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Impacts of COVID-19 on Global Poverty, Food Security and Diets

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ABSTRACT

This study assesses the impact of COVID-19 on poverty, food insecurity and diets, accounting for the complex links between the crisis and the incomes and living costs of vulnerable households. Key elements are impacts on labor supply; effects of social distancing; shifts in demand from services involving close contact; increases in the cost of logistics in food and other supply chains; and reductions in savings and investment. These are examined using IFPRI's global general equilibrium model linked to epidemiological and household models. The simulations suggest the global recession caused by COVID-19 will be much deeper than that of the 2008-2009 financial crisis. The increases in poverty are concentrated in South Asia and Sub-Saharan Africa with impacts harder in urban areas than in rural. The COVID-19-related lockdown measures explain most of the fall in output,
while declines in savings soften the adverse impacts on food consumption. Almost 150 million people are projected to fall into extreme poverty and food insecurity. Decomposition of the results shows that approaches assuming uniform income shocks would underestimate the impact by as much as one third, emphasizing the need for the more refined approach of this study.

JEL: C68, I18, I32, Q18.

Keywords: COVID-19; poverty; food security; dietary change; CGE analysis.

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1 Introduction

Global cases of COVID-19 worldwide have grown exponentially since February 2020, despite progress on managing this pandemic in some countries, with worldwide daily reported new cases rising from around 500 in late February to almost 600,000 by November, with the threat of further increases during the northern-hemisphere winter. The epicenter of the pandemic shifted from China to Europe and then to the United States and Latin America, with the disease resurgent in the northern autumn. COVID-19 is now also spreading rapidly in low- and middle-income countries in Africa and Asia, many of which lack robust health systems or strong social safety nets that can soften the pandemic's public health and economic impacts.

More than half of the world population has been, still is or is again under some form of social distancing regime designed to contain the health crisis. Business activity has fallen sharply because of a combination of policy action and personal responses designed to reduce risk of contracting the virus, with personal action probably more important than policy in reducing economic activity (Goolsbee & Syverson, 2020). The International Labour Organization estimates that during the first three quarters of 2020 the number of working hours worldwide declined by 17% relative to that in the last quarter of 2019; a drop equivalent to a loss of almost 500 million full-time jobs (ILO, 2020a). Governments in Europe, the U.S. and other high-income countries have taken unprecedented fiscal and monetary stimulus measures to compensate for the income losses of businesses and workers and contain an inevitable economic crisis. But the relief responses of low- and middle-income countries have been more limited.

COVID-19 poses a serious threat to global food security through various transmission mechanisms (Laborde et al., 2020). From what is currently known, the worst of these threats is the global economic recession causing many to lose income and leaving many vulnerable people unable to afford the food they need. Income declines not only reduce demand for food but also induce shifts in the mix of products consumed, notably resulting in less consumption of more nutrient-rich foods (like fruits, vegetables, and animal-sourced foods) and relatively more of calorie-rich foods (like basic grains and sugar). Other threats arise from disruptions in agricultural input markets, farm production, marketing and distribution of food caused by the need for social distancing to combat the global health crisis.

As COVID-19 and its economic fallout spread in the poorest parts of the world, more people have become poor and food insecure. While some context-specific estimates of the impacts of these shocks on poverty and food insecurity are available, it will be years before comprehensive and comparative survey-based information on these impacts become available. A key contribution of this paper is to assess these impacts using an integrated global modeling framework that includes national and household models. In a new scenario analysis, presented in this study, we estimate that globally, absent adequate responses in poorer nations, close to 150 million more people could fall into extreme poverty (measured against the PPP$1.90 poverty line) in 2020—an increase of 20% from pre-pandemic levels. This, in turn, would drive up food insecurity.

Assessing the poverty impact of COVID-19 is no trivial matter, however. This is so not only because the crisis is still unfolding and available information of its precise socio-economic consequences is incomplete, but also because the channels of influence are multiple and interconnected globally. While several analyses of the poverty impacts have used simple tools provided by the World Bank's PovcalNet website[1] and assumed uniform shifts in the distribution of income per country to provide estimates of the impacts on poverty, (see, for example, the studies by the World Bank in Mahler et al., 2020 and World Bank, 2020b; and that of UN-WIDER by Sumner et al., 2020), we are concerned that this assumption fails to account for the complexity of the channels of effect and may substantially underestimate the impacts of the pandemic. Our methodology allows to account for the disproportionate impact of the pandemic on the poor (Swinnen, 2020), something neglected in analyses using uniform shifts in all incomes. Results from a range of studies examining the impacts of COVID-19 on GDP and on poverty are presented in Appendix A.5. This shows that estimates of the severity of the impact increased dramatically after March 2020. The results of this study fall within the range of other estimates.

In this paper, we use information on the nature of the shocks to income, the structure of the global economy, and linked household models to provide more detailed estimates of the likely implications for income distribution, poverty and the food security of vulnerable families. The next section of the paper looks at the transmission channels from COVID-19 to poverty and food security. The third examines our modeling framework, including the MIRAGRODEP global CGE model and the POVANA framework. The fourth section presents the key assumptions of the COVID-19 scenario used in the analysis, while the fifth presents key results from the analysis and identifies the main transmission channels of the global macroeconomic and poverty impacts. A sixth section provides an update of the reference scenario to illustrate the sensitivity of the results to changes in

[1] http://iresearch.worldbank.org/PovcalNet/ .

key assumptions and to validate those assumptions against the most recent available evidence about observed impacts of the pandemic. The final section concludes.

2 Transmission channels of COVID-19's impact on poverty, food security and nutrition

COVID-19 has smaller direct impacts on agricultural production than many other pandemics. The 1918 "Spanish Flu" pandemic, for example, caused substantial losses in farm output because of high morbidity and mortality among working-age males (Schultz, 1964). Some other pandemics, such as Swine flu and Avian flu have directly reduced agricultural production. By contrast, COVID-19 involves a relatively short period of sickness for most of its victims, has its highest mortality rates among older people, many of whom have left the formal workforce; and does not directly affect crops or livestock. However, it does have substantial impacts on agriculture and food security, generally through less direct channels of influence. Therefore, it is useful to begin the discussion by laying out the channels through which COVID-19 affects food markets and food security. We then turn to the modeling framework that we use to evaluate these impacts.

The main channels of effect between the COVID-19 pandemic and food security are:

a. income losses and demand shocks;
b. food supply chain disruptions;
c. consumer responses, such as hoarding, food waste and dietary shifts;
d. policy responses, such as hoarding at country level (food export bans); lockdowns, and fiscal stimulus.

Income losses play an important role in reducing food security during the COVID-19 pandemic. We know from the work of Amartya Sen (1981) that food insecurity and even famines frequently are not associated with physical shortages of food. What matters more is people's ability to access food. Some of the current income declines are direct consequences of the disease, such as working time lost due to the disease; while others are policy responses designed to reduce the rate of disease transmission. It appears that the most important are individual responses as people try to avoid situations where they are likely to catch (or transmit) the disease (Goolsbee & Syverson, 2020). Because individuals consider primarily their own risk of infection, some degree of coordinated distancing is appropriate to reduce the externalities imposed on others and particularly the loss of life associated with the pandemic. These social distancing policies range from simple measures such as encouraging wearing of masks and frequent hand washing, through more intrusive policies such as restricting activities with high transmission risk, to strict lockdown requirements.

