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## **The Impact of COVID-19 and Associated Policy Responses on Global Food Security**

by Edward Balistreri, Felix Baquedano, and John Beghin

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# **The Impact of COVID-19 and Associated Policy Responses on Global Food Security**

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## **Abstract**

We analyze the impact of the COVID-19 pandemic and associated policy responses on the global economy and food security in 80 low- and middle-income countries. We use a global economy-wide model with detailed disaggregation of agricultural and food sectors following the GTAP10 database and a But-for-COVID (BfC) baseline extending the average economic growth during 2014-2019 to 2020. We shock the model by imposing aggregate income shocks driven by the April 2021 IMF World Economic Outlook for 2020. We impose total-factor productivity (TFP) losses in key sectors as well as consumption decreases induced by social distancing. The resulting shocks in prices and incomes from the CGE model simulations are fed into the United States Department of Agriculture (USDA) Economic Research Services' (ERS') International Food Security Assessment model to derive the impact of the pandemic on food security in the 80 countries of interest. We compute the impact on unskilled labor income, and derive changes in the food-distribution specific industries and supply chains disruptions, as well as trade impacts and the terms of trade. The main effect of the COVID-19 pandemic was to further deteriorate the already declining trend in food security. Food insecurity increases considerably in countries in Sub-Saharan Africa and Central South Asia through income shocks rather than prices as income from unskilled labor falls considerably in many countries. We also review trade policies that were put in place to restrict imports and exports of food, and we evaluate the potential these policies have for further disruption of markets focusing on the food-security implications.

**Keywords:** COVID-19, Food Security, trade costs, market disruption, pandemic

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## 1. Introduction

Global food security is an important concern, particularly in low- and middle income countries where more than 1 billion people are estimated to be food insecure while agricultural markets and trade remain volatile because of disruption in supply chains (Baquedano et al., 2021). Global food insecurity has been on the rise in recent years even before the COVID-19 pandemic which accentuated the growing insecurity (FAO SOFI, 2021). The COVID-19 pandemic and associated policies responses have had a considerable impact globally, disrupting agricultural and food supply chains, contracting income in most countries --often among the vulnerable economic groups-- and shrinking the travel and hospitality sectors an important source of revenue for not only OECD economies but low- and middle income countries. The food retail industry, in its food-away-from-home segment, has also been affected as many restaurants closed. Supply chains have been disrupted by labor shortages. The economic recovery in the first half of 2021 has been surprisingly fast in high-income countries, led by the United States (IMF, 2021b). But in low- and middle income countries, reflecting less access to vaccines, it has been much lower (IMF, 2021b and WHO, 2021).

Governments have responded to the pandemic first by imposing social distancing policies (e.g., lock downs and the use of Personal Protective Equipment), and then by reopening in a staggered fashion with several key sectors reopening at a fraction of their pre-pandemic levels (travel, hospitality, and retailing in particular). Further, programs have been put in place to soften the blow of the income shocks for consumers and several industries including in low-income countries with the help of international financial institutions. Growth of remittances has also helped families in low-income countries weather the strong income shocks from the pandemic (Ratha et al., 2020a and 2020b). In OECD countries considerable

unemployment took place in 2020 and then a recovery in labor markets has been taking place in 2021 as economies started re-opening, but unemployment levels still remain high (IMF, 2021a).

As the pandemic remains a foreseeable health threat and force of disruption, it is important to assess the implications of these economic shocks and partial recovery on global food security. What have been the impacts of the pandemic and associated policies on global agricultural, food supplies and trade, income, and consumption levels? Our paper assesses the impact of the pandemic and its various disruptions and policy responses on global food security, with its detailed impact on world food supplies and consumption by income group using the most recent (April 2021) aggregate income information from the IMF (IMF, 2021a).

We use an integrated modeling structure combining a world Computable General Equilibrium (CGE) model based on the GTAPinGAMS structure (Lanz and Rutherford, 2016) with the USDA ERS' International Food Security Assessment (IFSA) model (Beghin et al., 2017; and Baquedano et al., 2020) to assess the impacts of the COVID-19 pandemic shock of 2020, and the uneven recovery in 2021. The version of the IFSA model used in this paper uses an expanded database and focuses on 80 low- and middle-income countries. The CGE model provides changes in real prices of food, and real income which are then incorporated into the disaggregated food demand system of the IFSA model to predict nutritional gaps and food insecurity by income decile in these 80 low-and-middle-income countries.

We find that the aggregate real income shocks and those affecting unskilled labor were the major cause of a considerable increase in food insecurity, with the number of food insecure increasing by 172 million in 2020 compared to the 2020 BfC baseline. This increase caused by the pandemic shock comes in addition to the increasing food insecurity estimated in the BfC

baseline in 2020, relative to 2019 (nearly 79 million). Sub-Saharan Africa and Central South Asia accounted for most of this increase. Interestingly, we find that effective unskilled labor use falls but their real wage increases, partially offsetting the blow of lower employment.

Real food price changes contribute to a much lesser extent because the bulk of disruptions in food supply chains take place well beyond the farmgate, sparing most of agricultural production. Reliance on trade actually decreases in many countries during the pandemic because of reductions in food demand and increases in trade costs induced by logistics issues. Many real local food prices fall. We also note that trade-restricting policies have been limited in scope and over time and have had no measurable impact on food security and markets. Not included in this exercise is the fact that world commodity markets had ample supplies in 2020, helped mitigate excessive price volatility, unlike the 2007-2008 food crises.

