

Title: "AJAE appendix for The Importance of Agriculture in the Economy: Impacts from COVID-19"

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## Updating the CGE Model

The latest GTAP database is set to 2014 (i.e., using that database would tell us how the 2014 economy would change with COVID-19 in place). To update this database, we introduce a series of macroeconomic shocks to bring the model to 2020. This method is often used when providing a baseline analysis or updating a database, and as detailed in Beckman et al. (2012), involves providing the model information on actual changes to capital, gdp, labor, population, and productivity. These shocks are given in Appendix Table 1 and indicate that most countries had an increase in population and labor; although China, Europe, the Former Soviet Union, and Japan had a decrease in at least one of these. Brazil had a decrease in GDP; while all regions had an increase in capital and productivity.

Appendix Table 1. Macroeconomic and Policy Shocks to Update the CGE Model to 2020

	Population	GDP	Labor	Capital	Productivity	PSE
Argentina	5.62	2.10	5.95	24.26	8.08	17.84
Australia	6.36	15.52	4.98	19.11	11.11	-0.05
Brazil	4.47	-1.81	6.65	22.84	7.59	-1.67
Canada	4.46	11.00	2.21	17.43	9.54	0.76
Central America & Caribbean	5.98	13.93	12.36	26.98	10.95	0.62*
Sub-Saharan Africa	17.82	15.68	18.74	32.36	9.97	1.36*
China	2.40	46.58	-0.21	57.73	33.79	-2.84
Europe	1.27	12.32	-1.47	12.45	11.04	1.93*
Former Soviet Union	0.94	7.42	-2.01	23.95	29.00	-0.96*
India	7.26	52.49	10.46	35.59	20.56	7.99
Japan	-1.26	6.02	-2.36	10.66	7.97	0.27
Middle East & North Africa	12.54	16.49	9.96	28.68	7.10	-5.32*
Mexico	6.95	12.95	10.09	24.65	8.37	-2.00
Other Asia	6.64	24.80	10.15	31.60	9.29	-1.16*
Rest of Southern Hemisphere	6.67	-0.82	9.51	20.41	4.77	-0.42*
USA	4.29	14.75	2.96	15.51	5.64	3.35

Note: This table shows the percentage change in 2020 compared to 2014 across regions for population, gross domestic product (GDP), labor, capital, productivity, and the producer support estimate (PSE). The values for each variable are employed as region-specific exogenous shocks in the CGE model to update the 2014 base data to 2020. Asterisk, \*, indicates that Costa Rica is used for Central America & Caribbean; South Africa is used for Sub-Saharan Africa, Europe is a weighted average of the EU, Iceland, Norway, and Switzerland; Former Soviet Union is a weighted average of Kazakhstan, Russia, and Ukraine; Middle East & North Africa is a weighted average of Israel and Turkey; Other Asia is a weighted average of Korea, Indonesia, Philippines,

and Vietnam; and Rest of Southern Hemisphere is a weighted average of Chile, Colombia, and New Zealand.

Source: Macroeconomic shocks for population and GDP are from ERS (2020), while shocks for labor, capital, and productivity are from Fouré, Bénassy-Quéré, and Fontagné (2016). PSE numbers are from OECD (2020).

In addition to the macroeconomic shocks, we also note that there have been policy changes that have occurred over the 2014-2020 time period. One policy change has been domestic support—defined by the Organisation for Economic Co-operation and Development (OECD) as “the annual monetary value of gross transfers to agriculture from consumers and taxpayers arising from government policies that support agriculture, regardless of their objectives and economic impacts”. The OECD has numerous measures of domestic support, for this work we use the Producer Support Estimate (PSE), which measures transfers to agricultural producers. This data is shown in Appendix Table 1 (last column), where a positive value indicates that agricultural support as a share of gross farm receipts increased. As indicated in the table, half of the regions had an increase in their domestic support. These changes tend to be small, except for Argentina (17.84 percent), India (7.99 percent), and the USA (3.35 percent). The PSE data also provides a breakdown of where the support is used—if support is related to output, inputs, or are decoupled. We use this information to specify how the change in support is specified in the model.

In addition to changes in domestic support, other policies have changed from the 2014-2020 update time period. In particular, there have been changes in trade policy, but for agriculture the focus has been more on the increase in tariffs, rather than trade agreements. Perhaps the biggest development was the so-called trade war, from retaliatory measures imposed by foreign countries in response to United States’ Section 232 (steel and aluminum) and 301 tariffs (put in place on some imports from China). Retaliatory trade actions impacting U.S.

agricultural exports were implemented in different phases, by six countries (Canada, China, EU, India, Mexico, and Turkey), and on agricultural categories. On April 2, 2018, China retaliated against the U.S., imposing import tariffs on 128 product lines (93 agricultural products), with tariffs ranging between 5 and 50 percent (Regmi, 2019). Some of these disputes, such as those between the U.S. and Canada and Mexico, were resolved through negotiations, but the tariff exchange between the U.S. and China has continued. To account for the state of the tariffs in 2020, we also include them in our database update, following the data provided by Bown (2019).

