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Macro-economic Impacts of the COVID-19 Pandemic on Mongolia's Economy: CGE Analysis with the GTAP 10a Data Base

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Abstract

This paper evaluates macro-economic impacts of the various policy measures implemented by governments in response to the worldwide COVID-19 pandemic by employing the standard GTAP Model and Data Base 10a, with Mongolia as the focus area.

The simulation results demonstrate that Mongolia's real economy would witness a 4.9% contraction, which is relatively compatible with the actual rate of -4.6% in 2020. All components of the welfare indicator are negative, and the country's total welfare losses would equal $772.2 million. Most welfare deficits are associated with productivity drops followed by the terms of trade in goods and services and allocative efficiency losses. Also, both merchandise exports and imports decline along with worsening of the terms of trade.

The pandemic triggers output drops for almost all sectors in Mongolia, including its major industry—the extractive sector. A few industries, such as textiles, other foods, and apparel, would experience output growths despite the pandemic shocks. However, the low self-sufficiency rates of these industries would undermine their output expansions during a prolonged pandemic, such as COVID-19.

The Mongolian government's stimulus packages to minimize the negative impacts of the pandemic on its economy have had positive effects on households by supporting consumption. However, unskilled labor has been the most vulnerable group during the pandemic, so it is desirable to implement targeted programs over universal stimuluses.

JEL Codes: E01, F17, C68
Keywords: COVID-19 impacts, Economic growth, Welfare Impacts, CGE analysis

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1. Introduction

Mongolia was quick in responding to the initial outbreak of COVID-19 in China, and well before the WHO labelled it a pandemic, Mongolia had closed all schools, educational institututions and game centers along with prohibiting public cultural and sports events from January 27, 2020. Soon after, all air, rail and road transport borders with China were closed to inbound non-citizen passengers and most non-regular border crossings were shut from February 1. Then on February 13, the country moved into a nationwide "Partial heightened state of preparedness," and regular flights between Mongolia and the ROK were suspended from February 27; and those between Mongolia and Japan from February 28. On March 10, 2020, Mongolia registered its first case of COVID-19, which was an imported case. After the WHO declared a pandemic the following day on March 11, Mongolia suspended all remaining regular flights with the Russian Federation, Kazakhstan, and Turkey along with canceling international passenger travels by rail and road along the Mongolia-Russian border. Neighbored by only China and Russia, Mongolia has remained virtually closed to the outside world since then, and the"Partial heightened state of preparedness" has abolished on February 14, 2022 – 4.5 months earlier than its initial extension until the end of June 2022[1].

The first case of locally transmitted COVID-19 in Mongolia was registered on November 11, 2020, and since, nationwide or partial lockdowns have been initiated several times due to the rapid spread of the virus, especially in Ulaanbaatar. According to the Oxford COVID-19 Government Response Tracker[2], Mongolia's government response index to the COVID-19 pandemic was relatively more stringent than the global average during the initial year of the pandemic despite its successful efforts to prevent local infections for a longer period than seen elsewhere (Enkhbayar, Sh., 2021). However, local spread in Mongolia became much more severe than the global trend thereafter. As of January 31, 2022, total confirmed COVID-19 cases in Mongolia reached 443,392, equaling 13.2% of its total population of 3.36 million. This figure far exceeds the global infection rate of 4.75% (375.2 million cases[3] among a population of 7.9 billion).

Computable general equilibrium (CGE) models can be used to assess the various economic impacts (e.g., Maliszewska, M. et al, 2020; ADB, 2020) of this pandemic as it has disturbed virtually every aspect of each nation's economy on both a macro and micro level. This paper attempts to evaluate the expected short-term (annual) macro-economic

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[1] COVID-19 risk level has downgraded from "Yellow" to "Orange", when all restrictions are removed except the basic preventuons: wearing mask, keeping distance and avoiding crowds in indoor, poor ventilated places.

[2] https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker (Thomas Hale et al (2021); January 24, 2022)

[3] https://www.worldometers.info/coronavirus (Worldometers.info, January 31, 2022)

impacts of the pandemic in relation to the consequences of numerous policy and fiscal measures implemented by governments worldwide as part of their initial responses. These measures represent various positive and negative shocks to economies, such as stimulus packages introduced by the governments, increased trade costs due to various restrictions on border crossing and international shipments, loss of working hours due to the adoption of shorter business hours and shifts to remote work, a worldwide travel ban, and restrictions on tourists and business travelers. In short, international capital mobility has been problematic due to restrictions on the cross-border movements of people and goods.

This CGE analysis focuses on short-term macro-economic impacts of the above shocks on Mongolia's economy using the GTAP model and data base. The shocks are applied to all regions in the Model, i.e., to the economy in question and its worldwide trading partners[4]. Data used for setting the shock levels are those available as of October 2020, so some discrepancies from the annual records do exist. Although, the simulation results are provided for all regions in the model, the discussion section focuses solely on Mongolia's economy.

2. The Model and Data

The present study analyzes the macro-economic impacts of the COVID-19 pandemic on Mongolia's economy by employing the standard GTAP Model (Version 7.0 of June 2017, hereinafter referred to as "the Model") and GTAP Data Base 10A.

The GTAP Model is a global multi-region and multi-sector (CGE) comparative static model[5] with perfect competition and constant returns to scale. The Model is based on an input-output accounting framework and a complete representation of the global economy within the theory of the model in the sense that all sources and uses of each economic good and all inputs into production are accounted for. The standard GTAP Model is implemented using the GEMPACK suite of economic modeling software documented in Harrison and Pearson, 1996, and the equations in the model are recorded in percentage change form (Corong, E. et al, 2017).

A CGE model is a system of mathematical equations that describes an economy as a whole and the interactions among its agents. In the Model, bilateral trade is handled via the Armington assumption, which provides the possibility to distinguish imports by their origin and explains the intra-industry trade of similar products. It combines detailed bilateral trade, transport and protection data characterizing the economic linkages among regions, together with individual country input–output databases, which account for inter-

[4] Mongolia traded with 146 countries in 2020 (NSO, 2020)

[5] For more details on the GTAP model and database, refer to Corong, E. et al, 2017 and Hertel, T. (ed.), 1997.

sectoral linkages. CGE models allow us to quantify economy-wide impacts resulting from shocks to the economic system in equilibrium. The Model comes with some special restrictions and limitations. For example, all domestic agents in an economy use the same mix of imports from different countries; no re-exports; no international trade in primary factors; no foreign income receipts or payments; no remittances and no international aid flows; and the database does not reflect any concept of a government budget deficit; and all firms are homogeneous. However, several of the model extensions were developed to address these limitations (Corong, E. et al, 2017).