The income losses resulting from these actions are primarily outside the food system as food-related activities have generally been designated "essential" activities exempt from being locked down, except for some restaurants and other food-away from home outlets. Hence, most of the direct income losses are outside the agri-food system. Unskilled workers in non-essential activities are at greatest risk of falling into unemployment because they generally do not have the telecommuting options that have greatly reduced the impact of this pandemic on overall economic activity and employment.

Food supply chain disruptions caused by COVID-19 are also affecting food security. Staple food production in high-income countries has been relatively little affected, while labor intensive activities in some markets and processing activities have been strongly affected by disease outbreaks. Another key point of breakdown has been in processing of some agricultural products—and particularly production of meat—where low temperatures and proximity of workers can result in very high rates of disease transmission. Other disruptions to food supply chains have come from restriction on the movement of workers, the dramatic reduction in international air travel; and slowdowns in the administrative approvals for food trade. At the consumer end, restaurant services have been particularly hard hit both by lockdown policies and by consumer risk aversion.

Most *consumer responses* have been consequences of the COVID shocks, but some have injected additional volatility into the system. Uncertainty about the impact of the pandemic on availability of some foods has added volatility to food demand as consumers have sought to stockpile food items, such as meat and dairy products. Another early feature of adjustment to the pandemic was increased food loss as suppliers struggled to adjust their product mix in response to shifts in final sales away from food services to consumption at home. A third feature of adjustment appears to have been a run down in financial assets as affected households seek to reduce the impact of income losses on their access to food. In one carefully studied case, Abate et al. (2020) found that only a small fraction of Ethiopian households appear to have enough savings to cover more than a month's food needs. The same study tracking households during the COVID-19 outbreak, also finds that income losses and food price changes appear to have changed demand for food, with declines in consumption of nutrient-rich products like legumes, vegetables and dairy.

Policy responses to the pandemic also play a major role in the outcome. While economies would likely have had substantial reductions in economic activity as people sought to avoid catching (and/or transmitting) the disease, lockdown policies appear to have increased the adverse short-run impact on output, while—where properly implemented— reducing the rate of transmission and potentially allowing a swifter recovery. In some cases, this has had a high payoff, by sharply reducing the impact of the disease while, in other cases, such as the United States, the opportunity to reduce the incidence of the disease to low levels in the first round was missed. Even where containment policies were initially successful, frequent resurgences of the disease suggest that the economic impacts are likely to last until effective treatments and/or vaccines are widely available.

Fiscal and monetary stimulus appears to have had a substantial impact on output levels in many of the higher-income countries, with initial fiscal stimulus of around 11% of GDP in the United States and substantial stimulus packages in many other high-income countries.[2] While fiscal stimulus packages have been announced in many developing countries, these generally appear to be much smaller as a share of GDP than those in the higher-income countries. Expansion of social protection programs has been an important element in the response with 212 countries, mostly in the developing world, introducing almost 1,200 measures by September 2020.[3] About half the social assistance measures were cash based, with most being short term in duration. In developing countries, the size and duration of such responses seems to be highly variable. As little is known so far about the precise allocation of those resources across households, we do not account for the social protection measures taken by developing countries in the scenario analysis presented below. Our focus is rather on assessing the direct impact of the crisis on poverty in the absence of such social protection measures.

Many countries implemented restrictions on food exports early in the crisis designed to avoid increases in domestic food prices (Martin & Glauber, 2020). Fortunately, however, these restrictions did not set off an upward price spiral of the type seen in 2007-2008 (Anderson et al., 2014). While 22 countries had announced or imposed food export restrictions, affecting around five percent of calories embedded in traded food, early in the crisis, all but one had been eliminated by the end of September.[4]

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[2] See https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#I

[3] See the World Bank's "living paper" at https://tinyurl.com/yd4g4z45

[4] Up-to-date counts are available at IFPRI's food trade policy tracker.

3 The Modeling Framework

We use a global modelling framework to assess the potential impacts of the COVID-19 crisis on global poverty and food security. Specifically, we combine two economic modeling frameworks: IFPRI's global computable general equilibrium (CGE) model, MIRAGRODEP,[5] and the POVANA household dataset and model. This framework has been used previously to study the impact of a macroeconomic slowdown on global poverty in Laborde and Martin (2018). The main differences between the current work and the previous study are twofold. First, the Laborde-Martin study looks at a change in economic growth projections for 2015 to 2030 and compared poverty outcomes in 2030, using the dynamic version of the CGE and projecting household surveys until 2030.

In the current exercise, we focus on single-year (2020) scenario results under a range of assumptions about short-term impacts of COVID-19, as explained further below. Second, in Laborde and Martin (2018) alternative IMF projections for global growth are regenerated by imposing commensurate changes in total factor productivity on the corresponding MIRAGRODEP parameter values. In contrast, in the current exercise, the factors underlying the socio-economic impacts of COVID-19, such as health impacts, social distancing, restrictions on (labor) mobility, international transport, and the closure of some business activities are translated into MIRAGRODEP's model terms to simulate endogenously the impacts on economic growth, incomes, employment, consumption, prices, trade, and, ultimately, poverty.

The two modeling frameworks are linked in top-down fashion; that is, the relevant results of the CGE model-based scenario analysis are introduced, along with the direct impacts of the pandemic on households, as shocks to the household survey model to assess poverty outcomes. In addition, the health impacts of the disease on labor supply and productivity are linked to outcomes from epidemiological models. This process is summarized in Figure 1.

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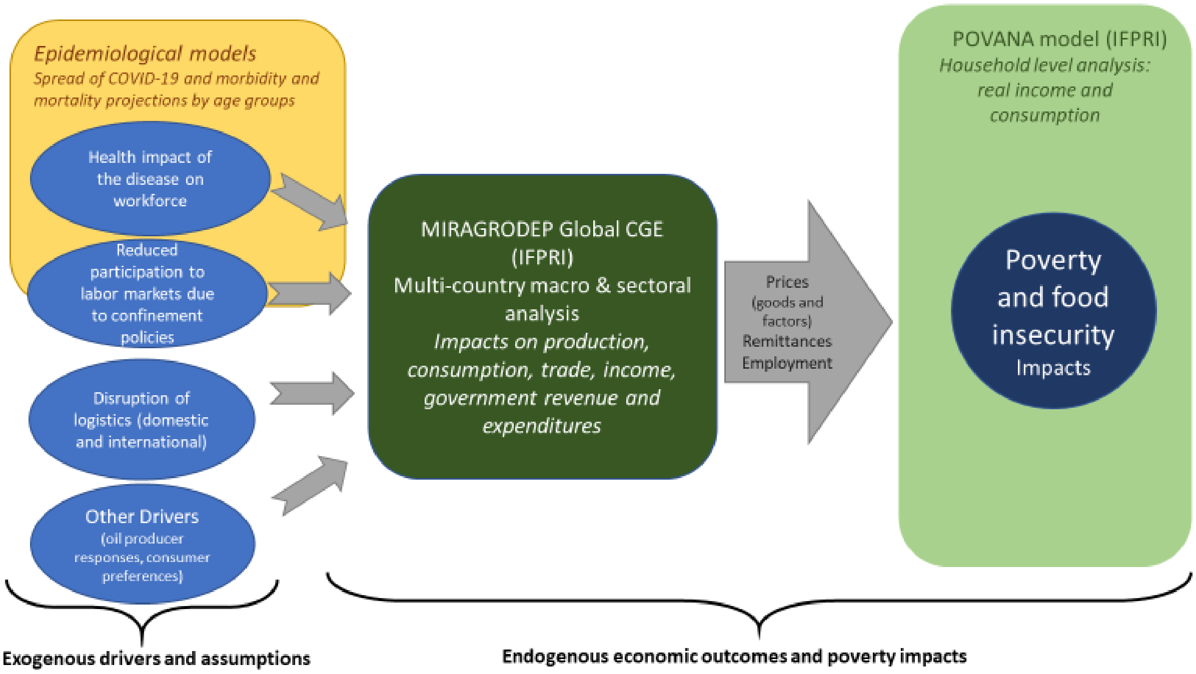
[5] Modelling International Relations under Applied General Equilibrium model enhanced for the AGRODEP modeling consortium (http://www.agrodep.org/models/library).

