025391 million USD for motor parts, 0.554025 million USD for electricity, 2.392381 million USD for natural gas and 0.002449 million USD for financial business.

***Figure 9:*** **Market Price of Commodity**

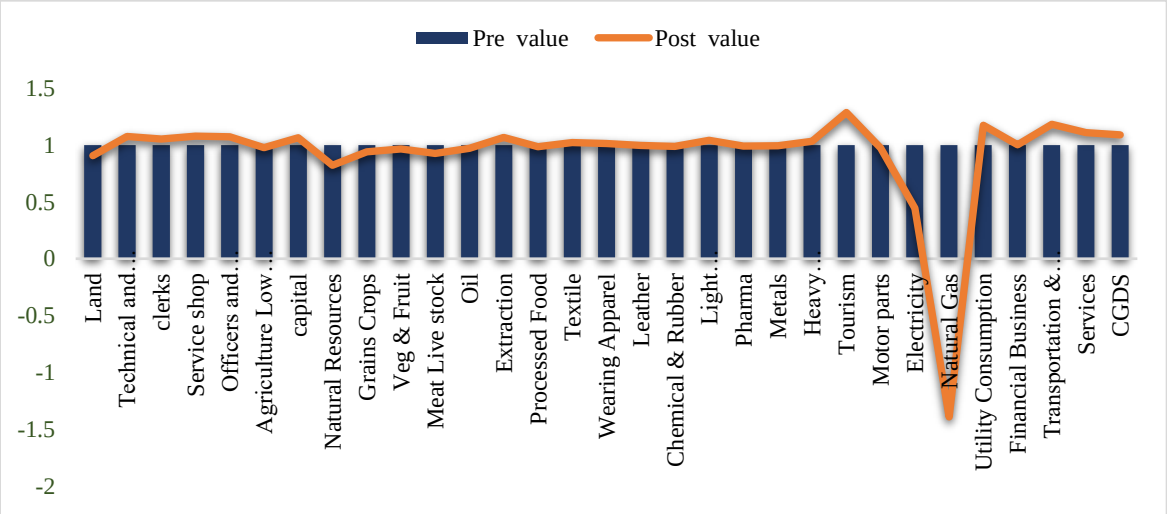




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Figure 9 shows market price of commodity for 31 sectors pre and post the lockdown period. The bar graph shows an increase in market prices for technical and professionals, clerks, service shops, officers and managers, agriculture low skilled workers, capital, extraction, textile, wearing apparel, chemicals, light manufacturing, pharma, heavy manufacturing, tourism, utility consumption, financial business, transport and communication, services and CGDS. However, market prices fell in the case of land, leather, natural resources, grain crops, vegetables and fruits, meat and livestock, processed food, metals, motor parts, electricity, natural gas and financial business.

**Table 10:** ***Value added in industry***

| **Pakistan** | **Simulation** |
|---|---|
| Grains Crops | -2.047419 |
| Vegetable & Fruit | -0.188201 |
| Meat Livestock | -3.513793 |
| Oil | -10.484274 |
| Extraction | -1.525975 |
| Processed Food | -0.063527 |
| Textile | -6.310023 |
| Wearing Apparel | -6.388264 |
| Leather | -7.780887 |
| Chemical & Rubber | -6.710108 |
| Light Manufacturing | -8.034597 |
| Pharma | -3.86811 |
| Metals | 5.944238 |
| Heavy Manufacturing | -2.08261 |
| Tourism | 14.307365 |
| Motor parts | -4.913346 |
| Electricity | -40.656017 |
| Natural Gas | -241.422714 |
| Utility Consumption | 5.407889 |
| Financial Business | -8.367641 |
| Transportation & Communication | 3.489039 |
| Services | -4.045132 |
| CGDS | -3.610926 |

**(Author Simulations)**



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Table 10 shows value addition in industry following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows: Value addition rose by 14.307365 million USD for tourism, 5.944238 million USD for metals, 5.407889 million USD for utility consumption and 3.489039 million USD for transport and communication, whereas it decreased by 0.063527 million USD for processed food, 2.047419 million USD for grain crops, 0.188201 million USD for vegetables and fruit, 3.513793 million USD for meat and livestock, 10.484274 million USD for oil production, 1.525975 million USD for extraction, 6.310023 million USD for textile, 6.388264 million USD for wearing apparel, 7.780887 million USD for leather, 6.710108 million USD for chemicals, 8.034597 million USD for light manufacturing, 3.86811 million USD for pharma, 2.08261 million USD for heavy manufacturing, 4.913346 million USD for motor parts, 40.656017 million USD for electricity, 241.422714 million USD for natural gas, 8.367641 million USD for financial business, 4.045132 million USD for services and 3.610926 million USD for CGDS.