Our paper contributes to the set of analyses based on general equilibrium models used to investigate COVID-19's impacts in different countries, including China (Zhao, 2020), the UK (Keogh-Brown et al., 2020), India (Sahoo and Ashwani, 2020), Brazil (Porsse et al., 2020) Kenya (Nechifor et al., 2021), Burkina Faso (Zidouemba et al., 2020), and globally or multi-regional levels (Laborde et al., 2021; McKibbin and Fernando, 2020; Maliszewska, Mattoo, and Van Der Mensbrugghe, 2020; Zhang et al., 2020; Zhao, 2020; Keogh-Brown et al., 2020; and Sahoo and Ashwani, 2020).

Our analysis contributes to the literature on the economic impact of COVID-19 in several ways. It uses estimates from the IMF World Outlook (2021a) and considers the two phases of the pandemic, that is, the steep contraction of 2020 and the uneven path to recovery projected for 2021. Many early studies had to make educated guesses on the likely income shocks and recovery paths of various countries. We differ from many previous analyses of the

COVID-19 shock in the way we model the shocks with our calibration to the consensus IMF outlook and creating a counterfactual baseline. The combination of two modelling frameworks (the multi-region general equilibrium GTAP model with the IFSA food-security model) is also unusual noting that IFPRI's evaluation by Laborde et al. (2021) also has a related setup with a recursive dual structure.

CGE models are typically used to simulate the impact of exogenous shocks and policy changes on income, trade and welfare (Giesecke and Madden, 2013). Here, we follow He et al. (2021), Bauer, Haltom, and Rubio-Ramirez (2005), Beckman, Baquedano and Countryman (2020) and Monte, Redding, and Rossi-Hansberg (2018) by reversing the process. We take exogenously observed and projected changes in GDP under COVID-19 as per the IMF's World Economic Outlook (IMF, 2021a), as well as trade and labor shocks and then recover the underlying fundamental conditions in labor and food markets, which are consistent with these large shocks in deviation from an established But-for-COVID (BfC) baseline scenario.

## **2. Modeling assumptions**

### ***Scenario assumptions***

The model uses GTAP 10 2014 nominal data for the initial calibration. The benchmark is then extended to 2019 based on the IMF World Economic Outlook GDP growth and macro data on the shares of consumption, public spending, investment, and trade including aggregate exports and imports.<sup>1</sup>

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<sup>1</sup> The WEO projections of aggregate imports and exports (measured in US dollars) at the regional level do not impose global consistency on capital flows. While we target regional trade imbalances based on the WEO projections, we use a transparent least-squares procedure to find the calibrated trade imbalance such that globally there is no net borrowing or lending. That is, the sum across regions of all net trade surpluses must be zero.

The BfC scenario extends the average growth rate observed in countries between 2014 and 2019, to 2020 by applying the average growth rate to the 2019 observed GDP figures in the IMF’s WEO. The 2020 IMF WEO figures become the COVID-19 shock for 2020. Income levels are shown in Table 1.a. We take the deviations (COVID-BfC) to measure the impact of the pandemic relative to the baseline. We then rely on these underlying conditions and parameters to derive the implied real income shocks for unskilled labor and food price changes consistent with the observed and projected shocks in deviation from the BfC baseline. For some regions, however, the combination of the 2019 base and the historic growth rate indicates a BfC GDP that is “below” the WEO 2020 projections. We view this as an anomaly. For these regions (Nigeria, CIS, NAF, EAF, WAF) we recalculate the BfC 2020 GDP target as the WEO 2020 (COVID) projection less the average global income shock.

Beyond matching aggregate value added in each country to the IMF GDP predicted shocks, we also shock Total Factor Productivity (TFP) in key sectors. This reflects the uneven nature of the scenario with a reduction in the productivity of all factors in sectors deeply affected by the pandemic and border closing—Trade (wholesale and retail), Warehousing and support activities, Water Transport, and Other Transport. We also capture the sharp decrease in demand in sectors for which consumers scaled back their consumption because of self-imposed or required distancing to abate health risk. We do this by scaling back the utility weight into the utility function. This corresponds to a decrease in effective utility of the good affected by the decrease. Demands are scaled back for hospitality and tourism related sectors (Accommodations and food services, Recreational and other services, and air transport). Finally, we capture the loss of productivity in perishable agriculture (Meat and Dairy, and Vegetables fruit and nuts) as in Laborde et al. (2021). These shocks work their way through



the model and translate into labor productivity changes and labor income, in particular for unskilled labor categories, which exacerbates food insecurity issues. Table 1.b summarizes the shocks in percent deviation from the BfC baseline for 2020.

The estimated changes in real income, income distribution and in real food prices are then fed recursively in USDA’s IFSA model (Beghin et al., 2017; Baquedano et al, 2020) to predict food insecurity consequences of COVID-19 in 80 low- and middle-income countries.

### ***Additional assumptions***

Regarding aggregation of sectors, all agricultural and food sectors are kept as in GTAP10, although we aggregate Meat and Dairy products into a single category we aggregate all nonfood manufacturing into a large single manufacturing sector. We keep the three GTAP transport sectors disaggregated, as well as warehousing with wholesale and retail trade, accommodation food and service activities (tourism-hospitality related), and recreation to simulate sector specific shocks in TFP and demand as shown in Table 1c. The detail sectoral aggregation is shown in Appendix Table B.1.