Figure 1 Implementation of the Covid-19 scenarios



Source: Authors' depiction.

The main technical features of the MIRAGRODEP and POVANA models and their linkages are summarized in Appendix A.1. For the present analysis, we assume in the MIRAGRODEP model that unskilled workers are harder hit than skilled workers by social distancing measures, as skilled workers are more likely able to continue work from home. We assume further that producers have very little ability to change the capital-labor utilization ratio within a single year. Governments in high-income countries are assumed to have put in place economic stimulus measures (see below under scenario assumptions), while—for the present analysis—those of poorer countries are assumed to have limited ability to borrow to provide such substantial stimulus, and so maintain the public deficit/surplus to GDP constant.

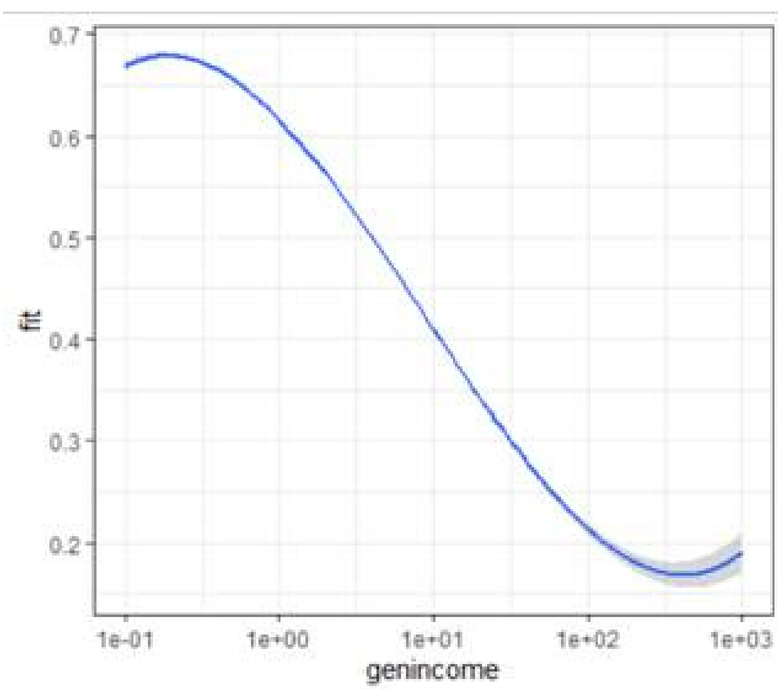
The POVANA household model uses data on the full income distribution for around 300,000 households.[6] Having this detail avoids having to make ex-ante or ad-hoc assumptions about how the economic shocks caused by COVID-19 change the distribution of income in any given country. In our approach, real incomes of households change endogenously with the simulated changes in the full vector of changes in employment, and changes in prices of goods, services, and factors

[6] See Appendix A.2 for the coverage of the household survey data used for the present analysis.

(including wages), and other income determinants (productivity). Changes in poverty levels are calculated by comparing the poverty rates before and after the changes in household incomes.

Finally, the POVANA data base provides information about household consumption patterns. This also allows to identify the impacts of economic shocks (like the consequences of COVID-19) on the costs of goods consumed by the household, and particularly on the costs of food consumed. Income losses and food price shocks will disproportionately hurt poor people's food security, since they spend most of their income on food: as much as 70%. Rich people spend only a small share—perhaps around 15%—of their incomes on food (Figure 2). The most immediate threat of COVID-19 to food security arises from reductions in the incomes of poor and vulnerable people. Some of these losses arise from income losses in agriculture, but a much larger share of these income losses arises from disruption to non-agricultural income sources.

Figure 2 Engel's Law: Declining food expenditure shares with rising incomes



Source: POVANA database. Authors' computation.
Note: The blue line represents estimated share of food consumption in total expenditures estimated through a polynomial of degree 3 on the log of individual income household, normalized by their own country's poverty line.

4 The COVID-19 scenario

We model a range of impacts of the COVID-19 pandemic. Beyond the direct effects of the disease on the ability to work, income losses arise from people's desire to avoid catching the disease and their altruistic concerns to avoid infecting other people, and from policy responses designed to reduce the adverse externalities associated with an unmitigated pandemic. No global economy-wide model incorporating these features is available to fully assess these potential impacts and behavioral changes. Many of the changes in behavior and in the functioning of economies are not yet fully understood and their impacts on economic activity were still not fully known when preparing this scenario analysis. It is also difficult to rely on experience from past events, since no events like the COVID-19 pandemic have occurred on this scale in today's globalized world. Therefore, we have had to make several assumptions about the responses of economic agents to this unprecedented situation.

In crafting the scenarios used here, we have based our choices on earlier work, such as the analysis we undertook in March 2020,[7] when we looked at the differential impacts on productivity and trade costs for a 1% global economic slowdown during 2020. Before looking at the specific scenario assumptions, it is important to keep in mind that the model operates on an annual timestep and the impacts of any shock are calculated as the average impact for the year. Therefore, a disruption lasting 10 days is associated with a 10/365 impact and a price shock, e.g. such as the decline in oil prices, must be calibrated on the shift in annual average prices and not on the "peak" value.

We distinguish four drivers of COVID-19 impacts: domestic supply disruptions, global market disruptions, household behavioral responses and policy responses.

a. Domestic supply disruptions

Disruptions in labor markets

We consider two broad impacts on labor markets. The first is the direct impacts of mortality and morbidity on labor supply. The second is the impacts on labor supply of social distancing actions undertaken to reduce transmission of the disease. The first impact is the relatively small direct impact of the disease on labor supply due to sickness and death. For our reference scenario, we use

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[7] https://www.ifpri.org/spotlight/ifpri-resources-and-analyses-covid-19-also-known-coronavirus

estimates provided by Imperial College London for each country (Walker et al. 2020).[8] Specifically, we use the "Social distancing of the whole population" scenario for all countries. Since their online materials do not provide results by age cohorts, we re-estimated those, following a procedure explained in Appendix A.3. We note that this direct effect is generally quite small due compared to the next type of disruption.

Social distancing results in some willing workers become unable to sell their labor. In our reference scenario, we use the "social-distancing" parameter from the Imperial College estimates as a base value, and assume that 12 weeks of confinement is imposed in each country, except in African countries, for which we limit it to 8 weeks, due to the more limited ability of poor populations to manage long periods of economic disruption; lower population densities than in South Asian countries; the younger average age of people in the region and the consequent more relaxed implementation of confinement policies. These assumptions result in reductions in labor supply of 23% in most countries or 15% in Africa. We consider that 1/3 of skilled workers impacted by social distancing can continue working through telecommuting. This crude estimate is based on the ILO's early review of the impact of COVID-19 on jobs of April 2020 (ILO 2020b) and Dingel and Neiman (2020)[9].