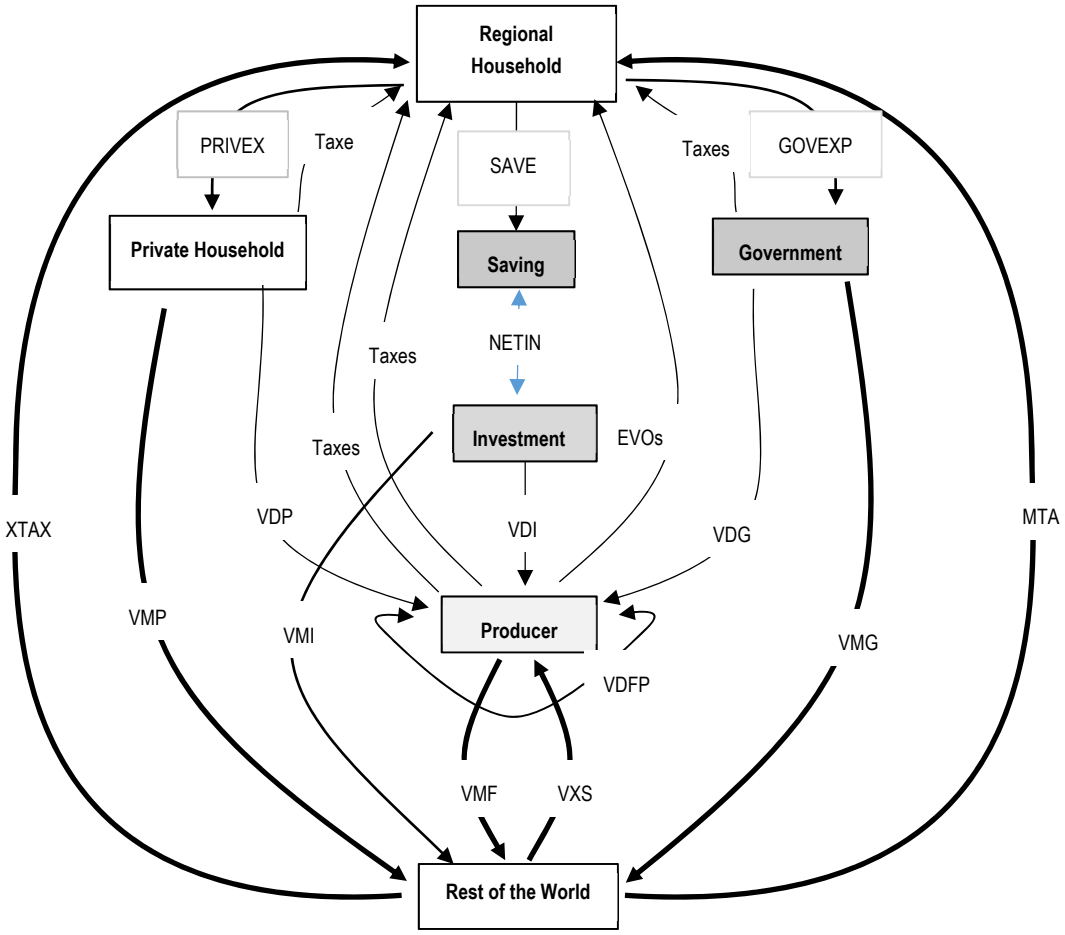
A simplified illustration of all economic agents in the Model and their interactions is provided in Figure 2.1. This is a graphical expression of a multi-region open economy with government interventions, i.e., taxes. The Model makes a zero-profit assumption for producers, so that all the revenues are completely used on expenditures. The Model incorporates a regional household, associated with each country (e.g. Mongolia) or composite region (e.g. Rest of East Asia, XEA). The regional household collects all the income that is generated in an economy. Expenditures by this household are allocated across three broad categories: private (*PRIVEXP*), government (*GOVEXP*), and savings (*SAVE*) expenditures. Domestic saving adjusted by net foreign saving flow is used to purchase capital goods, i.e. investment (NETIN). These represent final demand in an economy and each component roughly maintains a constant share of the total regional income. Modelling the components of final demand via this regional household has the advantage that it enables control of the condition where no agent can spend more income than it receives. Besides, this concept of a regional household is best suited to compute equivalent variation as a measure of regional welfare resulting from different policy scenarios. Compared to its previous classic version (GTAP v. 6.2), this standard GTAP Model and database allow for the possibility of each activity to produce more than one commodity; and for commodities to be the aggregation of output by one or more activities (Corong, E.2017; Brockmeier, 1996; Figure 2.1).

The GTAP Data Base 10A has four reference years (2004, 2007, 2011 and 2014) and this analysis uses data with the reference year of 2014. The GTAP Data Base is denominated in millions of base year US dollars. Thus, the values indicated in this part are expressed in constant 2014 US$ terms, unless otherwise specified. There are 141 regions and 65 commodities in the database. For this analysis, the regions are aggregated into 16 regions and the sectors are grouped into 35 sectors. The classifications of the regions and sectors are provided in Appendix Tables 1 and 2.

The original eight factors of production in the Model are aggregated into four factors:

unskilled labor, skilled labor, capital, and land & natural resources, where skilled labor and capital are mobile factors and land & natural resources are sluggish factors. However, as it has become difficult for unskilled labor to move between sectors due to various restrictions and business closures associated with the COVID-19 pandemic, and the fact that companies regularly face scarcity of unskilled labor due to border closures, here, unskilled labor is a fixed factor in the Model (Appendix Table 3).

Figure 1 Circular Flows in a Regional Economy



Source: Corong, E. et al. (2017), p.10.

GDP composition of the aggregated regions from the expenditure and source sides are provided in Tables 2.1 and 2.2. Mongolia is among the countries with the highest GDP shares of foreign trade, where exports and imports account for more than 55% of GDP. It is interesting to note that household consumption of Tajikistan is 10.2% higher than its GDP as the economy heavily depends on remittances from abroad which make it possible to consume without producing (EUROASIANET, 2020). Therefore, various disruptions of foreign trade and domestic production associated with the COVID-19 pandemic have

severely impacted households and businesses in these countries (Table 1).

From the sources side, the GDP share of factor income and tax in Mongolia represent 57.7% and 27.9%, respectively. Although its tax share of GDP is around the world average, it is higher than those of other developing countries. Thus, under the assumption that the Mongolian government were able to correctly plan and implement the countermeasures, its capacity to respond to the COVID-19 pandemic and support households and businesses would be better than those in other developing nations (Table 2).

Moreover, the share of unskilled labor in factor income is relatively high in Mongolia, while that of skilled labor is low. Therefore, unskilled labor has been hardest hit by the pandemic as it has less opportunity for remote work compared to skilled labor (Table 3).

Table 1 GDP Expenditure Composition (Share of total)

Regions	Household Consumption	Investment	Government Consumption	Export	Import	Total
Mongolia	0.566	0.285	0.130	0.579	-0.560	1.000
China	0.380	0.441	0.135	0.244	-0.201	1.000
ROK	0.509	0.295	0.153	0.480	-0.437	1.000
Japan	0.589	0.214	0.200	0.200	-0.203	1.000
Russia	0.532	0.212	0.185	0.272	-0.201	1.000
Other East Asia	0.473	0.289	0.124	0.675	-0.561	1.000
Tajikistan	1.102	0.265	0.148	0.119	-0.633	1.000
Other Central Asia	0.541	0.291	0.131	0.329	-0.291	1.000
Southeast Asia	0.584	0.291	0.119	0.561	-0.555	1.000
South Asia	0.645	0.302	0.111	0.201	-0.258	1.000
Advanced Economies	0.662	0.204	0.162	0.164	-0.192	1.000
EU_27	0.567	0.204	0.217	0.412	-0.400	1.000
LARNA	0.644	0.211	0.166	0.190	-0.212	1.000
MENA	0.538	0.248	0.182	0.367	-0.335	1.000
SSA	0.677	0.208	0.134	0.266	-0.285	1.000
Rest of the World	0.708	0.240	0.203	0.433	-0.584	1.000
World	0.582	0.249	0.169	0.272	-0.272	1.000

Source: GTAP 10A Data Base.

Table 2 GDP Composition from the Sources Side (Share of total)

Regions	Factor Income	Tax	Depreciation	Total
Mongolia	0.577	0.279	0.144	1.000
China	0.619	0.224	0.158	1.000
ROK	0.595	0.251	0.154	1.000
Japan	0.525	0.321	0.154	1.000
Russia	0.578	0.337	0.085	1.000
Other East Asia	0.667	0.194	0.140	1.000
Tajikistan	0.751	0.176	0.073	1.000
Central Asia	0.727	0.194	0.079	1.000
Southeast Asia	0.723	0.160	0.117	1.000
South Asia	0.768	0.116	0.116	1.000
Advanced Economies	0.580	0.291	0.129	1.000
EU_27	0.450	0.414	0.136	1.000
LARNA	0.644	0.241	0.115	1.000
MENA	0.706	0.188	0.106	1.000
SSA	0.695	0.202	0.103	1.000
Rest of the World	0.559	0.318	0.123	1.000
World	0.583	0.285	0.131	1.000

Source: GTAP 10A Data Base.