The IFSA model estimates the calorie intake per income decile in 80 low- and middle-income countries. The various food goods are aggregated in 4 groups (major grain, other grains, roots and tubers, other food) and then further aggregated into grain calorie equivalent to yield a total calorie intake. The specification follows a simple PIGLOG formulation relying on income, price and income distribution data to derive projected consumptions over time (Beghin et al., 2017). With the IFSA model in mind, we focus on grains and roots and tubers, which are the key staple foods of interest. The IFSA model incorporates real income, income distribution data (Theil’s inequality index), and the real price of the main grain by country (processed rice, wheat crop price, other grain crop price including corn), a second grain price

capturing grains other than the main grain, and the price of roots & tubers which is represented by the price of vegetables and fruits sector (v\_f sector) in GTAP10. The price of other foods in IFSA is not mapped here as we only consider the price changes in these staple food items. The IFSA demand specification does not capture the substitution possibilities across the 4 food groupings. This simplification tends to overstate the impact of price changes which are typically correlated in the case of global shocks.

**Table 1.a. Income levels in 2019, 2020-BfC, and 2020-COVID-19 (\$ billion)**

Countries/Regions	2019	2020-BFC	2020-COVID-19
Central Africa	208.44995	199.6823	179.122
China	14706.308	15638.45	15072.285
Commonwealth of Independent States	197.26309	195.5241	189.125
Central and Southern Asia + Other Asia	856.04681	881.7676	743.089
East Africa	255.37276	270.5243	262.239
Ethiopia	92.608	103.0943	96.611
Europe including GBR and CHE	18469.567	18419.98	17878.790
India	2870.5	3073.69	2708.770
Latin America and the Caribbean	1085.5074	1096.114	961.169
North Africa	689.03302	716.7222	694.369
Nigeria	448.12	443.9609	429.423
Pakistan	276.114	283.0411	262.799
Rest of World	23690.451	23563.26	22090.013
Southern Africa	98.948757	98.37634	92.581
South East Asia	1871.907	1969.627	1807.735
USA	21433.23	22313.22	20932.750
West Africa	244.67263	262.6903	254.753

**Table 1.b. Shocks (COVID-BfC baseline) in percent deviation**

Variable shock	GDP target	Balance of Payments	Government expenditures	Investment	Capital	Skilled labor	Unskilled labor
Central Africa	-9.863	-9.863	-10.295	-8.473	-1.055	-1.055	-14.315
China	-3.850	-4.120	7.946	-0.024	-7.780	-7.780	-10.840
Commonwealth of Independent States	-3.244	-3.240	8.889	-11.876	0.049	0.049	-2.176

Central & Southern Asia + Other Asia	-16.200	-16.196	-3.964	-12.616	-11.721	-11.721	-32.041
East Africa	-3.244	-3.213	-3.274	-10.769	-6.987	-6.987	-9.254
Ethiopia	-7.001	-6.992	-8.256	-16.633	-13.739	-13.739	-19.063
Europe including GBR and CHE	-2.930	-3.465	15.007	-5.950	-0.397	-0.397	-2.065
India	-12.713	-12.667	2.959	-18.371	-13.638	-13.638	-28.556
Latin America & the Caribbean	-12.432	-12.395	-2.385	-22.064	-7.788	-7.788	-23.766
North Africa	-3.244	-3.066	1.994	-11.148	-5.153	-5.153	-7.440
Nigeria	-3.244	-3.213	-5.258	-2.946	0.276	0.276	-1.465
Pakistan	-7.331	-7.306	0.087	-6.825	-6.356	-6.356	-15.279
Rest of World	-6.219	-7.073	11.263	-4.488	-2.292	-2.292	-9.124
Southern Africa	-5.857	-5.850	0.363	-1.044	-1.747	-1.747	-7.377
South East Asia	-8.648	-8.598	2.051	-15.447	-9.376	-9.376	-18.748
USA	-6.441	-5.230	24.635	-5.239	-6.881	-6.881	-13.231
West Africa	-3.244	-3.221	21.582	-3.538	-8.691	-8.691	-11.274

**Table 1.c. Sectoral shocks TFP(-1.25%) and demand shocks (-7.5%)**

Meat and Dairy	-1.25
Vegetables fruit and nuts	-1.25
Trade	-1.25
Warehousing and support activities	-1.25
Water Transport	-1.25
Other Transport n.e.c.	-1.25
Accommodations and food services	-7.50
Recreational and other services	-7.50
Air Transport	-7.50

### 3. Agricultural and food trade policy responses to COVID-19

Early in the pandemic, IFPRI researchers raised concerns about the emergence of trade restrictions endangering food security (Laborde et al., 2020) although price levels only moderately increased (Vos et al., 2020). The concern was to see another price spike in world grain prices induced by export restrictions as documented in Martin and Anderson (2012) and Ivanic and Martin (2008), in previous crises, such as rice prices surging in 2007-08, mostly

through export restrictions. These price increases exacerbate poverty in vulnerable households who spend a disproportionate share of their income on food.

Trade policy responses to COVID-19 focused mostly on export restrictions related to medical supplies (CRS, 2021). Agricultural and food trade was also targeted by some policies (ITC-MacMap, 2021). According to the database maintained by the ITC-MacMap, fifty-two agri-food trade restrictive policies were implemented affecting various goods from onions to rice and wild animals. The composition is as follows: 22 export restrictions, 4 export quotas, 3 export licenses, and 7 import bans, and 13 SPS restrictions on imports. Many measures were in place for less than 3 months although a majority are still active. The only potentially significant restrictions on commodity markets focus on rice from India (licensing) and Vietnam (export quotas for 37 days). Russia also set some temporary quotas on grain exports imposed at the end of 2020, but these were quite large (17.5 MMTs) and excluded exports to the Eurasian Economic Union. Export duties of €25/mt were also imposed in February 2021 and then additional duties on wheat, corn, and barley which expired in June 2021 and replaced by a floating duty on these grains (USDA, 2021). Despite these measures, USDA still predicts that Russia would export 40mmt of wheat, a higher volume than in the previous trade year of 2019/2020.