Disruptions in specific value chains

While agriculture and food sectors have been identified as essential in most countries, we also assume some supply disruption caused by reduced labor mobility (e.g., for seasonal migrant labor) and further, that perishable farm products suffer greater post-harvest losses due to logistics problems and demand fallout. An increase in post-harvest losses of perishable products (fruits, vegetables, meat and dairy) of 5 percentage points is included. While this estimate is conjectural, anecdotal evidence suggests that losses have been substantial in some cases and minimal in others making an average loss of 5% seem a reasonable guesstimate for the present purpose of analysis

Total factor productivity in transportation is assumed to decline by 5% to capture losses of logistical efficiency. This number is extrapolated based on anecdotal evidence ranging from monitoring of

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[8] In the updated scenario (discussed in section 6) we use alternative projections for the spread of COVID-19 of the epidemiological model of the London School of Hygiene and Tropical Medicine, LSHTM (Pearson et al., 2020).

[9] See Appendix A.3 for the procedure for deriving this estimate.

GPS tracking devices on truck fleets in the United States (see the work of ATRI)[10] and from recent surveys conducted in West Africa.[11] While crude, this estimate provides at least a reasoned estimate of the extent of disruption to transportation sectors, especially in developing countries.

Because both autonomous social distancing (driven by fear of catching the disease) and lockdown policies designed to reduce externalities tend to reduce activity in high-contact services such as restaurants, travel, bars and gyms, we introduce a "shadow tax"[12] of 25% for both final and intermediate consumption of these services. This reduces the demand for these services, *ceteris paribus,* by about one-third on average.

b. Global market disruptions

To capture the effects of the "oil war" between Saudi Arabia and Russia in late 2019 and early 2020 but pre-dating COVID-19, we introduce an exogenous expansion of the supply of oil. The combined effect of this larger supply of oil and the lower demand caused by the COVID-19 crisis induces a drop in global real energy prices by 25% for crude oil and natural gas and 17% for refined oil and gas products.[13]

The containment measures cause bottlenecks and delays in international freight and transport. In terms of the model parameters, this assumption has been translated into an increase in the average cost of international freight by 3%, not considering any feedback on energy prices. We calibrate these numbers to capture the increased time required to trade, because of logistical delays in harbors and at airports caused by new regulations, lack of inspectors, and other frictions associated with the pandemic. These lost days are converted into ad-valorem equivalents using a procedure developed by Hummels and Schaur (2013).

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[10] American Transportation Research Institute; see for instance https://tinyurl.com/yxkr92g6

[11] Reuters, 'West African food trade under strain as COVID-19 shuts borders', May 27, 2020. https://tinyurl.com/yxzjt9fm

[12] We use a shadow tax instead of a preference shifter in the model to avoid changing the utility function which would compromise the welfare analysis.

[13] For comparison, oil prices for WTI Crude contracts declined by 33% between June 2019 and June 2020 (from US$53 to US$35 per barrel) and by 35% between the start of 2020 and November 10 of the same year (from US$62 to US$40), after showing a steep decline between January and the end of April and a slow recovery since. Since the model combines natural gas and crude oil into one variable, the simulated decline in global energy prices is somewhat lower than the observed 35%, given that the impact of the supply and demand shifts on the price of natural gas has been smaller than that on oil.

c. Household and business responses

We assume that private sector agents and businesses reduce their savings as a coping mechanism to compensate for the adverse impact of the pandemic on current incomes. In the global CGE model, the savings reduction is defined for each country/region subject to two constraints: first, to the extent they can, private sector agents try to limit their welfare loss to 5% of initial income, but, second, they cannot cut their savings rates by more than 6% of initial income and cannot let their savings become negative. These boundaries were chosen based on changes in gross saving rates observed in previous crises. For instance, in the United States, between 2006 and 2009, the gross savings rate fell from 18.0% to 15.1%, while the world average declined from 26.6% to 24.1%[14].

It should be noted that MIRAGRODEP cannot fully capture the differences in savings behavior across economic agents. Typically, in contrast to the above, household savings tend to increase during recessions, which Keynes characterized as the 'paradox of thrift' (Keynes, 1936). While poor households may be unable to save and may even need to dispose of assets to survive, more affluent households try to save more in uncertain times, reducing consumption and thereby deepening the recession. In the U.S., for instance, COVID-19 substantially limited consumption spending, leading the personal savings rate (as a share of disposable income) to increase from around 7% in early 2020 to 32% in April to taper off to 23% in May of the same year.[15] Overall savings appear to be down, however, with the fall in corporate savings being larger than the increase in household savings, as happened during the Great Recession of 2008-2009,[16] and, as a result, investment decline as well. In MIRAGRODEP, the corporate sector is included with the household sector, so we assume that the expected impact of COVID-19 on corporate savings predominates the aggregate impact, with overall savings declining.

The composition of food demand will also change during the recession. Households are expected to reduce demand for fresh products (such as fruits, vegetables, meats, and fish). This food demand shift is endogenous to income and price shifts in the model. The simulated impacts shown further below could underestimate the true effects, since we do not account for changes in consumer perceptions. Some recent survey-based evidence suggests that consumers perceive fresh products as

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[14] World Bank, World Development Indicators, https://databank.worldbank.org/reports.aspx?source=world-development-indicators#, accessed 24 July 2020.

[15] https://fred.stlouisfed.org/series/PSAVERT

[16] https://fred.stlouisfed.org/series/B057RC1Q027SBEA

less safe in association with COVID-19, as apparent in the study by Tamru et al. (2020) for Ethiopia. In Europe and the United States, such perceptions plus awareness that better nourishment makes people less vulnerable to the virus, have led to shifts in food demand from animal-sourced towards plant-based food products.[17] However, the evidence is too scarce as yet to be able to make proper assumptions about such shifts in consumer preferences and hence they are not accounted for in the scenario analysis.

d. Policy responses

Due to their limited actual role, we did not include specific export restriction measures regarding food products (see section 2 and the IFPRI Food Trade Policy Tracker). The present scenario does account for the substantial economic stimulus packages being implemented by most high-income countries, including significant income transfers to households. For the OECD countries, except Mexico, Chile, Israel, and Turkey, we assume a stimulus package of, on average, 3.2% of GDP. The fiscal stimulus is introduced in the form of higher net income transfers (or lower income taxes) from the government to the representative household.

Because of the paucity of information about stimulus packages in the rest of the world, and a concern that some of what is reported may be an exaggeration of the extent of new stimulus provided, we have omitted the impacts of fiscal stimulus in the rest of the world. We are thus measuring the unmitigated impact of the shock in order to help calibrate policy responses, rather than an assessment of the consequences after mitigation policies have been implemented.