***Figure 10:*** **Value Added in Industry**

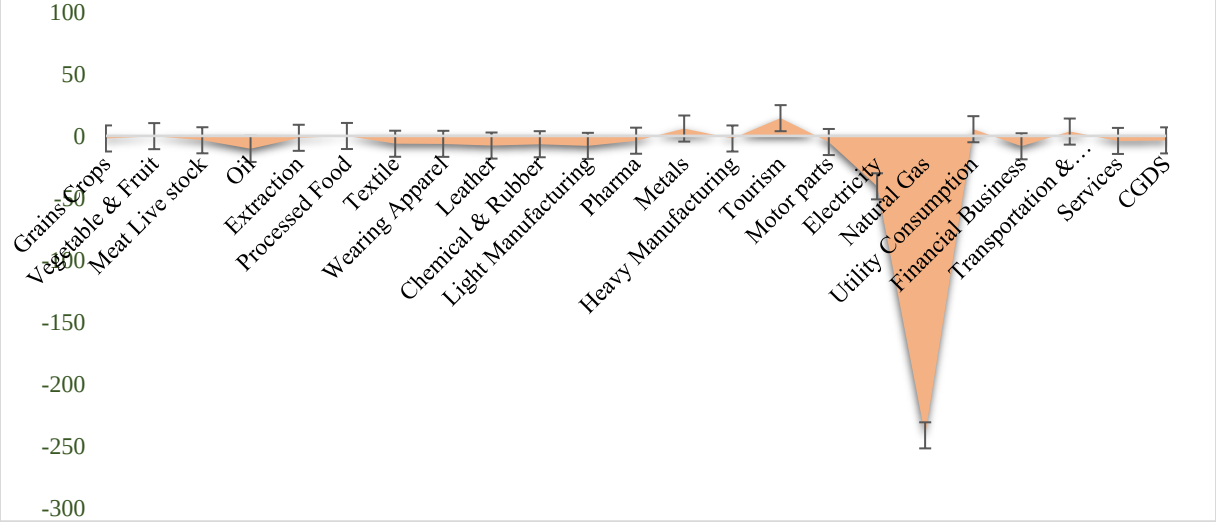


Figure 10 shows fluctuating trends of value added in industry.

**Table 11:** ***Supply prices of commodity***

| **Pakistan** | **Simulation** |
|---|---|
| Land | -9.229851 |
| Technical and Professionals | 7.564472 |
| Clerks | 5.229189 |
| Service shop | 7.879612 |



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| | |
|---|---|
| Officers and Managers | 7.218318 |
| Agriculture Low Skilled Workers | -2.139667 |
| Capital | 6.429389 |
| Natural Resources | -17.846436 |
| Grains Crops | -5.897249 |
| Vegetable & Fruit | -3.482954 |
| Meat Live stock | -7.263437 |
| Oil | -2.931124 |
| Extraction | 6.689344 |
| Processed Food | -1.360657 |
| Textile | 2.220895 |
| Wearing Apparel | 1.522858 |
| Leather | -0.33472 |
| Chemical & Rubber | -1.247836 |
| Light Manufacturing | 4.162733 |
| Pharma | -0.800068 |
| Metals | -0.691056 |
| Heavy Manufacturing | 3.493718 |
| Tourism | 28.708002 |
| Motor parts | -2.539122 |
| Electricity | -55.402546 |
| Natural Gas | -239.238098 |
| Utility Consumption | 17.552694 |
| Financial Business | 0.244906 |
| Transportation & Communication | 18.268433 |
| Services | 10.947333 |
| CGDS | 9.023763 |

**(Author Simulations)**

Table 11 shows supply price of commodity following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows:Supply price of commodity rose by 7.564472 million USD for technical and professionals, 5.229189 million USD for clerks, 7.879612 million USD for service shops, 7.218318 million USD for officers and managers, 6.429389 million USD for capital, 6.689344 million USD for extraction, 2.220895 million USD for textile, 1.522858 million USD for wearing apparel, 1.247836 million USD for chemicals, 4.162733 million USD for light manufacturing, 3.493718 million USD for heavy manufacturing, 28.708002 million USD for tourism, 17.552694 million USD for utility consumption, 0.244906 million USD for financial



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business, 18.268433 million USD for transport and communication, 10.947333 million USD for services and 9.023763 million USD for CGDS.