Table 3 Sources of Factor Income (Share of total)

Regions	Land and Natural Resources	Unskilled Labor	Skilled Labor	Capital	Total
Mongolia	0.125	0.217	0.095	0.563	1.000
China	0.032	0.369	0.111	0.488	1.000
ROK	0.008	0.284	0.220	0.488	1.000
Japan	0.002	0.221	0.248	0.529	1.000
Russia	0.067	0.180	0.214	0.538	1.000
Other East Asia	0.012	0.288	0.211	0.490	1.000
Tajikistan	0.093	0.254	0.075	0.578	1.000
Central Asia	0.095	0.231	0.102	0.572	1.000
Southeast Asia	0.060	0.247	0.168	0.526	1.000
South Asia	0.066	0.270	0.211	0.453	1.000
Advanced Economies	0.012	0.277	0.390	0.321	1.000
EU_27	0.004	0.208	0.294	0.493	1.000
LARNA	0.027	0.246	0.229	0.498	1.000
MENA	0.079	0.188	0.147	0.586	1.000
SSA	0.068	0.304	0.212	0.416	1.000
Rest of the World	0.034	0.241	0.279	0.445	1.000
World	0.024	0.261	0.272	0.443	1.000

Source: GTAP 10A Data Base.

3 The COVID-19 Scenarios and Shocks

*3.1 The **Base** COVID-19 Scenario*

Evaluation of the macro-economic impacts of the COVID-19 pandemic is carried out by observing the changes in the Model due to shocks and parameter adjustments. The shocks are introduced on all regions in the Model to capture the impacts of both the domestic and foreign, or the country's trading partners' policy, shocks on Mongolia's economy. These are:

a) Stimulus packages introduced by the governments;
b) Increased trade costs due to various restrictions on border crossing and international shipments;
c) Loss of working hours due to the adoption of shorter business hours and shifts to remote work;
d) Worldwide travel ban and restrictions on tourists and business travelers;
e) International capital mobility has become problematic or immobile;
f) Unskilled labor is less mobile due to reduced economic activities on the one hand and scarce due to border-crossing restrictions on the other.

The last two shocks (e and f) are captured by changing the parameters in the Model, while shocks are applied to the others. Thus, a new parameter file is created, where the binary flag for endowment mobility is set to "fixed" for unskilled labor to capture the relative immobility of the unskilled labor compared to that of skilled labor, which has a higher probability of undertaking remote work. Also, the investment allocation binary coefficient RORDELTA is set to Zero (RORDELTA=0) to capture the rigidity of international capital. When RORDELTA is Zero, investments are allocated across regions to maintain the existing composition of capital stock in the Model. The shocked variables and their corresponding equations in the Model are described in Boxes 1 and 2. The applied shocks are described below:

a) The major response of all governments was the introduction of stimulus packages for businesses and households aimed at minimizing the negative impacts of the pandemic on their economies. This effect is acquired by introducing a shock to the output/income tax variable "*to*" in the Model by way of treating the stimulus packages as subsidies. The IMF Fiscal Monitor Database of Country Fiscal Measures in Response to the COVID-19 Pandemic (Oct. 2020) provides the scales of subsidies expressed as percentage shares of GDP. The shock levels equal to the corresponding percentage changes of the new taxes from the base taxes in the Model are adjusted to the Data Base 10A (2014). Estimation of the shock levels is provided in Appendix Table 5 (Appendix Table 4).

b) The COVID-19 pandemic has taken a heavy toll on international trade, leading to slumping worldwide trade. This effect is captured by introducing shocks to import and export tax variables in the Model as the increased trade costs. A preliminary simulation was carried out to observe the Model's response to 1% changes in these tax variables, and the results mirrored the corresponding actual trade data of 2020. Due to data availability, the data coverage differs by region. However, as they are expressed in annual percentage change terms, i.e., percentage changes from the corresponding periods of 2019, i.e., the pre-COVID-19 year, they may reflect the actual situation as neither major worldwide worsening nor improvements to tackle the COVID-19 pandemic observed in 2020 (Appendix Table 5).

c) Losses of working hours associated with the COVID-19 pandemic led to labor productivity drops, and the variable "*afeall*" in the Model can capture this effect. According to the National Statistical Office of Mongolia (NSO, 2020 Dec.), labor productivity in Mongolia dropped by 9.8%, or almost 10% during the first three quarters of 2020. Thus, the "*afeall"* of skilled and unskilled labor is shocked by 10% for all activities in Mongolia (Appendix Table 6).

d) A worldwide travel ban for tourists and business travelers has afflicted not only the tourism industry, but also those sectors directly linked to tourism and business travel, such as hotels, restaurants, and recreation facilities. These sectors were hit hardest by the pandemic, with both demand and supply side shocks undermining their productivity. This effect is gained by introducing a shock to the technical change variable "*afesec*", which may account for not only technological changes (productivity), but other policy changes as well. The shock is introduced uniformly to the Hotel, Restaurant, and Recreation ("*HotelResRec*") sector worldwide[6]. ILO (2021) reported a 33% year-on-year decline in the working hours for accommodation and food service activities in the second quarter of 2020 (Q2) and a 17.5% year-on-year drop in the third quarter 2020 (Q3). The figures in the arts, entertainment, and recreation sector were -20.8% and -9.1%, respectively. It is noteworthy that the new data reveals working-hour losses to be higher than previous estimates. Thus, the shock level is set to a more pessimistic -40% for "*afesec*".

A summary of all shocks for the above COVID-19 base scenario is provided in Table 4. The solution method used is Gragg, or a multiple step extrapolation method.

[6] "Altogether, 94% of the world's workers currently live in countries with some sort of workplace closure measure in place" (ILO, 2020, p.2).

3.2 The Sensitivity Analysis

The systemic sensitivity analysis (SSA) tools of the GTAP Model allow observing a range of scenarios about uncertainty in model inputs by running multiple simulations with different inputs, and calculating the means and variances of the model results from these simulations (Horridge, M., & Pearson, K., 2011).

The shock level introduced for the productivity variable "*afesec*" for the Hotel, Restaurant, and Recreation sector may differ greatly by country resulting in deviations of the assumed shock level. For example, the ILO (2020) reported the average level of working hours lost over first three quarters of 2020 to be 11.7% worldwide, while it equaled 16.9% in the Americas and 9.7% in Africa. Also, it was 9.4% for high income countries and 14% for lower-middle income countries, such as Mongolia. The levels varied by 74.2% in the former and 48.9% in the latter group. The Hotel, Restaurant, and Recreation sector is likely to show a similar tendency.

Therefore, in order to test sensitivity of the model results with respect to variations of the initial productivity shock worldwide, the technical change variable "*afesec"* in the Model is varied using the standard SSA procedure built into RunGTAP. The variation level is 50%. The SSA provides the mean and standard deviation of the Model results for each variable when the productivity declines in the Hotel, Restaurant, and Recreation sector ranges between 20% and 60% worldwide. The other shocks and parameters are not altered. The mean and standard deviations for the selected indicators by sector are provided in Appendix Table 9.

According to Chebyshev's Theorem, at least the fraction $(1-1/k^2)$ of any set of observations lies within "*k"* standard deviations of the mean. Therefore, 95% of the observations are contained in the interval "$\overline{x} \pm 4.47sd$", where $\overline{x}$ is mean and *sd* is standard deviation (Burfisher, E. Mary, 2011, p.247).

Table 4 Summary of COVID-19 Shocks in the Model (Base Scenario)

Regions	Governme nt stimulus	Increase of trade cost		Loss of working hours		Restrictions on travel, worldwide
	Corresponding GTAP Variables and Shocks					
	Output/ Income tax changes (% change) (to)	Import Tax (% change) (tm)	Export Tax (% change) (tx)	Labor Productivity (% change) (afeall)		Factor input technical change, worldwide (% change) (afesec)
				Unskille d labor	Skilled labor	HotelResRec
Mongolia	-27.2	9.5	2.5	-10	-10	- 40
China	-20.6	0.5	0.6			
ROK	-13.8	2.2	2.0			
Japan	-35.1	1.3	2.5			
Russia	-7.1	2.3	9.9			
Other East Asia	-31.5	0.1	0.8			
Tajikistan	-19.5	1.3	3.3			
Other Central Asia	-13.5	4.2	5.2			
Southeast Asia	-27.7	3.5	2.7			
South Asia	-12.7	12.4	8.3			
Advanced Economies	-36.9	3.8	3.1			
EU_27	-12.1	5.3	6.3			
LARNA	-6.4	5.9	4.6			
MENA	-13.8	6.1	9.4			
SSA	-11.0	5.3	11.0			
Rest of the World	-9.1	2.8	2.3			

Source: The author's estimations and assumptions.