5 Scenario results

Global macroeconomic impacts

Under the given assumptions, we conclude that COVID-19 will result in a severe global recession with global GDP falling by 5%[18] in 2020. This COVID-19 recession looks likely to be much deeper than that seen during the global financial crisis of 2008-2009. The economic fallout in the initial

[17] https://tinyurl.com/y4w97xee

[18] This decline is relative to 2019 levels. Relative to the 2020 baseline (counterfactual without the COVID-19 shock) this implies a 7% decline in global GDP. Only in Table 1 we present the macroeconomic impacts relative to the previous year (for ease of comparison with other estimates and projections). All other simulation results are with respect to the 2020 baseline (counterfactual without the COVID shock).

epicenters of the pandemic (China, Europe and the United States) is also severely hurting net commodity-exporting developing countries through declines in trade and other commodity prices, restrictions on international travel and freight, compounding the economic costs of poorer nations' own COVID-19 related restrictions on movements of people and economic activity. We consider first the macroeconomic impacts and then the effects on poverty.

For developing countries as a group, we project the economic fallout to lead to a decline of aggregate GDP of 3.6% relative to 2019, but economies in Central Asia, Africa, Southeast Asia and Latin America would be hit much harder due to their relatively high dependence on remittances, trade and/or primary commodity exports. The recession is expected to be less severe in China and the rest of East Asia, where – with the present scenario assumptions – we expect the economic recovery to start sooner with the earlier lifting of containment measures.

Table 1 Macroeconomic impacts of MIRAGRODEP-COVID 19 scenario (April 2020) by country and country group, 2020

(*(Percentage change from previous year)*

	Real household consumption	***Real GDP***	***Agri-food GDP***	***Exports***	***Agri-food Exports***
World	-1.0	-5.1	-1.8	-17.9	-24.8
Developed Countries	-0.2	-6.2	-3.1	-19.3	-20.3
United States and Canada	2.0	-5.8	-4.7	-21.5	-29.8
EU	-3.4	-7.6	-2.8	-40.5	-27.5
Developing Countries	-2.5	-3.6	+0.1	-16.0	-30.5
Africa South of Sahara	-3.2	-8.9	3.9	-31.2	-20.7
North Africa & Middle East	-4.0	-6.4	1.1	-28.6	-34.6
Asia (ex. Central Asia)	-3.9	-4.6	-1.4	-23.3	-31.0
East Asia					
China	-4.2	-4.5	-1.7	-21.8	-29.2
South Asia	-3.7	-5.0	-2.0	-22.9	-30.7
India	-3.9	-5.9	-2.2	-21.8	-30.8
South-East Asia	-4.2	-7.0	-2.8	-23.9	-31.9
Central Asia	-4.1	-9.9	2.0	-21.6	-8.3
Latin America & Caribbean	-4.4	-5.9	-3.9	-27.5	-28.5
Central America	-6.2	-8.7	-5.7	-20.2	-30.7
Rest of LAC	-4.4	-5.7	-3.9	-27.5	-28.2

Source: MIRAGRODEP Simulation Note: Regions in bold aggregated results computed post simulations, weighted by the relevant country level variable. Details for rich countries are omitted. Real consumption is limited to household private consumption and defined as the equivalent variation (welfare) Note: Regions in bold aggregated results computed post simulations, weighted by the relevant country level variable. Real household consumption is measured as the "equivalent variation" of welfare. Real GDP is computed following national accounting principles. Fisher price indices between base prices and simulation prices are used. Exports of goods and services are measured FOB at constant international dollars but final export prices.

We expect harsh economy-wide impacts in sub-Saharan Africa with GDP falling on average by almost 9% from the previous year, although agri-food sectors may be spared and could even expand, as the collapse in export earnings and remittance incomes,[19] with domestic production rising in light of reduced ability to import food push. Lower labor demand in urban service sectors may push workers to return to agriculture, also contributing to greater domestic food production. With more workers in the sector, however, individual incomes would remain low.

Poverty impacts

Without social and economic mitigation measures such as fiscal stimulus and expansion of social safety nets in the global South (scenario assumption), the impact on extreme poverty (measured against the PPP$1.90 per person per day international poverty line) is devastating as shown in Figure 3. The number of poor increases by 20% (almost 150 million people) with respect to the situation in the absence of COVID-19, affecting urban and rural populations in Africa south of the Sahara the most, as 80 million more people join the ranks of the poor, a 23% increase. The poverty increase in rural areas is expected to be smaller than that in urban areas, partly because of the lower rate of transmission of the disease and partly because of the robustness of demand and supply for food relative to many other, more vulnerable sectors. Accordingly, we estimate that, in Sub-Saharan Africa, the number of poor people could increase by 15% in rural areas, but as much as by 44% in urban areas. In this scenario, the number of poor people in South Asia is projected to increase by 15% or 42 million people.

In both cases, the impacts on rural populations are smaller because the direct impact of COVID-19 on agriculture is less severe than on other sectors. As these estimates refer to the numbers of extremely poor people, i.e., those who typically lack the means to buy enough food, we expect a commensurate rise in the number of food-insecure people. The ability to distinguish the reduced sensitivity of rural households to COVID-19 is an important advantage of the more complex framework used in this study. Applying uniform income declines to the initial distribution of income will almost always result in larger poverty increases for rural people because their initial incomes are so much lower than those of urban residents in developing countries.

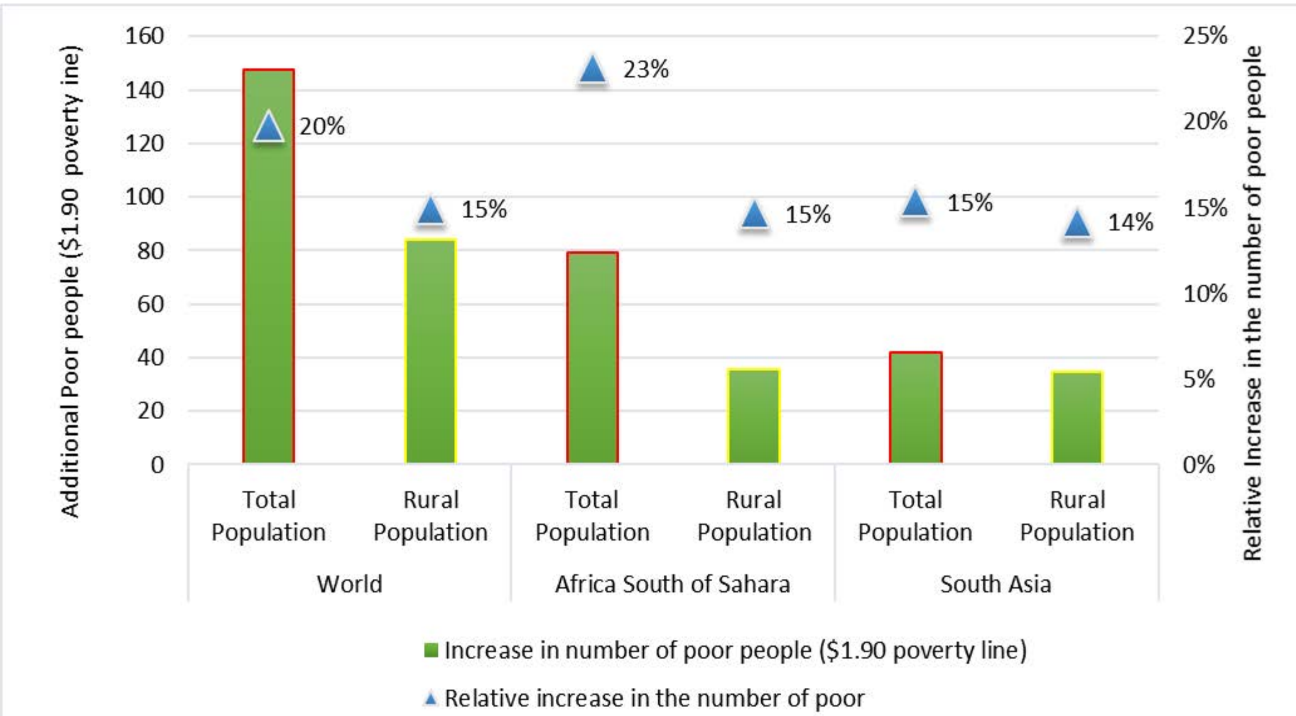
The estimated income declines due to COVID-19 are much larger than seen in many earlier studies such as in Vos et al. (2020), Mahler et al. (2020), and World Bank (2020a) and in most of the