To counter these restrictions, twenty-seven countries implemented trade facilitating measures to pre-empt price increases for food imports. Sixteen of these measures are still active as of (7/15/2021). There were twenty-one tariff reductions, eliminations and/or quota increases, and a few cases of easing some certifications requirements. Overall, these measures have had limited impact on availability and prices of major commodities such as rice given that most major producers showed some restraint in their policy reactions to the pandemic.

Their impact on prices and availability of grains has been moderate. High stock-to-use ratios in early 2020 for most grains helped to stabilize prices. The concerns of higher price levels and volatility created by potential trade restrictions had faded by end of 2020 (Baffes and Wu, 2020). Therefore, we do not attempt to model their impact and focus on trade cost increases created by logistic disruptions in transportation, trade, and warehousing sectors.

#### **4. Scenario Results**

##### ***Impact on real Income***

The income shocks are shown in Table 2. The impact on factor income combines the shock on effective supplies of factors and change in returns and cost of living. Table 2 shows the real income shocks derived using the local price index (the true-cost-of-living index for the representative agent), in several cases the change in return (wage relative to the cost of living) mitigates the large shock imposed on unskilled labor. The resulting shock on factor income of unskilled labor is in many cases not as large as the skilled labor income impact or even GDP shock, such as in the Central and East Africa regions.

Capital income takes the brunt of the economic impact of COVID-19, such as in Central and Southern Asia region and Pakistan. The impact of the economic contraction is widespread affecting both demand and available supply of effective labor and capital. In some cases, the reduction in availability of labor or capital is stronger than the reduction in demand, leading to increase in nominal returns. In addition, the local cost of living falls in many countries relative to the BfC cost of living which contributes to higher real returns for factors. In any case the income shocks are very sizable, especially in Central and Southern Asia, Central Africa, India, and Latin America and Caribbean regions which leads to large exacerbations of

food insecurity as later discussed.

<b>Table 2. Income shocks in percent deviation from the BfC scenario</b>				
<b>Income category</b>	skilled labor	Unskilled labor	Capital	GDP
Central Africa	-11.41	-7.06	-11.22	-9.86
China	-2.84	-3.54	-3.91	-3.85
Commonwealth of Independent States	-1.54	-3.01	-3.66	-3.24
Central & Southern Asia + Other Asia	-15.94	-14.41	-16.16	-16.20
East Africa	-4.25	-1.76	-3.40	-3.24
Ethiopia	-11.89	-2.32	-7.84	-7.00
Europe including GBR and CHE	-2.39	-3.87	-2.83	-2.93
India	-11.78	-8.34	-13.94	-12.71
Latin America and the Caribbean	-13.62	-8.99	-13.16	-12.43
North Africa	-3.24	-1.82	-3.55	-3.24
Nigeria	-3.67	-1.92	-4.08	-3.24
Pakistan	-7.04	-4.99	-7.65	-7.33
Rest of World	-5.10	-5.27	-7.06	-6.22
Southern Africa	-4.93	-5.11	-6.85	-5.86
South East Asia	-9.31	-6.33	-8.86	-8.65
USA	-5.77	-6.00	-6.87	-6.44
West Africa	-0.12	-5.52	-3.29	-3.24

### ***Impact on food prices***

Food price changes are expressed in relative deviation from the BfC baseline in real terms.

Nominal prices are deflated by the local cost of living index. They are shown in Table 3. The majority of food prices decrease, except for the two perishable food sectors affected by the greater loss of productivity and level of disruption in supply chains. For the other sectors, the dominant influence is the demand contraction brought about by reduced incomes in all markets. This leads to price decreases in most but not all cases.

Looking first at the two sectors experiencing mostly price increases, prices in the Vegetable, fruits, root & tubers sector increase the most, especially in Central Africa (5.86%), Central and Southern Asia (5.44%), Ethiopia (3.40%), and LAC (2.89%). Smaller increases of less than 2% take place in Pakistan (1.82%), India (1.45%), and East Africa (1.40%). Meat and Dairy product prices increase moderately, by 2.25% in Central and Southern Asia, 1.67% in India, and 1.23% in Pakistan and 1.19% in South East Asia. Other Meat and Dairy price increases are even more limited, even though they are observed in most countries.

Grain prices increase in a few countries and decreases in many others. For example, in the Cereal grains n.e.c. sector, prices increase in Central Africa (4.60%), Central and Southern Asia (3.78%), and Ethiopia (1.78%) and LAC (0.91%). Other countries and regions experience price decreases for the same grain category, notably a decrease of 1.45% in West Africa. Rice prices increase in Central Africa (1.98%), Ethiopia (1.78%), India (1.32%), and West Africa (0.84%). Rice prices decrease in China (0.89%). Wheat prices increase in Central and Southern Asia (2.74%) and Ethiopia (1.49%) but also decrease in many other countries, driven principally by the demand-income contractions. For example wheat prices decrease by 1.64% in Central Africa and 1.23% in Nigeria. Oilseed prices increase as well, in Central Africa (4.96%), Central and Southern Asia (1.41%), Ethiopia (1.84%), and LAC (1.1%), and decreases in most other regions. Vegetable oil prices decrease in most countries. In summary Central Africa, Central and Southern Asia, Ethiopia, and Latin America and Caribbean regions are the most affected by price increases and face large income contractions. These are the hotspot for increases in food insecurity under COVID.