Box 1 GEMPACK: Technical Change Variables and Equations in the Model

Variable (**all**,e,ENDW)(**all**,a,ACTS)(**all**,r,REG)
    afeall(e,a,r) # *primary factor e augmenting tech change for act. a in r* #;
Equation E_afe
sector/region specific average rate of prim. factor e augmenting technical change
(**all**,e,ENDW)(**all**,a,ACTS)(**all**,r,REG)
    afe(e,a,r) = *afecom*(e) + *afesec*(a) + *afereg*(r) + **afeall**(e,a,r);

Variable (**all**,a,ACTS)
    afesec(a) # *factor input tech change of act. a, worldwide* #;
Equation E_afe
sector/region specific average rate of prim. factor e augmenting tech change
(**all**,e,ENDW)(**all**,a,ACTS)(**all**,r,REG)
    afe(e,a,r) = *afecom*(e) + **afesec**(a) + *afereg*(r) + **afeall**(e,a,r);

Source: Standard GTAP Model

Box 2 GEMPACK: Tax Variables and Equations in the Model

```
Variable (all,c,COMM)(all,a,ACTS)(all,r,REG)
to(c,a,r) # power of tax on com. c supplied by act. a in region r #;

Equation E_ps
# links basic and supply price of commodity c produced by activity a in r #
(all,c,COMM)(all,a,ACTS)(all,r,REG)
      pca(c,a,r) = ps(c,a,r) + to(c,a,r);

      E_ps links supplier/producer (pre-) and basic (post-tax) prices for firms.
      This captures the effect of output taxes or subsidies.
      Note: The power of activity tax, to, is commodity- and activity-specific.
            to(c,a,r) > 1 in the case of a tax
            to(c,a,r) < 1 in the case of a subsidy.
Equation E_del_taxrout
# change in ratio of output tax payments to regional income #
(all,r,REG)
      100.0 * INCOME(r) * del_taxrout(r) + TAXROUT(r) * y(r)
            = sum{c,COMM, sum{a,ACTS,
                  MAKEB(c,a,r) * to(c,a,r) + PTAX(c,a,r) * [ps(c,a,r) + qca(c,a,r)]}};
```

```
Variable (all,c,COMM)(all,r,REG)
      tm(c,r) # source-gen. change in tax on imports of c into r #;

Equation E_pmds
# links basic domestic import prices and CIF import prices #
(all,c,COMM)(all,s,REG)(all,d,REG)
      pmds(c,s,d) = pcif(c,s,d) + tm(c,d) + tms(c,s,d);
Equation E_del_taxrimp
# change in ratio of import tax payments to regional income #
(all,d,REG)
      100.0 * INCOME(d) * del_taxrimp(d) + TAXRIMP(d) * y(d)
            = sum{c,COMM, sum{s,REG,
                  VMSB(c,s,d) * [tm(c,d) + tms(c,s,d)]
                  + MTAX(c,s,d) * [pcif(c,s,d) + qxs(c,s,d)]}};
```

```
Variable (all,c,COMM)(all,r,REG)
      tx(c,r) # dest.-gen. change in subsidy on exports of c from r #;
tx(c,r)  > 1 in the case of a tax
tx(c,r)  < 1 in the case of a subsidy.
Equation E_pfob
# links basic and FOB exports prices #
(all,c,COMM)(all,s,REG)(all,d,REG)
      pfob(c,s,d) = pds(c,s) + tx(c,s) + txs(c,s,d);
Equation E_del_taxrexp
# change in ratio of export tax payments to regional income #
(all,s,REG)
      100.0 * INCOME(s) * del_taxrexp(s) + TAXREXP(s) * y(s)
            = sum{c,COMM, sum{d,REG, VFOB(c,s,d) * [tx(c,s) + txs(c,s,d)]
            + XTAXD(c,s,d) * [pds(c,s) + qxs(c,s,d)]}};
```

Source: Standard GTAP Model

4 The Results

The simulation results demonstrate that public welfare, measured by equivalent variation (EV), would worsen by $772.2 for Mongolia. The bulk of welfare losses are associated with technical change effects. The same pattern is observed for all other regions in the Model. This implies that the COVID-19 related responses and measures have been most damaging to the efficiency of economic activities, thus greatly undermining productivity worldwide. The technical change effect totaled -$453 million for Mongolia. The second largest component of welfare loss is deterioration in the terms of trade in goods and services, followed by allocative efficiency loss. They equal -$164 million and -$148 million, respectively. Terms of trade in investments and savings would incur an $8 million loss as well. The results of SSA indicate that welfare losses would range between $203.9 million and $1,368 million at 95% confidence interval. The model calculates a 4.9% drop of Mongolia's real GDP in this COVID-19 scenario, while the actual 2020 figure reported by the National Statistical Office of Mongolia (NSO) is -4.6%. Thus, the model settings and level of shocks come close to replicating the true state of Mongolia's economy during the initial year of the spreading pandemic (Table 5, Appendix Table 8).

The effects on welfare, real GDP changes and EV decomposition of the other regions in the Model are listed in Appendix Tables 7 and 8. As expected, each region experiences welfare losses and real GDP contraction within this COVID-19 scenario. The largest real GDP contraction observed among the regions in the Model is -5.9% for the Other East Asia region, while that of China is lowest at -2.1%. The scale of real GDP contraction for Other East Asia is consistent with the belief that the economic activities in this region were hardest hit by the COVID-19 pandemic given their relatively high dependence on international tourism. The region includes Hong Kong, Special Administrative Region of China, Taiwan, Macao (a part of the Rest of East Asia), and Brunei Darussalam. (Appendix Tables 7 and 8).

The Model results show that Mongolia's merchandise exports and imports would drop by 9.1% and 10%, respectively, while their price indices may increase by 3.5% and 6.1%, respectively. Therefore, the country's terms of trade would deteriorate by around 2.5% due to the difference in price increase between imported goods and exports. At the same time, private consumption expenditure would increase by 1.9%, implying that the government stimulus packages have had a positive impact on households' disposable income to cope with the pandemic. Thus, it can be said that the Mongolian government's intention to minimize the pandemic's negative impacts on the economy have been somewhat successful. However, per capita utilities would worsen as prices increase and wages drop. The overall per capita utility would decline by 7.4% and per capita utility

from private expenditure would drop by 6.8%, while the price index for private household consumption expenditure would increase by 9.3%. According to the NSO, food inflation increased to 8.5% year-on-year at the end of 2020, and in Mongolia food accounts for the largest portion of the consumer basket (26.1%). Hence, the prolonged COVID-19 shocks threaten to undermine the efficacy of the government stimulus packages on household welfare. Moreover, the model results indicate that wages of skilled labor would see a 0.4% dip despite the group's improved chances for remote work and increased mobility between industries (Table 5).

Most sectors in Mongolia would experience output drops in the COVID-19 scenario. Output decline of the extractive industry, the country's dominant industrial sector, would equal 5.7%. However, the textile, other manufacturing, other food, and apparel sectors would show output increases ranging between 2.3% and 18.5%. Output of the other food sector, which consists mostly of processed foods, may increase by 8.5% as supply of imported food becomes scarce due to cross-border restrictions and worldwide supply-chain disruptions. Therefore, these sectors are relatively resilient to various shocks and can act as potential agents for import substitution. However, self-sufficiency rates or domestic production shares of total use for these sectors are low, at under 30%. Although domestic producers have the opportunity to substitute imports in emergencies, low levels of self-sufficiency may hinder their immediate expansions in times of prolonged shocks, such as the COVID-19 pandemic. As mentioned earlier, the pandemic has broken global supply-chains and hindered international capital and labor mobility. These circumstances would pose a huge challenge for a country, like Mongolia, where the domestic supply of machinery and equipment needed for expanding any production capacity is limited (self-sufficiency rate of machinery is 2.6%) when import supplies are restricted. Therefore, Mongolia's industrial development policies must specifically target sectors which show output increases to improve the country's resilience to further similar shocks (Table 6).