[19] Remittance incomes make up more than 10% of gross foreign exchange earnings in sub-Saharan Africa. In the model, we assume the region's earnings from remittances drop by 8%. Recent projections project a decline of 9% for 2020 (World Bank 2020c).

scenarios considered in McKibbin and Fernando (2020). However, they are substantially below the (uniform) income declines of 20% considered as an upper bound in Sumner et al. (2020). The estimates in this study fall within the range of studies surveyed in Appendix Table A.5.

Figure 3. Global and Regional Poverty Impacts of MIRAGRODEP-COVID 19 scenario (April 2020) by selected regions

(Absolute and percentage change from 2020 baseline values)



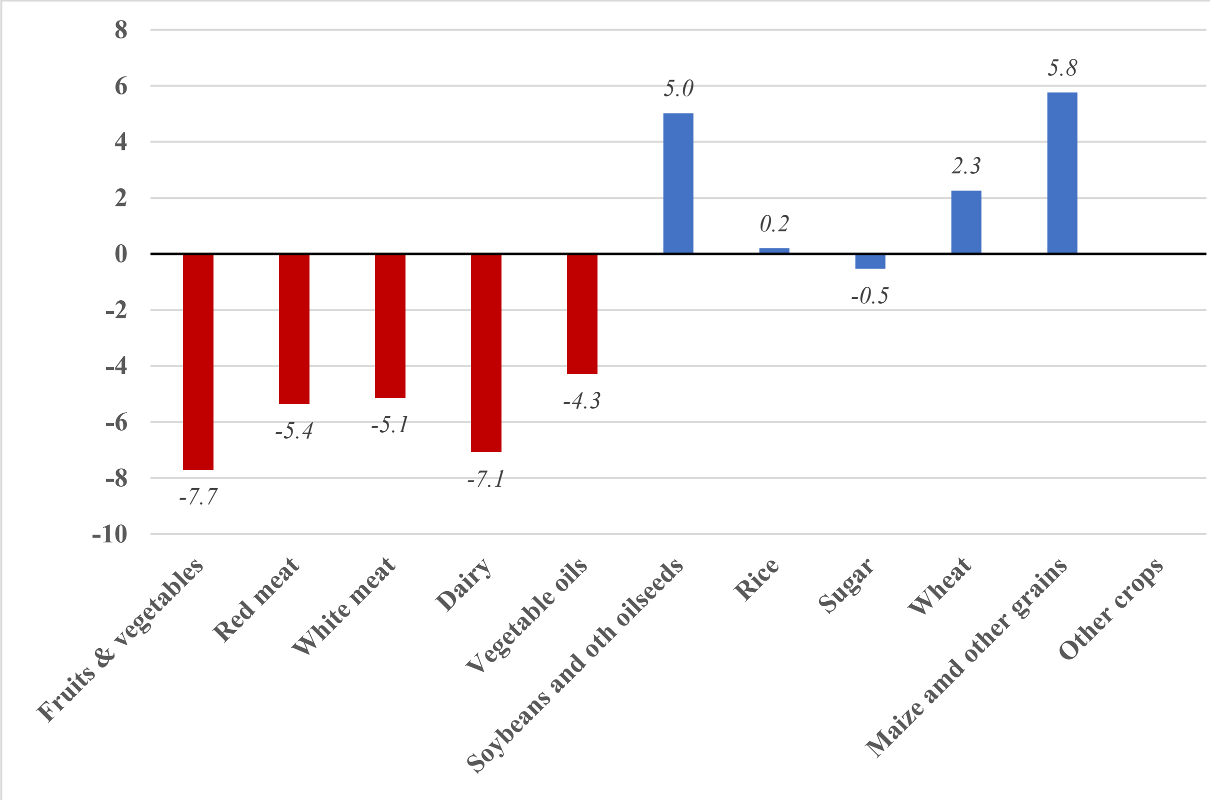
Source: MIRAGRODEP and POVANA Simulations

Changes in diets and impacts on nutrition

The income and price changes associated with the pandemic are likely to result in some quite substantial changes in patterns of food consumption, with adverse nutritional consequences. The declines in income and supply disruptions are likely to cause quite substantial shifts in demand away from nutrient-dense foods such as fruits and vegetables, dairy products and meats, and towards basic staple foods such, as rice, maize and other basic grains. Figure 4 confirms this as a global pattern. The dietary shift is (on average) similar in both developed and developing regions. The changes in consumption can be considerably sharper at the country level as shown in Figure A.4.

Figure 4 COVID-19 impacts on diets (average effect for world)

(Percentage change in average global household consumption by product)



Source: MIRAGRODEP Simulation (April 2020 scenario)

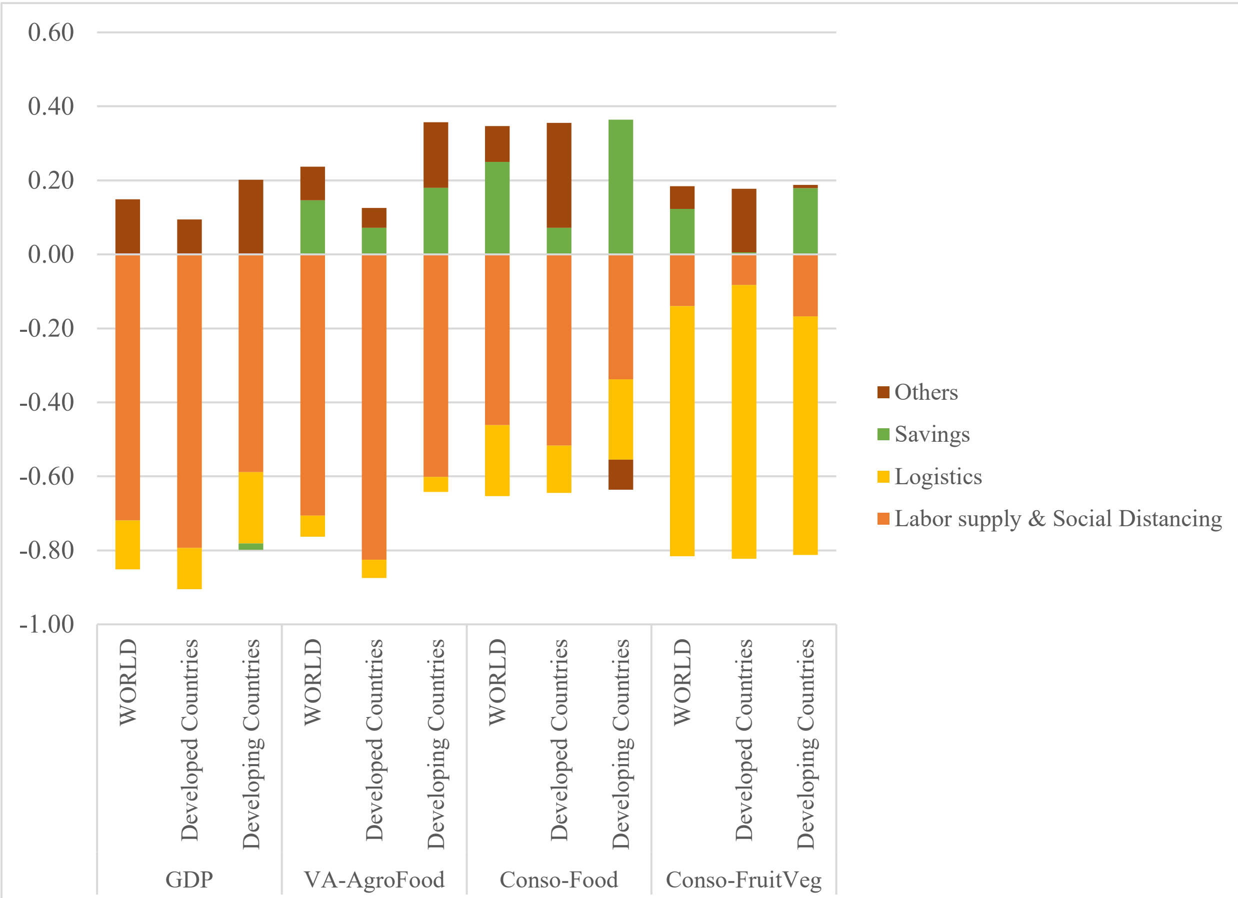
Note: Global average based on weighted changes at the estimated at the country or regional levels. Weights are based on base value of consumption, while changes are computed on the evolution of the volume of consumption for each national representative household.