**Table 3. Impact on real food prices (deflated by local cost of living index) in % deviation from baseline**

<b>region</b>	<b>Fish</b>	<b>Grains other than wheat and rice</b>	<b>Meats and Dairy</b>	<b>Oilseeds</b>	<b>Rice</b>	<b>Sugar</b>	<b>Vegetables, fruits, root &amp; tubers</b>	<b>Vegetable oil</b>	<b>Wheat</b>
Central Africa	-1.02	4.60	0.48	4.96	1.98	-0.03	5.86	-1.10	-1.64
China	-1.14	-0.67	0.89	-0.63	-0.89	-0.88	0.78	-0.76	-0.68
Commonwealth of Independent States	-1.31	-0.92	0.75	-0.87	0.41	-0.50	0.52	-0.35	-0.49
Central and Southern Asia & Other Asia	-1.15	3.78	2.25	1.41	0.86	-2.04	5.42	-1.88	2.74
East Africa	-1.23	-0.11	0.71	-0.14	0.28	0.12	1.40	-0.02	0.31
Ethiopia	-5.10	1.76	0.12	1.84	1.78	-3.49	3.40	0.66	1.49
Europe including GBR and CHE	-1.59	-1.36	0.10	-1.34	-0.75	-1.30	0.04	-1.04	-1.40
India	1.19	-0.32	1.67	0.14	1.32	-0.13	1.45	-1.17	-0.58
Latin America and the Caribbean	-2.59	0.91	0.86	1.10	-0.26	-0.33	2.89	-0.81	0.48
North Africa	-1.07	-0.25	0.83	-0.37	-0.44	-0.28	0.94	0.07	-0.13
Nigeria	-1.41	-0.63	-0.10	-0.62	-0.13	-1.16	0.68	-0.47	-1.23
Pakistan	-1.72	0.13	1.23	0.36	-0.29	0.12	1.82	-0.08	0.34
Rest of World	-1.78	-0.95	0.38	-1.26	-0.69	-1.24	0.58	-1.10	-0.79
Southern Africa	-1.24	-0.20	0.73	-0.33	0.41	-0.55	1.14	-0.01	0.10
South East Asia	-1.67	0.09	1.19	0.00	-0.10	-0.36	1.07	0.00	-0.77
USA	-2.50	-2.14	0.31	-2.18	-0.71	-0.87	-0.51	-1.18	-2.04
West Africa	-1.32	-1.45	0.70	-1.35	0.84	-0.22	-0.06	-0.07	0.04



### *Impact on trade*

Aggregate agricultural and food trade effects are shown in Table 4. Agricultural export values fall for all countries and the magnitudes of these contractions are large in absolute value. Imports of agricultural and food goods also fall but often by smaller percentages than agri-food exports fell, except in the EU and the USA.

<b>Table 4. Agricultural and food trade impact in % deviation from the BfC scenario</b>			
<b>Country/region</b>		<b>Exports</b>	<b>Imports</b>
Central Africa		-18.28	-5.34
China		-12.77	-15.72
Commonwealth of Independent States		-12.05	-7.58
Central & Southern Asia + Other Asia		-30.54	-1.43
East Africa		-11.36	-3.63
Ethiopia		-19.16	3.11
Europe including GBR and CHE		-15.69	-17.42
India		-16.72	-11.96
Latin America and the Caribbean		-23.37	-5.63
North Africa		-11.48	-2.12
Nigeria		-14.21	-3.96
Pakistan		-13.06	-6.69
Rest of World		-15.06	-15.95
Southern Africa		-12.43	-11.57
South East Asia		-17.28	-6.68
USA		-12.43	-23.93
West Africa		-7.63	-12.52

Ethiopia increases its imports of food slightly, by 3.45%. With that exception, all countries decreased their reliance on foreign market to fulfill consumer demand. Export revenues for these agri-food sectors fell as well, contributing to the loss of income. These magnitudes are all computed using the global cost of living benchmark as the price of a “common global basket.”<sup>2</sup>

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<sup>2</sup> The global cost of living price index is computed as the benchmark-consumption weighted average of the local (regional) cost of living indexes, where the benchmark is the 2019 equilibrium.

At the agri-food sectoral level (see appendix table A1 for details by country), there are large changes, positive and negative in imports, depending on the country. We find increases in wheat imports in Central and Southern Asia (30.71%) and Ethiopia (25.57%), oilseeds in Central Africa, meat and dairy in Central and Southern Africa (14.35%) vegetables, fruit, roots and tubers in Ethiopia (10.89%). However, there are many more large import decreases as well, especially in the USA, EU and China.

Agri-food exports at the sectoral level are reported in Appendix Table A2. Most sectors in most countries fall by 10% or more. There are large decreases, exceeding 20% in rice exports in Central and Southern Asia, Central Africa, India, Latin America and Caribbean, Southern Africa, and South East Asia. We also observe large decreases in exports of roots and tubers from Central Africa, Central and Southern Asia, and LAC. Similar patterns are projected for wheat in the same countries and in Ethiopia. Exports of other grains n.e.c. fall by more than 20% in Central and Southern Asia, and LAC. Meat and dairy exports fall similarly in many of the same countries. In sum, Central and Southern Asia and then LAC exhibit the most accentuated changes in agri-food exports. These changes motivate the aggregate changes shown in Table 4.