On the other hand, supply price of commodity declined by 0.800068 million USD for Pharma, 0.33472 million USD for leather, 2.139667 million USD for agriculture low skilled labor, 2.931124 million USD for oil production, 9.229851 million USD for land, 17.846436 million USD for natural resources, 5.897249 million USD for grain crops, 3.482954 million USD for vegetable and fruits, 7.263437 million USD for meat and livestock, 1.360657 million USD for processed food, 0.691056 million USD for metals, 2.539122 million USD for motor parts, 55.402546 million USD for electricity and 239.238098 million USD for natural gas.

***Figure 11:*** **Supply Price of Commodity**

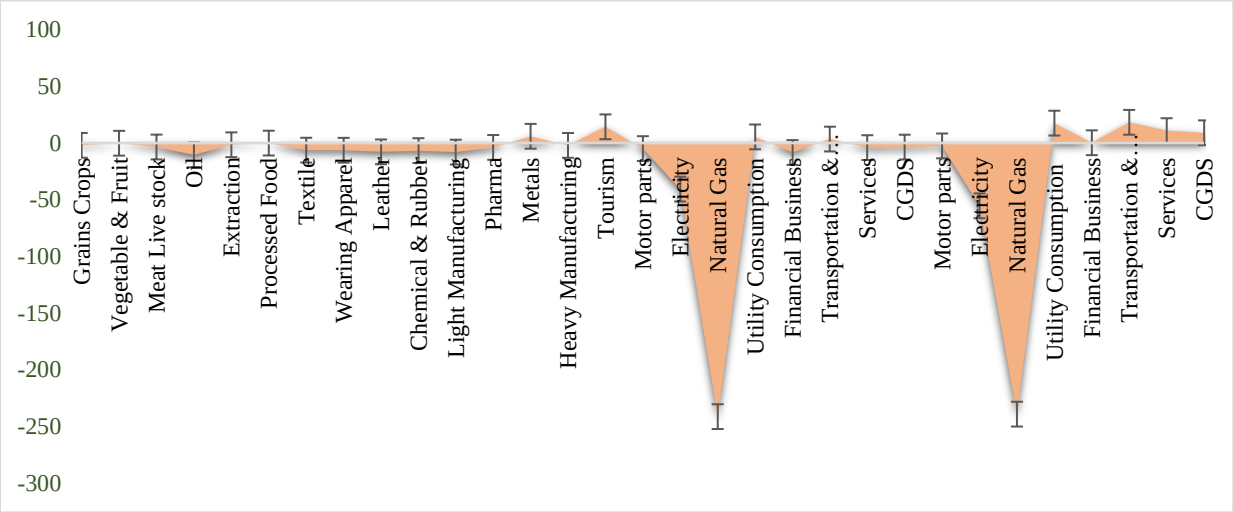


Figure 11 shows fluctuating trends in supply price of commodity.

**Table 12:** ***Private consumption prices for commodity***

| **Pakistan** | **Simulation** |
|---|---|
| Grains Crops | -5.648772 |
| Vegetable & Fruit | -3.478157 |
| Meat Livestock | -7.14499 |
| Oil | -1.534527 |
| Extraction | 6.458766 |
| Processed Food | -1.198087 |
| Textile | 1.843628 |



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| | |
|---|---|
| Wearing Apparel | 1.340131 |
| Leather | -0.252433 |
| Chemical Rubber | -0.701822 |
| Light Manufacturing | 3.313489 |
| Pharma | -0.641634 |
| Metals | -0.305838 |
| Heavy Manufacturing | 2.52203 |
| Tourism | 28.479427 |
| Motor parts | -1.728705 |
| Electricity | -55.217552 |
| Natural Gas | -238.643616 |
| Utility Consumption | 17.540356 |
| Financial Business | 0.153416 |
| Transportation Communication | 18.059992 |
| Services | 10.520031 |

**(Author Simulations)**

Table 12 shows changes in private consumption price for commodity following an 8% shock to the 11 selected sectors and a 5% shock to electricity. The results are as follows:

Private consumption price increased by 1.534527 million USD for oil, 6.458766 million USD for extraction, 1.843628 million USD for textile, 1.340131 million USD for wearing apparel, 3.313489 million USD for light manufacturing, 0.641634 million USD for pharma, 2.52203 million USD for heavy manufacturing, 28.479427 million USD for tourism, 17.540356 million USD for utility consumption, 0.153416 million USD for financial business, 18.059992 million USD for transport and communication and 10.520031 million USD for services.