### **Sectors and Regions in the CGE Model**

The disaggregated GTAP base data contain over 141 regions and 65 sectors; researchers often aggregate these to make the results easier to comprehend and interpret. For this work, we leave most agricultural sectors disaggregated, and aggregate non-agriculture into 6 sectors (Appendix Table 2). We split the corn sector from coarse grains, as WASDE provides information for each sector separately. To split the commodity, we use the SplitCom utility developed by Horridge (2008). SplitCom is a matrix balancing program that allows the user to subdivide the rows and columns of a commodity from a balanced social accounting matrix (SAM). The user provides data to disaggregate a GTAP sector's input demands, uses in intermediate and final demand and trade, and tax and tariff payments. SplitCom then uses methods similar to maximum entropy to balance the disaggregated SAM and to satisfy accounting identities. The utility manipulates only the disaggregated sectors, which can be re-aggregated to restore the original values in the GTAP SAM.

Appendix Table 2: Sector Aggregation Scheme

No.	Name	Description	GTAP sector code
1	rice	Paddy and milled rice	pdr, pcr
2	wheat	Wheat	wht
3	corn	Corn	gro*
4	coarse grains	Cereal grains	gro
5	fruits & vegetables	Fruits, nuts, and vegetables	v_f
6	oilseeds	Oilseeds	osd
7	sugar	Sugar	c_b, sgr
8	plant-fibers	Plant-based fibers	pfb
9	other crops	Other crops	ocr
10	cattle	Cattle	ctl
11	other animal products	Other live animals	oap, wol
12	natural resources	Natural resources	frs, fsh
13	energy/mines	Energy and mining activities	coa, oil, gas, oxt, p_c, nmm, i_s, ely, gdt
14	beef	Beef	cmt
15	other meat	Other meat	omt
16	vegetable oil	Vegetable oil and fats	vol
17	milk products	Milk and milk products	rmk, mil
18	processed food	Processed food	ofd
19	beverages & tobacco	Beverages and tobacco	b_t
20	fafh	Food away from home	afs, ros
21	clothing	Clothing	tex, wap
22	labor manufacturing	Labor intensive manufacturing	lea, lum, ppp
23	capital manufacturing	Capital intensive manufacturing	chm, bph, rpp, nfm, fmp, mvh, otn, omf, ele, eeq, ome
24	services	Services	trd, whs, cmn, ofi, ins, rsa, obs, osg, edu, hht, dwe

Note: This table describes the sectoral aggregation scheme employed in this analysis.

The food away from home (fafh) sector is created to account for the portion of agriculture that has been affected by the decrease in food purchased outside the home. To determine what sectors to include, we look at the portion of sector-specific costs (i.e., non-factor costs) for each disaggregate nonagricultural sector that are from agriculture for the U.S. There are 4 nonagricultural sectors in the original GTAP database that have a share of sector-specific costs for agriculture greater than 1 percent. They are noted in Appendix Table 3 as afs (accommodation, food and service activities), ros (recreational and other services), osg (public administration and defense), and obs (business services nec). As noted in the table, most of the sector-specific costs for these sectors are from services. In terms of costs from agriculture, afs

and ros have shares greater than 10 percent, note that afs would include restaurants and ros include sports activities. These are the two we include in the fafh category.

Appendix Table 3. Sectors with a Share of Sector-Specific Cost in Agriculture More than 1 Percent for the U.S.

sector	afs	ros	osg	obs
rice	1.1	0.1	0.2	0.1
wheat	0.1	0	0	0
corn	0.1	0.1	0.1	0.1
coarse grains	0.1	0.1	0.1	0.1
v_f	1.5	0.3	0.4	0.2
oilseeds	0.2	0	0	0
sugar	0.5	0.1	0.1	0
pfb	0	0	0	0
ocr	0.2	0.2	0	0.2
cattle	0.2	0	0	0.1
other animals	1.3	0.1	0.1	0.2
natural resources	2.1	0.2	0.2	0.2
energy/mines	5.1	3.8	3.8	2.9
beef	2.2	0.6	0.6	0
other meat	2.5	0.7	0.4	0
vegetable oil	1.3	0.1	0.2	0.1
milk	1.9	1.2	0.5	0.1
processed food	10.4	4.2	1.5	0.7
beverages & tobacco	8.4	3.1	0.5	0.4
fafh	2.5	26.0	5.4	8.1
clothing	0.5	0.9	1.9	0.9
labor manu	1.9	2.7	2.6	3.9
capital manu	5.9	7.1	12.1	15.9
services	49.9	48.8	69.7	66.3
total agriculture	32.0	10.8	4.6	2.2

Note: This table shows the percentage of sector-specific costs for the sectors afs (accommodation, food and service activities), ros (recreational and other services), osg (public administration and defense), and obs (business services nec). These are the 4 sectors in the model that have greater than 1 percent of their cost structure attributable to agriculture.