The model results demonstrate that both consumer and producer prices would rise in all sectors except wool, silk, and housing. This indicates an economy-wide inflationary pressure due to disruptions in the commodity and service supplies stemming from the pandemic shocks. As expected, price increases were lower for sectors with higher self-sufficiency rates, such as livestock meat, which has a rate of 100.6% (Table 6).

Price and demand changes for endowments in Mongolia are illustrated in Table 7. Wages of skilled labor and capital rents would drop uniformly across all sectors owing to the mobility of skilled labor, whereas the wage changes for unskilled labor would vary across sectors as this group became virtually immobile during the pandemic, leading to states of scarcity for expanding sectors and oversupply in shrinking sectors. Consequently, to arrest the supply shortage, expanding sectors would pay higher than earlier wages for

their unskilled labor. Moreover, wages of unskilled labor in shrinking industries would drop by much larger scales compared to those of skilled labor. This highlights a vulnerability in unskilled labor during crises and necessitates the targeting of this group in the government's safety net programs. Unskilled labor in the service sector would be most vulnerable as both wages and demand decline. The mean and standard deviation of the selected SSA results are provided in Appendix Table 9 (Tables 7 and 8, Appendix Table 9).

Table 5 Selected Macro-economic Indicators for Mongolia

Indicators		Variables	Model result	95% confidence interval	
				Upper limit	Lower limit
Welfare change, US$ Million		*EV*	- 772.2	-203.9	-1,368.0
Real GDP, % change		*qgdp*	- 4.9	-2.9	-7.1
Merchandise exports, % change		*qxwreg*	- 9.1	-8.6	-9.7
Merchandise imports, % change		*qmwreg*	- 10.0	-5.9	-14.3
Price index of merchandise exports, % change		*pxwreg*	3.5	7.6	-0.6
Price index of merchandise imports, % change		*pmwreg*	6.1	7.6	4.8
Terms of trade, % change		*tot*	- 2.5	2.6	-7.7
Private consumption expenditure, % change		*yp*	1.9	8.5	-4.9
Per capita utility, % change		*u*	- 7.4	-1.9	-13.1
Per capita utility from private expenditure, % change		*up*	- 6.8	-1.3	-12.6
Price index for private household consumption expenditure		*ppriv*	9.3	9.9	8.7
Price of mobile endowments (pfe(e,a,r)), % change	Skilled labor		-0.4	3.7	-4.6
	Capital		-4.0	-0.3	-7.8

Notes (Description of the variables):

1. EV(r) # *equivalent variation, $ US million #*;
2. qgdp(r) # *GDP quantity index #*;
3. qxwreg(r) # *volume of merchandise exports, by region #*;
4. qmwreg(r) # *volume of merchandise imports, by region #*;
5. pxwreg(r) # *price index of merchandise exports, by region #*
6. pmwreg(r) # *price index of merchandise imports, by region #;*
7. tot(r) # *terms of trade for region #*;
8. yp(r) # *regional private consumption expenditure in region r #*;
9. u(r) # *per capita utility from aggregate hhld expend. in region r #*;
10. up(r) # *per capita utility from private expend. in region r #*;
11. ppriv(r)#*price index for private household consumption expenditure in region r#*;
12. pfe(e,a,r) # *price of endowment e purchased by activity a region r #*;

Source: The results reported here were obtained using the GEMPACK economic modelling software [Horridge et al. (2018)].

Table 6 Model Results: Mongolia's Output and Price Changes by Sectors

Sectors	Self-sufficiency rate, %	Output (qo)	Producer Price (pb)	Consumer Price (ppa)
		(% change)		
Rice	0.8	-1.9	9.8	11.4
Wheat	94.3	-5.8	13.3	12.8
Other Grain	54.7	-5.9	11.0	6.0
Vegetables, Fruits	80.5	-6.2	12.2	11.3
Other Crop	280.5	-35.7	6.6	11.8
Sugar	3.6	4.4	9.9	14.3
Livestock Meat	100.6	-3.7	4.8	4.9
Other Animal Products	86.3	-3.3	9.2	9.9
Milk, Dairy Products	83.4	-2.5	9.6	12.5
Wool, Silk	196.9	-8.3	-0.5	-0.5
Forestry	98.3	-3.7	6.3	6.5
Fishing	55.4	-1.5	2.4	5.3
Other Food	28.3	8.5	6.1	13.2
Beverages, Tobacco	32.2	-1.2	8.2	12.4
Extractive Industry	1284.8	-5.7	0.0	0.1
Textile	19.5	18.5	3.0	11.7
Apparel	17.3	2.3	6.6	12.7
Light Manufacturing	47.5	-0.5	6.4	13.0
Petrochemical Industry	6.9	7.1	7.7	13.5
Other Manufacturing	28.8	12.6	6.7	13.8
Metal Manufacturing	78.4	-13.9	6.0	13.2
Electronics	4.5	19.0	6.6	16.1
Machinery, Equipment	2.6	24.4	6.3	15.4
Auto Vehicles	5.4	9.7	5.6	16.4
Utilities	96.1	-2.9	5.3	6.0
Construction	92.8	-0.9	7.7	8.3
Trade	94.4	-2.9	1.8	2.1
Transport	98.1	-4.3	6.2	9.4
Hotel, Restaurant, Recreation	86.3	-5.1	33.8	40.1
Communication	90.5	-2.6	3.8	5.6
Financial Service	89.8	-1.6	1.6	3.3
Other Service	83.0	-5.1	9.0	10.8
Education	83.8	-8.5	10.8	10.9
Health	93.8	-9.3	11.7	11.8
Housing	100.0	-4.9	-0.6	-0.6

Notes: 1. qo(ACTS,REG) [%-change]: output of activity a in region r; 2. pb(ACTS,REG) [%-change]: price index: basic (tax-inclusive) price of output of act. a: "Mongolia" column; 3. ppa(COMM,REG) [%-change]: private consumption price for commodity c in region r: "Mongolia" column;
Source: The results reported here were obtained using the GEMPACK economic modelling software [Horridge et al. (2018)].

Table 7 Model Results: Price and Demand Changes for Endowments in Mongolia

(% change)

Sectors	Price Changes (pfe[**Mongolia])		Demand Changes (qfe[**Mongolia])		
	Land, Natural Resources	Unskilled Labor	Land, Natural Resources	Skilled Labor	Capital
Rice	-8.23	22.74	10.31	11.33	7.79
Wheat	-15.08	26.04	2.07	6.11	-1.03
Other Grain	-15.17	25.36	1.96	5.96	-1.16
Vegetables, Fruits	-15.98	19.53	0.99	4.70	-2.34
Other Crop	-30.88	-444.91	-15.60	-20.99	-27.01
Sugar	-6.71	15.25	12.14	10.67	9.94
Livestock Meat	-10.87	4.34	7.14	3.14	1.99
Other Animal	-10.45	12.55	7.64	6.78	3.70
Milk, Dairy Products	-8.46	11.30	10.03	7.71	6.59
Wool, Silk	-20.10	-6.93	-3.96	-1.69	-8.30
Forestry	-16.61	28.59	0.24	5.25	-2.55
Fishing	-15.44	39.84	1.65	7.03	-0.90
Other Food	-4.30	7.24	15.04	8.64	14.65
Beverages, Tobacco	-8.92	-2.36	9.48	-2.20	3.21
Extractive Industry	-19.08	7.36	-2.74	1.51	-6.00
Textile	-1.90	9.40	17.91	12.57	21.17
Apparel	-2.02	9.16	17.77	12.26	20.84
Light Manufacturing	-6.60	0.19	12.27	0.76	8.47
Petrochemical	-4.19	4.86	15.16	6.72	14.88
Other Manufacturing	-3.41	6.40	16.10	8.69	17.00
Metal Manufacturing	-15.60	-16.46	1.45	-19.87	-13.74
Electronics	0.17	13.59	20.41	18.02	27.05
Machinery,	4.75	23.07	25.91	30.57	40.55
Auto Vehicles	-5.68	1.97	13.38	3.02	10.89
Utilities	-7.27	-1.10	11.47	-0.87	6.71
Construction	-7.49	-3.17	11.20	-3.85	5.58
Trade	-9.11	-8.19	9.26	-12.77	-0.33
Transport	-8.49	-7.20	10.00	-11.18	1.49
Hotel, Restaurant,	20.26	49.56	44.61	81.51	101.19
Communication	-9.83	-5.94	8.39	-6.95	0.17
Financial Service	-9.32	-4.99	9.00	-5.76	1.45
Other Service	-6.84	-0.28	11.98	0.16	7.82
Education	-7.35	-1.25	11.37	-1.06	6.51
Health	-7.94	-2.38	10.66	-2.48	4.97
Housing	-11.83	-9.66	5.98	-11.55	-4.79