Contrarily, private consumption price decreased by 0.701822 million USD for chemicals, 0.252433 million USD for leather, 5.648772 million USD for grain crops, 3.478157 million USD for vegetables and fruit, 7.14499 million USD for meat and livestock, 1.198087 million USD for processed food, 0.305838 million USD for metals, 1.728705 million USD for motor parts, 55.217552 million USD for electricity and 238.643616 million USD for natural gas.



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***Figure 12:*** **Private Consumption price for Commodity**

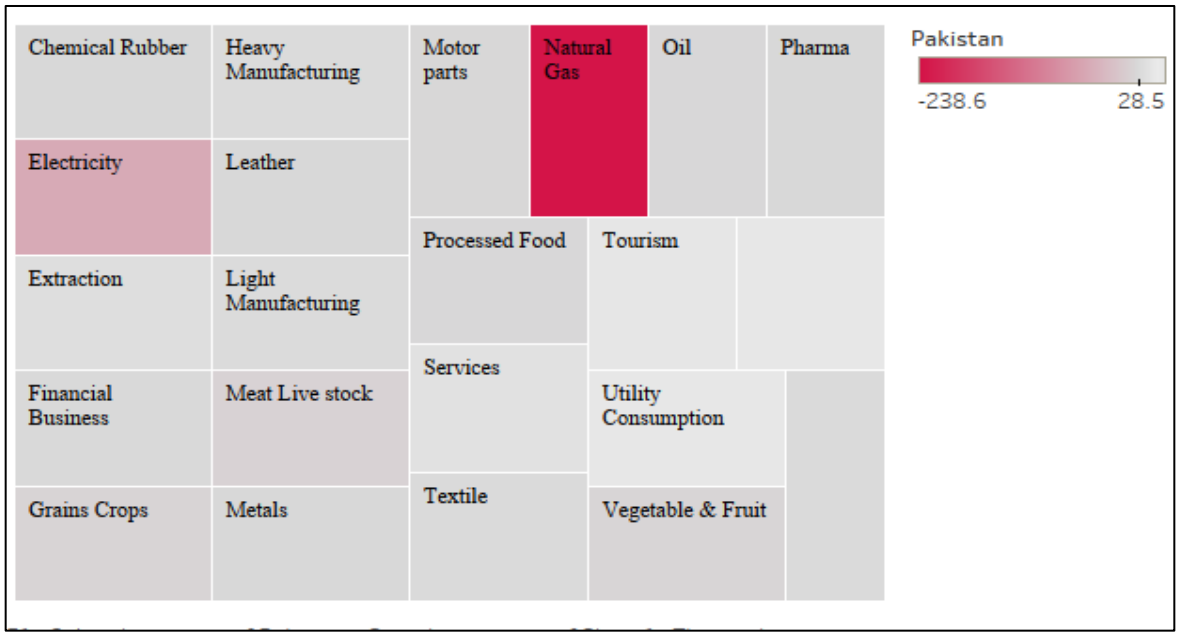


Figure 12 shows private consumption price for commodity following an 8% shock to the 11 selected sectors and a 5% shock to electricity.

## CONCLUSIONS

Pakistan's economy was in a fragile state and had just began to become stable when the pandemic hit. Experts have feared that the economic fallout of the corona virus pandemic is likely to derail Pakistan's process of recovery in a considerable way. In our research work, we seek to understand the effects of an 8% shock to 11 sectors of the economy and a 5% negative shock to electricity on the overall 31 sectors that are part of the model. The results are as follows:

- There was a decline in Real GDP, Real Exports, Real imports, and Per Capita Utility from Private Expenditure. Terms of trade and Regional household income increased.
- Sectorial output remained unchanged for 18 sectors, declined for 11 sectors, and rose for 2 sectors.
- Exports decreased for 10 sectors and rose for 12 sectors, while imports rose for 10 sectors and declined for 12 sectors.
- Sectorial prices rose for 16 sectors and declined for 15 sectors.
- Domestic sales increased for 3 sectors and decreased for 19 sectors.
- Real returns to factors rose for 4 sectors and decreased for 4 sectors.
- Market prices increased for 16 commodities and declined for 15 commodities.