The regional aggregation is based on information available from WASDE, the mapping is noted in Appendix Table 4. As noted in the table, there are several regions kept as countries—Argentina, Australia, Brazil, Canada, China, India, Japan, Mexico, and the U.S. We kept a

country disaggregated if it appeared in at least 3 of the WASDE commodity categories. The only deviation from this is Russia and Ukraine, who we aggregate into the FSU category for brevity.

Appendix Table 4. Country and Region Mapping from WASDE to GTAP

<b>GTAP Regions</b>	<b>WASDE Regions</b>
Argentina	Argentina
Australia	Australia
Brazil	Brazil
Canada	Canada
Central America & Caribbean	C. Amer. & Carib.
Sub-Saharan Africa	Afr. Fr. Zone, Nigeria, S. Africa
China	China
Europe	EU
Former Soviet Union	Russia, Ukraine, Kazakhstan
India	India
Japan	Japan
Middle East & North Africa	Sel. Mideast, N. Africa, N. Africa & Mideast, Pakistan, Egypt, Saudi Arabia, Turkey
Mexico	Mexico
Other Asia	SE Asia, Central Asia, Bangladesh, Indonesia, S. Korea, Thailand, Vietnam, Philippines, Burma
Rest of Southern Hemisphere	S. Hemis., Paraguay
U.S.	U.S.

Note: This table maps the GTAP regions used in this analysis to the corresponding WASDE country groupings.

## WASDE Data Description

Each monthly WASDE report consists of four data sections. The first section (WASDE Tables 8-10) reports output, supply, trade, use, and ending stocks for commodities and is broken down into World, U.S., and Foreign regions. (Note: data from section 1 was not used in this analysis.) The second section (WASDE Tables 11-17) includes U.S. commodity supply and use of wheat, feed grains, corn, sorghum, barley, oats, rice, soybeans, soybean oil, soybean meal, sugar, and cotton, documenting production, imports, exports, etc. The third section (WASDE Tables 18-30) focuses on major importing and exporting countries and includes data for wheat, coarse grains, corn, rice, cotton, soybeans, soybean oil, and soybean meal. The coarse grains sector includes corn, sorghum, barley, oats, rye, millet, and mixed grains. Corn is also reported individually due to data limitations. In May 2019, the USDA updated the countries considered for each specific commodity (i.e., wheat in Japan was not accounted for until May 2019. Also, FSU-12 was only included until May 2019.). Appendix Table 5 shows the countries included in each aggregate WASDE region. The fourth and final section (WASDE Tables 31-34) consists of U.S. Animal Production data including beef, pork, red meat, broiler, turkey, total poultry, egg, and milk products.

Appendix Table 5. Countries Included in WASDE Regions

WASDE Region	Countries Included in each WASDE Region
SE Asia	Indonesia, Malaysia, Philippines, Thailand, Vietnam
N. Africa	Algeria, Egypt, Morocco, Tunisia
Sel. Mideast	Lebanon, Iraq, Iran, Israel, Jordan, Kuwait, Saudi Arabia, Yemen, United Arab Emirates, Oman
Afr. Fr. Zone	Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Mali, Niger, Senegal, Togo
Central Asia	Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
N. Africa & Mideast	Algeria, Egypt, Iran, Israel, Jordan, Libya, Morocco, Syria, Tunisia, Turkey
S. Africa	South Africa



While this data serves well, two challenges exist. The first drawback is that the USDA updated the countries considered for a specific commodity in May 2019. The second drawback is the measurement of coarse grains. U.S. data on coarse grains are reported both individually (sorghum, oats, and barley separately) and as an aggregated commodity grouping within the imports and exports section of the WASDE data that includes a broader set of grains (corn, sorghum, barley, oats, rye, millet, and mixed grains.) WASDE also reports corn as a separate commodity. To map directly to our GTAP commodity groupings across countries, coarse grains should exclude corn; however, corn values cannot be subtracted from the international data on coarse grains because of data limitations (i.e. Australia reports coarse grains but not corn; while India reports corn but not coarse grains.).

## References

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