Decomposition of impacts by main drivers

Given the multiple shocks used for these simulations, it is useful to understand which shocks influence the simulated outcomes the most. Not only does this provide insights into the driving forces behind both the macroeconomic and poverty outcomes, but also it allows a comparison of our approach relative to the much simpler approach of simply reducing consumption uniformly in line with the decline in GDP at constant prices used by Sumner et al. (2020), Mahler et al. (2020) and World Bank (2020b). The decomposition was done by deleting one shock at a time from the full simulation and assessing the impact of that shock. Adding up these effects provides a good estimate of the total impact and allows a decomposition of the total effect into its sources.

Figure 5. Decomposition of the simulated macroeconomic impacts by main transmission channel

(Shares of total impact)



Source: MIRAGRODEP simulations results (April 2020 scenario).

Note: Each bar in the graph represents 100% of the change in each variable in the COVID-19 scenario and shows for each driver its positive or negative contribution (in percentage shares) to the overall change.

The first three bars in Figure 5 show that the dominant influence on the loss of aggregate GDP due to the pandemic is the reductions in labor supply, both from individual health-related responses and from social-distancing policies. Disruptions in logistics and the savings adjustment play small to negligible roles in the declines in GDP. The second group of bars shows the decomposition for the impacts on agri-food sector GDP. Again, reductions in supply are primarily driven by reductions in labor availability, although these are less important than for the whole economy because a large share of agricultural value added is treated as essential. The savings adjustment mitigates the impact on food consumption and hence also on agri-food production.

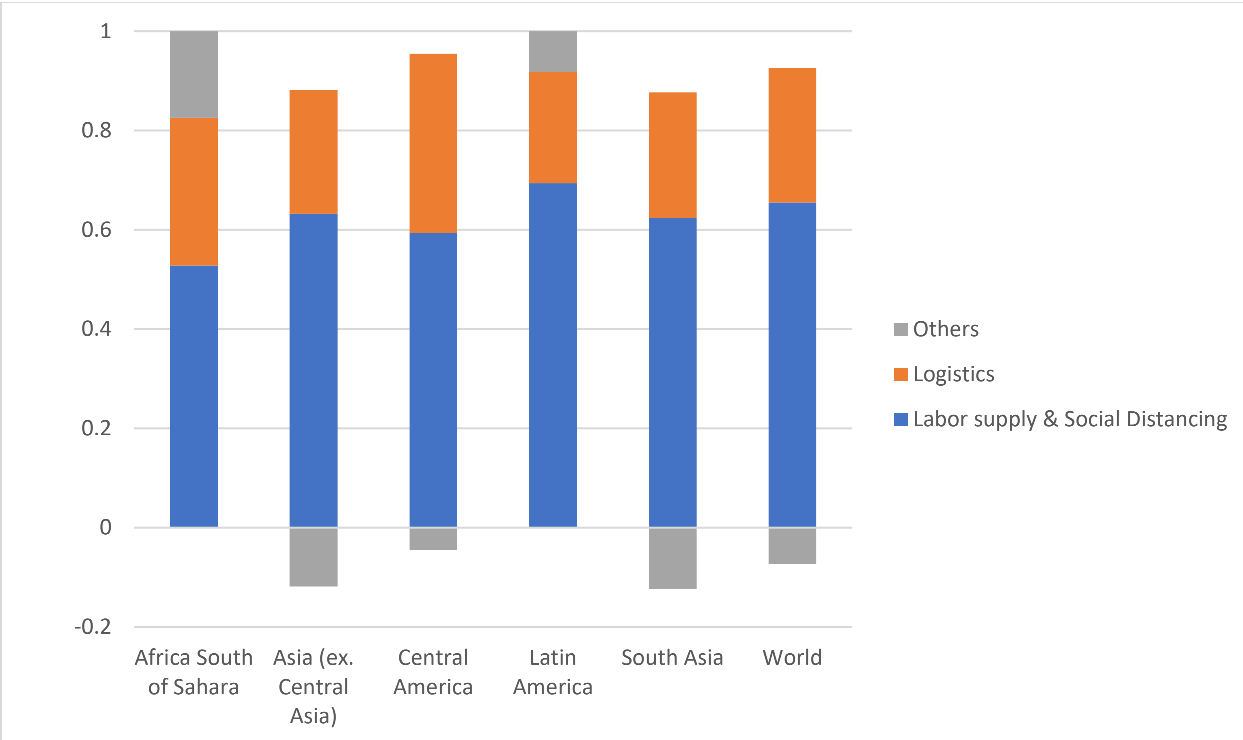
Income losses owing to the pandemic's direct impact on people's ability to work and that of the social distancing measures also explain most of the reduction in total food consumption, compounded by supply disruptions raising the logistical costs embedded in food prices. The savings adjustment is a mitigating factor. The increases in logistical costs affect demand for fruits and vegetables most strongly, outweighing income losses through social distancing; most notably in developing countries.

Figure 5 further shows that the adjustment rule regarding private savings mitigates the macroeconomic impact of the recession on overall household consumption.[20] The mitigating effect on consumption is generally stronger in developed than in developing countries whose, on average, much poorer economic actors have less capacity to absorb the shock by drawing on own savings. These results show that different shocks have different impacts on the different outcomes, with the direct reductions in labor having the largest impacts on GDP, while reductions in saving have important impacts on consumption, and increases in the cost of logistics in food supply chains having the greatest impact on consumption of fruits and vegetables.

Figure 6 provides a decomposition for the total poverty impacts parallel to that for the macroeconomic impacts presented in Figure 5. Not surprisingly, it shows that the reductions in employment and in labor supply and social distancing have the largest impacts on poverty. Logistical costs have the second largest impacts, while other influences, such as oil price changes and changes in savings and investment reduce the total increase in poverty in several regions.