### ***Impact on terms of trade***

We have two measures of changes in purchase power in the regions covered by the model. First, we look at the true cost of living index over the benchmark weighted average of these indexes globally, which provides a gauge of the impact of local cost of living relative to the “global” benchmark cost of living (how well a country’s cost of living is faring relative to what is happening globally). Second, we have a more traditional terms of trade measures (index of export prices over an index of import prices). They are shown in Table 5.

<b>Table 5. terms of trade effects and change in relative cost of living in % deviation from the BfC scenario</b>		
	Relative cost of living/global benchmark	Terms of trade change
Central Africa	0.46	-0.60
China	-0.90	-0.12
Commonwealth of Independent States	-0.82	-0.88
Central & Southern Asia + Other Asia	3.02	0.82
East Africa	-0.99	-0.74
Ethiopia	-0.33	1.02
Europe including GBR and CHE	-0.11	-0.01
India	0.41	1.67
Latin America and the Caribbean	1.05	0.27
North Africa	-1.11	-0.69
Nigeria	-0.14	-1.92
Pakistan	-0.15	0.48
Rest of World	0.08	-0.08
Southern Africa	-0.95	-0.34
South East Asia	-0.17	0.03
USA	0.12	0.53
West Africa	-1.34	-0.59

First, we note that the relative cost of living falls in many countries, except in Central and Southern Asia (+3.02%), and LAC (+1.05%). The largest price decreases are in West and Northern Africa regions (-1.34% and -1.11%). Elsewhere, relative changes in the cost of living are small (less than 1%). Terms of trade improve for India (+1.67%) and for Ethiopia (1.02%), and deteriorates for Nigeria (-1.92%), and to a lesser extent for Commonwealth of Independent States, Central and Southern Asia, and East Africa regions (less than a 1% decrease). The two measures of relative purchase power are poorly correlated. One would expect a negative correlation if all goods were tradable –improvements in terms of trade would lead to reduction

of the local cost of living. However, as import dependency is variable among regions, this is not the case. For example, terms of trade improve in India but its relative cost of living also increases. Conversely, Nigeria experiences a deterioration of its terms of trade but its relative cost of living falls.

## **5. COVID-19's impact on food insecurity trends**

Our analysis builds on previous finding of Baquedano et al. (2021) and Beckman et al. (2021) of the effects of COVID-19 on food security in two important ways. First as discussed above the shocks to income, as proxied by GDP changes, and price are more robust and take into account the influence of trade shocks as well as distinguishing the effects on skilled and unskilled labor. This is important, as the IFSA model, directly uses the GDP and price shocks to derive the estimates of food insecurity from COVID-19. Second, unlike the previous studies we evaluate the increase in food insecurity from 2019 on to our BfC baseline and then under COVID-19 in 2020. This allows us to decompose the deterioration of food security over time into its two components (one created by the pandemic, the other reflecting underlying trends observed in recent years). The previous studies only compared a 2020 scenario without COVID-19 to a 2020 scenario with COVID-19. Moreover, at the time of these studies the effects on GDP and food prices for 2020 were unknown and were based on early projections. Our estimates for 2020 are now more definitive as the effects on GDP and prices are known. The food security results highlighted below are for a subset of the GTAP results presented above, as the expanded IFSA database only covers 80 low- and middle-income countries. A much lower number than the GTAP database which covers the world. All macroeconomic shocks to GDP and prices are based on 2019 price levels for the two scenarios (BfC, and COVID-19).

Our discussion on food security is focused on two metrics, the share of the population

that is food insecure –a metric that helps us measure the depth of food insecurity—and the number of food insecure people. The first major finding is consistent with FAO et al. (2021); food insecurity had been increasing even before the COVID-19 pandemic, driven mainly by regions and countries with protracted conflicts or protracted economic crises. In 2020, in the scenario without COVID-19 (BfC), we find that the prevalence of food insecurity was estimated to increase by 1.5 percentage points or 8.4 percent from its 2019 estimate (Table 6). In absolute terms, the number of food insecure people increased at higher rate, increase by 10.1 percent in 2020 if COVID-19 had not occurred. Central Africa, Ethiopia, and Southern Africa would have been the regions that drove food insecurity trends in 2020 if COVID19 had not occurred, as they had the three highest shares of food insecurity in their population. Both Central Africa and Ethiopia are suffering from armed conflict, and in particular Central Africa which includes the Republic of the Congo and the Democratic Republic of the Congo.

The effect of COVID-19 was to sharply increase food insecurity trends. The prevalence of food insecurity (share of population being food insecure) in 2020, after accounting for COVID-19, increases by 4 percentage points or 20 percent from its BfC 2020 levels (Table 6). The number of food insecure in 2020 increased by 251 million people or 32 percent from 2019. Roughly two thirds of the increase (172 million) comes from the pandemic and the other third (79 million) from the underlying trends observed before the pandemic, between 2019 and 2020 (under the BfC baseline). The Asia (Central and Southern Asia, India, Pakistan, South East Asia) region accounted for most of the increase in food insecurity from 2019 to 2020. As highlighted above in 2020 the countries in Asia had some of the sharpest declines in GDP and reductions in agricultural and food trade impact, as well as sharp increases in food prices, particularly rice. Jointly Asia, accounted for 50 percent of the 1.03 billion people estimated to