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- Supply price of commodity increased for 16 sectors and declined for 15 sectors.
- Value addition declined for 19 sectors and increased for 4 sectors.
- Private consumption price of commodity increased for 10 sectors and declined for 12 sectors.

It is suggested Pakistan's government should treat the crisis due to COVID-19 as an opportunity to undertake economic, political, and foreign policy reforms so that prospects of increased downturn in the economy can be quashed.



DOI: http://doi.org/10.48165/sajssh.2021.2314

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## APPENDIX

**Table 13:** ***Review and Background of Previous Studies***

| S No. | Author(s) | Area(s) | Data Time Period | Variables | Methodology | Results |
|---|---|---|---|---|---|---|
| 1 | Dev and Sen Gupta et al. 2020 | India | 2020 | COVID-19 Cases, GDP, Unemployment, Bank Credit | Case study | Unanticipated economic challenges have been posed to India as a result of the COVID19 pandemic. The damage resulting from lockdown is likely to be far worse than what is currently estimated. |
| 2 | Ruchi Saini | India | 2020 | GDP Growth Rate, Changes In | Analysis of demand and supply chains | The extent of economic impact will depend upon the severity of the |



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| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Policy, Rate of Unemployment | | pandemic and the extent of lockdown, as well as the aftermath. |
| 3 | Vikas Rawal et al. 2020 | India | 2020 | COVID-19 Lockdown, Rural Economy and Agriculture | Case study | As there has been an absence of proper planning by the government, lockdown due to COVID-19 has caused great damage to the economy of India as well as the country's working population. |
| 4 | Abdulkadir Atalan (2020) | 49 countries | 2020 | COVID-19 cases, Lockdown dates | Correlation Tests | The measures taken by countries to suppress the COVID-19 pandemic may lead to economic disaster. |
| 5 | Inoue and Todo (2020) | Tokyo | 2020 | Supply chains of 1.6 million Japanese firms | Agent-based model | If Tokyo faces a lockdown for a month, total production loss would stand at 27 trillion Japanese yen, causing a 5.2% loss to GDP. |
| 6 | Dr John Taskinsoy | Italy, USA, Russia, France, Germany, China, UK, Spain | 1930s-2020 | Great depression, Spanish flu, World War 1 and 2, Asian crisis, Global financial crisis, COVID-19, banking system | Case Study | COVID-19 is not a financial crisis so it cannot be compared to great recession or great depression. Banks are now stronger compared to 2008 and can withstand exogenous shocks. |
| 7 | Abdelrhim and Elsayed (2020) | America, China, Japan, Germany, UK | 15 March 2020 – 25 May 2020 | COVID-19, Global e-commerce companies | Descriptive Analysis, Aggregate Model | The companies attained positive returns on a daily basis. The extent of impact of the COVID-19 fluctuated from company to company. |
| 8 | Nader Alber (2020) | Italy, USA, China, France, | March 1 2020-April 10 2020 | COVID-19, Stock Market Returns | GMM technique, Panel Analysis | Returns from the stock market are sensitive to the cases of COVID-19, with negative impacts on returns from stock markets of all these economies. |



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| | | | | | | |
|---|---|---|---|---|---|---|
| | | Germany , Spain | | | | |
| 9 | Bhat et al. 2020 | Kashmir | 2020 | COVID-19, psychological health, precautionary measures | Online Survey, Stratified Random Sampling | 76.5% of those who responded were of the opinion that lockdown is not a permanent solution and causes issues such as psychological problems, economic issues, social as well as academic issues. |
| 10 | Rosen and Stenbeck (2020) | Sweden | 2020 | Expected future unemployment rates owing to COVID-19 | Systematic review, Data of important statistics | Interventions made to control the pandemic as well as the shutting down of economic activities has led to an overall rise in mortality. |
| 11 | Ian McCulloh et al.2020 | USA | 2020 | Infection fatality ratios and and time to death distributions | Monte Carlo Method | Social distancing strategies caused a fall in new infections. The association between observed cases and number of true infections is not useful in predicting trends regarding real rate of infection. |
| 12 | Asif Javed (2020) | Pakistan | 2020 | COVID-19, Services Sector | Descriptive Analysis | The most highly affected sectors due to Covid-19 within the services sector are tourism and transport industries. SMEs in millions are likely to close in the long run. |



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