Notes: 1. Variable: pfe(*,*,Mongolia) [%-change]: price of endowment e purchased by activity a in Mongolia; 2. qfe(*,*,Mongolia) [%-change]: demand for endowment e by act. a in Mongolia.

Source: The results reported here were obtained using the GEMPACK economic modelling software [Horridge et al. (2018)].

3. Conclusions

This paper aims to evaluate macro-economic impacts of the various policy measures implemented by governments in response to the worldwide COVID-19 pandemic. The various cross-border and domestically imposed restrictions triggered negative shocks on economic activities globally, disrupting international trade and investment activities. Each government has introduced unanimously generous stimulus packages to minimize the negative effects of the shocks on its own economy. This CGE analysis employs the standard GTAP Model and Data Base 10a, and the focus area is Mongolia.

The simulation results demonstrate that Mongolia's real economy would witness a 4.9% contraction, a scale which is compatible with the actual figure of -4.6% in 2020. Mongolia's welfare losses would equal $772.2 million, with the majority of deficits associated with productivity drops followed by the terms of trade in goods and services and allocative efficiency losses. Also, the country's terms of trade in investment and services would also deteriorate, though at a scale much lower than observed in other components. Furthermore, both merchandise exports and imports would decline along with worsening of the terms of trade.

Pandemic shocks would trigger output drops in almost all sectors, including the country's major industry—the extractive sector. A small number of industries, such as textile, other food, and apparel, would experience output growths despite the shocks. That said, the low self-sufficiency rates of these industries would undermine their own output expansions during a prolonged pandemic.

Unskilled labor would be most vulnerable during the pandemic as their wages decline at a much larger scale than those of skilled workers, whereas consumer prices increase. The Mongolian government's stimulus packages to minimize the negative impacts of the pandemic on the economy have had a positive effect on households by supporting household disposable incomes or expenditures. However, the scale of support was much lower than the eventual price increases, undermining their utilities. Therefore, specifically targeted programs are preferable to universal stimuluses.

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Appendix Table 1 Classification of Regions in the GTAP Model

Region code	Description	
	The Model (16 regions)	GTAP 10A (141 regions)
Mongolia	Mongolia	Mongolia
China	China, mainland	China, mainland
ROK	South Korea	South Korea
Japan	Japan	Japan
Russia	Russian Federation	Russian Federation
OthEastAsia	Rest of East Asia	Hong Kong, Special Administrative Region of China; Taiwan; Rest of East Asia; Brunei Darussalam;
Tajikistan[7]	Tajikistan	Tajikistan
CentAsia	Other Central Asia	Kazakhstan; Kyrgyzstan; Rest of Former Soviet Union; Armenia; Azerbaijan
SEAsia	Southeast Asia	Cambodia; Indonesia; Lao PDR; Malaysia; Philippines; Singapore; Thailand; Vietnam; Rest of Southeast Asia;
SouthAsia	South Asia	Bangladesh; India; Nepal; Pakistan; Sri Lanka; Rest of South Asia;
AdvEcon	Advanced economies	Australia; New Zealand; Canada: USA; Rest of European Free Trade Association; Albania; Bulgaria;
EU_27	European Union 27	Austria; Belgium; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Slovakia; Slovenia; Spain; Sweden; United Kingdom; Switzerland; Norway;
LARNA	Latin America and Rest North America	Mexico; Rest of North America; Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Paraguay; Peru; Uruguay; Venezuela; Rest of South America; Costa Rica; Guatemala; Honduras; Nicaragua; Panama; El Salvador; Rest of Central America; Dominican Republic P; Jamaica; Puerto Rico; Trinidad and Tobago P; Rest of Caribbean;
MENA	Middle East and North Africa	Bahrain; Iran, Islamic Republic of; Israel; Jordan; Kuwait; Oman; Qatar; Saudi Arabia; Turkey; United Arab Emirates; Rest of Western Asia; Egypt; Morocco; Tunisia; Rest of North Africa;
SSA	Sub-Saharan Africa	Benin; Burkina Faso; Cameroon; Côte d'Ivoire; Ghana; Guinea; Nigeria; Senegal; Togo; Rest of Western Africa; Rest of Central Africa; South Central Africa; Ethiopia; Kenya; Madagascar; Malawi; Mauritius; Mozambique; Rwanda; Tanzania, United Republic of; Uganda; Zambia; Zimbabwe; Rest of Eastern Africa; Botswana; Namibia; South Africa; Rest of South African Customs Union;
RestofWorld	Rest of World	Rest of Oceana; Belarus; Croatia; Romania; Ukraine; Rest of Eastern Europe; Georgia; Rest of the World

Source: GTAP 10A Data Base.

[7] Tajikistan was included as a separate region for use of the simulation results for a further joint study on Mongolia and Tajikistan.

Appendix Table 2 Classification of Sectors in the GTAP Model

The Model (35 sectors)	GTAP 10A (65 sectors)
1 Rice	Paddy rice; Processed rice;
2 Wheat	Wheat
3 Other Grain	Cereal grains nec.
4 Vegetables, Fruits	Vegetables, fruit, nuts
5 Other Crop	Oil seeds; Plant-based fibers; Crops nec.
6 Sugar	Sugar
7 Livestock Meat	Bovine cattle, sheep and goats, horses; Bovine meat products;
8 Other Animal Products	Animal products nec.; Meat products nec.
9 Milk, Dairy Products	Raw milk; Dairy products;
10 Wool, Silk	Wool, silk-worm cocoons
11 Forestry	Forestry
12 Fishing	Fishing
13 Other Food	Vegetable oils and fats; Food products nec.
14 Beverages, Tobacco	Beverages and tobacco products
15 Extractive Industry	Coal; Oil; Gas; Other Extraction;
16 Textile	Textiles
17 Apparel	Wearing apparel
18 Light Manufacturing	Leather products; Wood products; Paper products, publishing;
19 Petrochemical Industry	Petroleum, coal products; Chemical products;
20 Other Manufacturing	Basic pharmaceutical products; Rubber and plastic products; Mineral products nec.; Manufactures nec.
21 Metal Manufacturing	Ferrous metals; Metals nec. Metal products;
22 Electronics	Computer, electronic and optical products; Electrical equipment;
23 Machinery, Equipment	Machinery and equipment nec.
24 Auto Vehicles	Motor vehicles and parts; Transport equipment nec.
25 Utilities	Electricity; Gas manufacture, distribution; Water
26 Construction	Construction
27 Trade	Trade; Warehousing and support activities;
28 Transport	Transport nec.; Water transport; Air transport
29 Hotel, Restaurant, Recreation	Accommodation, Food and service activities; Recreational and other services;
30 Communication	Communication
31 Financial Service	Financial services nec.; Insurance;
32 Other Service	Real estate activities; Business services nec.; Public Administration and defense;
33 Education	Education
34 Health	Human health and social work activities
35 Housing	Dwellings

Notes: 1. Nec-not elsewhere cited; 2. GTAP sectors begin with capital letter.
Source: GTAP 10A Data Base and the author's aggregation.