**Table 6. Food security indicators for 2019 and 2020 BfC and 2020 under COVID-19**

	Share of the population food insecure				Number of people food insecure		
<b>Region</b>	<b>2019</b>	<b>2020</b>	<b>2020</b>		<b>2019</b>	<b>2020</b>	<b>2020</b>
	<b>Baseline</b>	<b>But for COVID</b>	<b>COVID-19</b>		<b>Baseline</b>	<b>But for COVID</b>	<b>COVID-19</b>
	(percent)				(millions)		
Total	18.3	19.9	23.9		779.6	858.3	1,030.6
Central Africa	48.7	57.8	64.9		66.5	81.4	91.3
Commonwealth of Independent States	5.3	9.5	10.9		6.1	6.9	7.9
Central and Southern Asia & Other Asia	31.3	32.7	40.8		96.3	101.9	127.0
East Africa	40.3	37.9	40.2		103.7	100.1	106.4
Ethiopia	9.5	21.2	25.9		22.7	22.9	28.1
India	9.9	11.6	16.3		129.4	153.7	216.7
Latin America and the Caribbean	8.2	9.8	13.9		45.4	55.0	77.4
North Africa	5.7	6.6	7.4		10.9	12.9	14.3
Nigeria	23.1	23.9	25.8		48.2	51.3	55.3
Pakistan	35.3	35.7	41.3		80.8	83.3	96.5
Southern Africa	43.3	46.9	50.7		86.7	96.2	103.8
South East Asia	10.2	11.7	13.8		50.2	58.5	69.0
West Africa	17.6	18.1	19.4		32.7	34.3	36.8

Source: Estimates derived using USDA's International Food Security Assessment Model

be food insecure in 2020 under COVID-19, with India accounting for the largest share. Although, in terms of the depth of food insecurity, sub-Saharan Africa saw sharper increase in the share of food insecure than in Asia, particularly in Ethiopia and Central Africa. While LAC and North Africa jointly account for 8.9 percent of the number of food insecure people in 2020, after COVID-19, both these regions saw sharp increases in their prevalence of food insecurity. In LAC, the share of the population food insecure increased from 8.2 percent in 2019 to 13.9 percent in 2020 due to COVID-19. In North Africa, the same metric increased from 5.7 percent in 2019 to 7.4 percent in 2020.

## **6. Conclusion**

We analyzed the impact of the COVID-19 pandemic and associated policy responses on the global economy and food security in 80 low- and middle-income countries. We used a global economy-wide model with added detailed disaggregation of agricultural and food sectors and a But-for-COVID (BfC) baseline for 2020. We incorporate aggregate income shocks, sectoral losses in productivity, rising transaction costs, and decreases in demand induced by distancing. We compute changes in income and food prices from the pandemic shocks in 2020 with and without the effects of COVID-19.

The resulting shocks in prices and incomes from the CGE model simulations were incorporated into USDA ERS' IFSA model to analyze the deterioration in food security in these 80 countries. Food insecurity increases considerably in countries in Sub-Saharan Africa and Central South Asia through income shocks rather than prices as aggregate income and income of unskilled labor falls considerably in many countries. Few sectors exhibit price increases as income contractions reduce demand in most sectors and most countries.

Our findings confirm that food insecurity had been deteriorating prior to the COVID-

19 pandemic. The main effect of the pandemic was to sharply increase the deteriorating trend in food security in the 80 low- and middle-income countries covered in this study. Most of the increase in the number of food insecure people from COVID-19 in 2020 is driven by Asian countries. However, sub-Saharan African countries saw a sharper increase in the share of the population food-insecure. Relative to these two regions, Latin America and the Caribbean and North Africa were relative less affect.

We also note that many countries of interest experience moderate terms-of-trade deteriorations and losses of purchase power on world markets; these countries also experience more dramatic decreases in exports and often as well in imports, except Ethiopia. The decreased reliance on trade was not induced by restrictive trade policies, but rather by the generalized demand contractions, as a result of lower incomes, damping agri-food export demands and by general equilibrium export supplies. Income derived from export sales also falls. Similarly, imports contracted because of lower income in importing countries.

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**Appendix Table A1. Agricultural and food import impact in % deviation from baseline**

<b>Regions</b>	b_t	fsh	gro	M_D	ocr	ofd	osd	pcr	sgr	v_f	vol	wht
Central Africa	-8.490	-8.782	-0.158	-5.657	22.603	-7.819	17.119	2.649	-2.967	7.223	-7.937	-11.238
China	11.568	-19.037	-14.963	-19.480	-13.727	-18.045	-17.568	-25.006	-17.556	-15.242	-18.998	-20.418
Commonwealth of Independent States	-6.008	-5.394	-7.008	-8.259	-13.127	-6.146	-8.604	-6.693	-5.614	-7.113	-5.923	-10.936
Central and Southern Asia												
+ Other Asia	14.605	-14.196	-6.162	14.348	9.512	-9.291	-3.935	-5.601	-12.677	1.894	-10.250	28.885
East Africa	-3.260	-2.226	-1.099	-5.789	-4.850	-4.175	-1.338	-4.011	-3.742	-4.335	-3.697	-2.332
Ethiopia	-0.143	-7.353	6.125	-4.030	15.242	2.568	-9.136	2.002	-12.586	10.893	4.764	25.573
Europe including GBR and												
CHE	18.208	-17.570	-15.502	-18.309	-16.547	-17.396	-14.691	-18.836	-17.832	-19.325	-16.538	-17.691
India	11.058	-11.001	-14.479	-3.642	-10.574	-10.326	-8.241	-3.793	-9.304	-10.819	-16.303	-15.405
Latin America and the												
Caribbean	10.301	-12.358	-6.266	-2.249	5.646	-9.524	-3.522	-5.503	-8.544	-3.465	-8.368	8.093
North Africa	-1.581	-0.654	-0.865	-5.107	-0.968	-0.497	-1.296	-6.752	-1.629	-1.960	-0.870	-1.845
Nigeria	-2.723	-2.334	-2.063	-5.203	-0.487	-2.959	-1.046	-2.885	-3.247	-2.009	-2.198	-2.170
Pakistan	-8.307	-8.647	-6.426	-5.440	-4.623	-6.804	-4.022	-7.437	-3.041	-7.221	-7.913	-3.860
Rest of World	17.740	-16.117	-15.763	-16.263	-15.032	-16.354	-13.725	-20.817	-17.468	-15.175	-16.397	-13.644
Southern Africa	11.285	-11.810	-11.365	-14.209	-9.480	-11.528	-11.055	-11.871	-11.803	-11.559	-11.537	-12.140
South East Asia	-6.289	-8.561	-7.159	-6.449	-5.583	-7.383	-7.477	-6.327	-4.525	-4.357	-4.711	-8.954
USA	25.687	-22.695	-23.610	-22.697	-20.560	-23.504	-23.332	-25.281	-22.644	-27.153	-21.643	-31.203
West Africa	10.945	-11.868	-13.427	-14.950	-19.454	-11.713	-11.643	-13.450	-12.775	-13.179	-14.160	-9.872

**Appendix Table A2. Impact on agri-food exports in % deviation from BfC scenario**

<b>Countries</b>	<b>b_t</b>	<b>fsh</b>	<b>gro</b>	<b>M_D</b>	<b>ocr</b>	<b>ofd</b>	<b>osd</b>	<b>pcr</b>	<b>sgr</b>	<b>v_f</b>	<b>vol</b>	<b>wht</b>
Central Africa	-15.031	-13.981	-14.823	-20.903	-36.995	-16.957	-30.246	-23.156	-14.791	-29.138	-13.779	-26.667
China	-13.298	-16.675	-14.333	-12.943	-10.335	-14.919	-12.116	-11.480	-8.725	-10.044	-10.446	19.577
Commonwealth of Independent States	-16.307	-15.887	-13.403	-10.308	-10.024	-14.108	-12.542	1.244	-10.245	-14.208	-12.144	-1.180
Central and Southern Asia + Other Asia	-18.093	-20.516	-26.409	-41.528	-37.705	-25.340	-33.201	-31.654	-32.053	-28.327	-31.652	-55.849
East Africa	-11.991	-16.997	-6.880	-9.514	-10.695	-12.384	-14.144	-9.454	-15.053	-13.430	-3.943	-11.165
Ethiopia	-11.937	-12.199	-13.554	-12.396	-25.480	-15.818	-24.120	0.000	-5.512	-7.586	-25.361	-25.174
Europe + GBR and CHE	-18.224	-17.413	-14.524	-15.806	-12.703	-16.157	-13.806	-15.004	-15.963	-16.815	-14.950	-7.567
India	-18.870	-18.870	-10.733	-16.365	-16.087	-20.977	-18.285	-19.751	-15.053	-15.336	-14.523	3.150
Latin America and the Caribbean	-20.275	-18.790	-23.253	-20.417	-31.732	-19.107	-23.031	-16.576	-21.455	-25.237	-19.081	-45.550
North Africa	-12.423	-16.406	-13.525	-1.289	-7.708	-13.167	-9.850	-14.449	-8.151	-13.080	-10.401	-13.588
Nigeria	-10.971	-16.812	-15.503	-11.103	-16.122	-14.517	-14.662	-8.777	-8.850	-10.812	-15.907	-15.930
Pakistan	-13.941	-16.893	-9.325	-13.943	-16.524	-13.199	-17.696	-12.541	-16.269	-10.973	-15.921	17.336
Rest of World	-17.301	-17.333	-13.384	-15.246	-13.959	-16.517	-16.980	-10.250	-12.337	-17.578	-12.901	-10.869
Southern Africa	-13.574	-16.061	-7.880	-10.536	-13.250	-13.658	-13.357	-15.161	-13.685	-14.873	-10.845	-10.154
South East Asia	-14.263	-17.702	-12.821	-16.611	-16.847	-17.915	-14.601	-15.152	-20.180	-17.290	-18.541	-16.893
USA	-15.194	-15.187	-12.257	-14.379	-4.246	-15.676	-13.000	-12.200	-16.296	-11.550	-11.890	-0.503
West Africa	-10.073	-15.922	-12.924	-9.517	-6.156	-14.274	-11.458	-7.798	-8.540	-7.587	-7.497	-4.377

**Appendix Table B.1. Sectoral aggregation**

Sectors		Definition
pdr	Agriculture	Paddy rice
wht		Wheat
gro		Cereal grains n.e.c.
v_f		Vegetables, fruit, nuts
osd		Oil seeds
c_b		Sugar cane, sugar beet
pfb		Plant-based fibers
ocr		Crops n.e.c.
ctl		Bovine cattle, sheep and goats
oap		Animal products n.e.c.
rmk		Raw milk
wol		Wool, silk-worm cocoons
frs		Forestry
fsb		Fishing
vol	Processed Food	Vegetable oils and fats,
M_		
D		Meat and Dairy products,
pcr		Processed rice
sgr		Sugar
ofd		Food products n.e.c.
b_t		Beverages and tobacco products
EES	Energy and extractive	Energy and extractive
MAN	Manufacturing	Manufacturing
trd	Trade	Trade
whs		Warehousing
atp	Transport	Air Transport
wtp		Water Transport
otp		Other Transport
afs	Services	Accommodations food and service activities
ros		Recreation and other services