Appendix Table 3 Classification of Production Factors in the Model

Factor Code	Description		Endowment Type in the Model
	The Model (4 factors)	GTAP 10A (8 factors)	
LandNatRes	Land; Natural resources	Land; Natural resources	Sluggish
UnSkLab	Unskilled labor	Clerks; Service/Shop workers; Agricultural and Unskilled;	Fixed
SkLab	Skilled labor	Technicians/Associates, Professional; Officials and Managers	Mobile
Capital	Capital	Capital	Mobile

Source: GTAP 10A Data Base.

Appendix Table 4 Calibration of COVID-19 Stimuluses to GTAP 10A Data Base

Regions	Base GDP in GTAP 10A	COVID-19 stimulus levels*	GTAP 10A Base GDP equivalent of the stimulus (tax reduction)	Base tax revenue in GTAP 10A	New tax revenue	Tax change from base (*to*)
	$ Million	% of GDP	Values, $ Million			%
	(1)	(2)	(3 = 1*2)	(4)	(5 = 4-3)	(5/4)
Mongolia	12,225.8	7.6	929.2	3,412.0	2,482.8	-27.2
Tajikistan	9,236.3	3.4	314.0	1,623.0	1,308.9	-19.3
China	10,351,106.1	4.6	476,150.9	2,316,676.3	1,840,525.4	-20.6
ROK	1,411,312.3	3.5	49,395.9	354,868.1	305,472.2	-13.9
Japan	4,596,162.1	11.3	519,366.3	1,476,294.3	956,927.9	-35.2
Russia	2,030,970.8	2.4	48,743.3	684,356.7	635,613.4	-7.1
Other East Asia	911,247.7	6.1	55,586.1	176,661.1	121,075.0	-31.5
Central Asia	428,366.8	2.6	11,137.5	83,037.9	71,900.3	-13.4
Southeast Asia	2,506,569.3	4.4	110,289.1	400,275.4	289,986.3	-27.6
South Asia	2,583,580.0	1.5	38,753.7	300,531.6	261,777.9	-12.9
Advanced Economies	24,984,914.8	10.7	2,673,385.9	7,263,803.0	4,590,417.1	-36.8
EU_27	15,542,448.0	5.0	777,122.4	6,436,041.0	5,658,918.6	-12.1
LARNA	6,404,732.1	1.5	96,071.0	1,540,884.1	1,444,813.1	-6.2
MENA	4,277,515.9	2.6	111,215.4	804,554.9	693,339.5	-13.8
SSA	1,743,567.2	2.2	38,358.5	351,758.7	313,400.2	-10.9
Rest of the World	432,157.5	2.9	12,532.6	137,425.8	124,893.2	-9.1

Note:*Taken from IMF, 2020 Oct.; *to*=output tax variable in GTAP;

Source: Estimated from IMF, 2020 Oct. and GTAP 10A (2014) Data Base.

Appendix Table 5 Estimation of Shock Equivalents of COVID-19 Impact on Trade

Regions	Model Response to 1% simultaneous changes of tm and tx		Changes in 2020, % (year-on-year changes)		Shock Equivalents (% change)	
	Import	Export	Import	Export	Import	Export
GTAP variables	*qmwreg*	*qxwreg*	(actual data)		*tm*	*tx*
	(1)	(2)	(3)	(4)	(3/1)	(4/2)
Mongolia*	-1.319	-1.117	-13.60	-0.60	10.3	0.5
Tajikistan***	-7.481	-3.032	-10.00	-10.00	1.3	3.3
China	-4.24	-3.732	-1.92	-2.14	0.5	0.6
ROK*	-3.951	-3.743	-8.69	-7.63	2.2	2.0
Japan	-3.516	-3.636	-4.40	-9.20	1.3	2.5
Russia**	-3.027	-2.283	-7.00	-22.50	2.3	9.9
Other East Asia	-3.49	-2.813	-0.25	-2.33	0.1	0.8
Central Asia	-2.404	-1.923	-10.00	-10.00	4.2	5.2
Southeast Asia	-3.651	-3.631	-12.76	-9.69	3.5	2.7
South Asia	-3.117	-3.792	-38.56	-31.61	12.4	8.3
Advanced Economies	-4.078	-4.675	-15.50	-14.60	3.8	3.1
EU_27	-3.573	-3.508	-18.80	-22.00	5.3	6.3
LARNA	-3.879	-4.212	-22.81	-19.55	5.9	4.6
MENA	-3.212	-2.804	-19.70	-26.29	6.1	9.4
SSA	-2.849	-2.887	-15.05	-31.78	5.3	11.0
Rest of the World	-3.011	-3.785	-8.50	-8.80	2.8	2.3

Notes:

1. qmwreg(REG) [%-change]: volume of merchandise imports, by region;
2. qxwreg(REG) [%-change]: volume of merchandise exports, by region;
3. tm(COMM,REG) [%-change]: source-gen. change in tax on imports of c into r
4. tx(COMM,REG) [%-change]: destination gen. change in subsidy on exports of c from r:
5. Simulation with COVID-19 parameter;
6. *Import, export data for January-November 2020;
7. **Import, export data for January-October 2020;
8. ***Import, export data is the authors' assumption;
9. Import, export data for other countries and regions are for the second quarter of 2020;

Sources: Mongolia: NSO, 2020 Dec.; Russia: ROSSTAT, 2021 Jan.; ROK: KOSIS, 2021 Jan.; Others: UNCTADstat, 2020 Oct.

Appendix Table 6 Mongolia's GDP per Person Employed (Year-on-year change)

(%)

Sectors	2020-I	2020-II	2020-III	Average
Labor Productivity, national	-13.4	-11.2	-4.9	-9.8
Agriculture	29.2	25.3	10.9	21.8
Mining and quarrying	-19.1	-21.0	0.3	-13.3
Industry and Construction	-4.9	-16.8	-2.4	-8.0
Service	-14.6	-16.6	-11.6	-14.3

Source: NSO, 2020. Dec.

Appendix Table 7 GDP and Welfare Changes (COVID-19 Base Scenario)

Regions	Real GDP Change, %	Welfare Changes (EV), $ Million
Mongolia	-4.9	-772.2
China	-2.1	-245,786.2
ROK	-3.5	-45,287.2
Japan	-3.6	-164,143.6
Russia	-3.8	-84,830.9
Other East Asia	-5.9	-50,950.6
Tajikistan	-3.5	-198.8
Central Asia	-2.5	-15,442.7
Southeast Asia	-3.1	-78,080.2
South Asia	-4.3	-93,146.7
Advanced Economies	-3.9	-984,103.6
EU_27	-4.6	-665,364.8
LARNA	-4.1	-269,339.8
MENA	-3.0	-142,227.4
SSA	-3.1	-60,670.7
Rest of the World	-3.1	-16,574.7

Source: The results reported here were obtained using the GEMPACK economic modelling software [Horridge et al. (2018)].

Appendix Table 8 EV Decomposition Summary (COVID-19 Base Scenario), $ Million

Regions	Allocative Efficiency	Technical Change	Terms of Trade in:		Total
			Goods & Services	Investment & Savings	
Mongolia	-148	-453	-164	-8	-772
China	-50,981	-169,113	-33,081	7,405	-245,770
ROK	-8,610	-40,376	2,213	1,484	-45,289
Japan	-9,707	-157,006	3,143	-576	-164,146
Russia	-24,899	-52,311	-12,888	5,268	-84,829
Other East Asia	-83	-53,023	-106	2,261	-50,951
Tajikistan	-43	-277	84	37	-199
Central Asia	-1,878	-8,706	-5,019	160	-15,443
Southeast Asia	-16,370	-60,236	-1,291	-182	-78,079
South Asia	-34,459	-77,637	23,119	-4,204	-93,181
Advanced	-112,165	-867,568	11,598	-15,968	-984,103
EU_27	-194,046	-516,829	38,415	7,095	-665,365
LARNA	-48,058	-215,729	-2,330	-3,223	-269,340
MENA	-42,208	-87,430	-15,776	3,188	-142,225
SSA	-18,693	-34,729	-5,761	-1,487	-60,670
Rest of the World	-3,684	-9,789	-2,049	-1,053	-16,575
World	-566,030	-2,351,211	107	197	-2,916,936

Source: The results reported here were obtained using the GEMPACK economic modelling software [Horridge et al. (2018)].

Appendix Table 9 Selected SSA Results of Mongolia

Sectors	Output		Producer Price		Consumer Price		Price of Endowments				Demand for Endowments					
	qo[*Mongolia]		pb[*Mongolia]		ppa[*Mongolia]		pfe[**Mongolia]				qfe[**Mongolia]					
							Mean		SD		Mean			Standard Deviation (SD)		
	Mean	SD	Mean	SD	Mean	SD	Land, Natural Resources	Unskilled Labor	Land, Natural Resources	Unskilled Labor	Land, Natural Resources	Skilled Labor	Capital	Land, Natural Resources	Skilled Labor	Capital
0	1	2	3	4	5	6	7	8	9	10	11	12	12	14	15	16
Rice	-1.81	0.34	9.65	1.22	11.35	0.81	-8.39	22.92	2.14	0.17	10.51	11.45	7.90	1.25	0.46	0.41
Wheat	-5.84	0.06	13.18	1.88	12.67	1.85	-15.33	25.78	2.89	4.03	2.10	6.06	-1.07	0.05	0.61	0.58
Other Grain	-5.94	0.50	10.85	2.31	5.83	2.66	-15.50	24.66	3.86	11.17	1.85	5.74	-1.37	1.13	2.14	2.01
Vegetables, Fruits	-6.25	0.09	12.04	2.43	11.16	2.29	-16.24	19.20	2.90	4.11	1.00	4.63	-2.41	0.00	0.66	0.63
Other Crop	-35.99	0.59	6.62	1.62	11.65	1.92	-32.43	-427.12	3.17	47.32	-16.87	-22.19	-28.07	7.61	6.58	5.74
Sugar	4.44	0.38	9.84	1.06	14.24	0.65	-6.87	15.31	2.04	0.40	12.34	10.76	10.02	1.43	0.45	0.40
Livestock Meat	-3.69	0.12	4.65	2.16	4.72	2.15	-11.11	4.12	2.76	2.66	7.19	3.02	1.87	0.39	1.11	1.13
Other Animal Products	-3.34	0.04	9.09	1.88	9.79	1.70	-10.69	12.36	2.58	2.06	7.71	6.70	3.63	0.61	0.51	0.53
Milk, Dairy Products	-2.48	0.28	9.50	1.32	12.39	0.89	-8.69	11.17	2.20	0.93	10.15	7.67	6.54	1.16	0.07	0.03
Wool, Silk	-8.24	0.12	-0.54	1.02	-0.53	1.02	-20.31	-6.96	2.34	0.78	-3.90	-1.68	-8.30	0.51	0.02	0.01
Forestry	-3.76	0.14	6.18	0.95	6.41	0.96	-16.87	28.25	2.70	2.82	0.25	5.20	-2.59	0.21	0.27	0.26
Fishing	-1.57	0.88	2.22	2.13	5.13	2.08	-15.75	38.95	3.48	10.39	1.56	6.85	-1.06	0.68	1.40	1.31
Other Food	8.52	0.17	6.02	0.91	13.16	0.55	-4.48	7.18	1.92	0.76	15.24	8.64	14.64	1.68	0.28	0.22
Beverages, Tobacco	-1.22	0.38	8.22	0.59	12.39	0.31	-9.12	-2.47	2.12	1.30	9.63	-2.26	3.14	1.23	0.44	0.53
Extractive Industry	-5.80	0.59	-0.05	1.03	0.08	1.03	-19.36	6.86	3.00	5.38	-2.77	1.41	-6.10	0.26	0.83	0.78
Textile	18.66	2.42	2.94	0.63	11.71	0.11	-2.02	9.48	1.04	0.93	18.24	12.78	21.39	2.84	2.53	2.64
Apparel	2.33	0.87	6.60	0.31	12.70	0.05	-2.17	9.18	1.30	0.40	18.06	12.38	20.97	2.52	1.85	1.90
Light Manufacturing	-0.39	1.30	6.34	0.62	12.99	0.09	-6.71	0.26	1.07	0.70	12.58	0.94	8.65	2.61	2.08	2.16

Appendix Table 9 Selected SSA Results of Mongolia (continued

0	1	2	3	4	5	6	7	8	9	10	11	12	12	14	15	16
Petrochemical Industry	7.11	0.13	7.71	0.73	13.51	0.64	-4.36	4.80	1.87	0.79	15.38	6.72	14.87	1.74	0.24	0.18
Other Manufacturing	12.64	0.93	6.65	0.50	13.80	0.02	-3.57	6.38	1.55	0.14	16.35	8.75	17.05	2.16	1.10	1.09
Metal Manufacturing	-13.71	2.01	6.03	0.42	13.25	0.06	-15.69	-16.38	0.73	1.00	1.75	-19.69	-13.56	2.64	2.16	2.26
Electronics	19.36	4.21	6.58	0.62	16.14	0.20	0.11	13.83	0.29	2.55	20.84	18.48	27.53	3.84	4.73	5.00
Machinery, Equipment	24.76	4.01	6.32	0.62	15.47	0.22	4.69	23.33	0.31	2.74	26.37	31.07	41.08	4.00	5.21	5.50
Auto Vehicles	9.96	3.03	5.53	0.56	16.41	0.21	-5.77	2.09	0.71	1.43	13.73	3.28	11.17	3.08	3.03	3.19
Utilities	-2.97	0.40	5.30	0.65	5.98	0.62	-7.47	-1.23	2.15	1.40	11.62	-0.97	6.60	1.27	0.61	0.73
Construction	-0.97	0.14	7.74	0.31	8.29	0.28	-7.66	-3.24	1.89	1.00	11.40	-3.89	5.54	1.58	0.13	0.23
Trade	-2.95	0.33	1.75	0.52	2.11	0.49	-9.27	-8.27	1.81	1.02	9.46	-12.82	-0.39	1.61	0.26	0.40
Transport	-4.29	0.04	6.17	0.40	9.40	0.15	-8.64	-7.25	1.67	0.79	10.23	-11.18	1.49	1.80	0.12	0.04
Hotel, Restaurant, Recreation	-5.23	1.11	35.08	9.22	41.58	10.78	20.60	51.17	5.64	15.43	45.88	85.59	105.67	11.87	30.14	33.22
Communication	-2.71	0.37	3.84	0.43	5.57	0.31	-10.01	-6.04	2.00	1.16	8.56	-7.01	0.10	1.35	0.35	0.44
Financial Service	-1.64	0.30	1.63	0.56	3.31	0.45	-9.50	-5.09	1.97	1.10	9.17	-5.82	1.38	1.40	0.26	0.36
Other Service	-5.22	0.74	9.04	0.05	10.90	0.10	-7.06	-0.44	2.30	1.69	12.11	0.03	7.67	1.10	0.96	1.11
Education	-8.65	1.32	10.85	0.23	10.98	0.23	-7.60	-1.48	2.67	2.39	11.44	-1.30	6.25	0.64	1.86	2.08
Health	-9.53	1.61	11.81	0.47	11.92	0.47	-8.20	-2.63	2.82	2.68	10.71	-2.75	4.68	0.43	2.24	2.49
Housing	-5.02	1.40	-0.65	0.66	-0.65	0.66	-12.04	-9.80	2.35	1.84	6.09	-11.69	-4.94	0.84	1.23	1.40

Note: For description of the variables see Tables 6 and 7;
Source: The results reported here were obtained using the GEMPACK economic modelling software [Horridge et al. (2018)].