[20] It is important to point out that the impact on consumption is softened further in the model estimations because GDP is measured in real terms through a Fisher index, while the impact on consumption is measured through a welfare metric (equivalent variation) typically used in CGE models.

Figure 6. Simulated changes in extreme poverty by cause (shares of total impact)



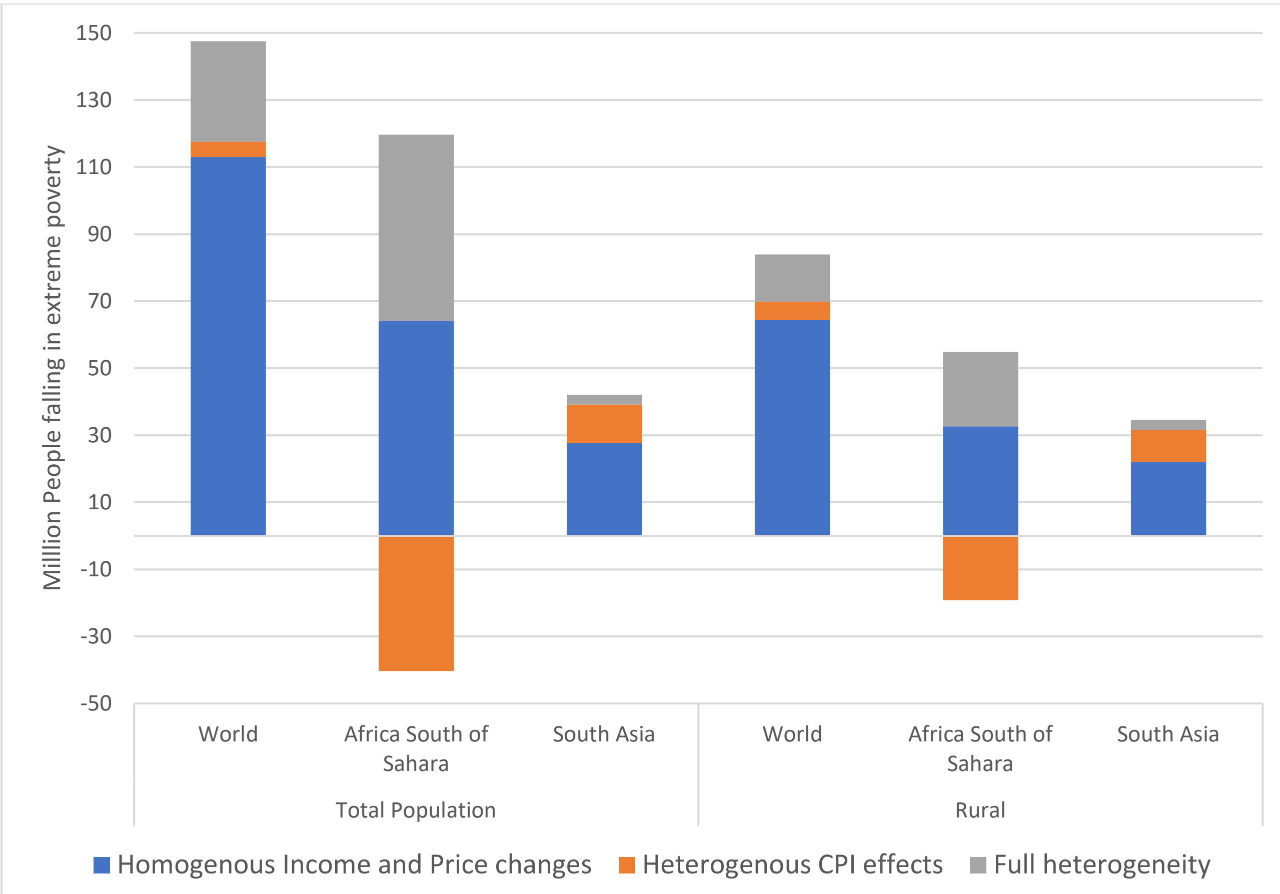
Source: MIRAGRODEP simulations results (April 2020 scenario).

Note: Each bar in the graph represents 100% of the change in each variable in the COVID-19 scenario and shows for each driver its positive or negative contribution (in percentage shares) to the overall change.

To illustrate the difference between our approach and other studies assessing the poverty impact of the pandemic, we decompose in Figure 7 the change in the poverty rate into three components. The first, shown in the blue bar, is the impacts of average changes in incomes and in the cost of living on household real incomes. The second incorporates the non-neutral impacts of the COVID-19 shocks on the cost of living to each household and the consequent impact on household incomes. The third considers, in addition, the non-neutral impact of the shocks on households' individual incomes. It takes into account, for instance, the fact that many workers supplying unskilled labor—which is assumed to be the situation of the poorest—are unable to work remotely, and hence generally suffer greater income losses than higher-income workers, both through the quantity of labor they can supply and the wage rates they receive.

It is clear from Figure 7 that the traditional estimate of the poverty impact of the pandemic—the observed changes in real incomes resulting from changes in average nominal incomes and consumer costs— explain most of the changes in poverty. At the global level, these uniform changes explain just over 110 million of the nearly 150 million increase in poverty. In sub-Saharan Africa, both the uniform income effect and the differential impact on the incomes of the poor raise poverty, but this is substantially offset by many poor people being lifted out of poverty by declines in their idiosyncratic costs of living. This benefit, likely largely driven by declines in farm prices, explains why the increase in poverty observed in Figure 3 is so much smaller in Africa than in South Asia. The pattern for changes in rural poverty follows closely that observed for overall poverty.

Figure 7. Decomposing the simulated changes in extreme poverty owing to COVID-19 by average income and distributional shock (shares of total impact)



Source: MIRAGRODEP simulations results (April 2020 scenario). Note: Each bar in the graph represents 100% of the change in each variable in the COVID-19 scenario and shows for each driver its positive or negative contribution (in percentage shares) to the overall change.

6 A scenario update

In previous sections, we discussed at length the analytical framework used to assess the macroeconomic and poverty impacts of the COVID-19 crisis and described the contributions of the different drivers to the outcomes for poverty and food insecurity. That reference scenario was elaborated in April 2020, based on our observations and interpretations of the world economy, the health crisis and the mitigation options taken up to that point in time. Although our basic methodology has not changed, new information available by the final quarter of 2020 about COVID-19 effects on social distancing, labor supply, and policy responses differs in a number of respects from used the underpin the assumption of the original reference scenario.

To illustrate the changes in information and approach over that time, we provide an updated scenario, based on new information available for the period up to September 2020, using updated assumptions as summarized in Table 2. For health effects, we shifted from the estimates in the epidemiological model of Imperial College (Walker et al., 2020) to that of the London School of Hygiene and Tropical Medicine (Pearson et al., 2020) which provides greater detail on pandemic mitigation options adopted by countries around the world. We further rely on Google Mobility reports (Google, 2020) to track the evolution of social distancing intensity and the changes in face-to-face services (e.g., mobility to recreation location). Also, more recent macroeconomic assessments, such as the ADB Economic Outlook (ADB, 2020), allow us to update the assumptions about changes in consumption behavior and participation to labor markets, and the value of some specific parameters (e.g., number of workday losses) under varying mitigation strategies adopted by countries.

Table 2 Comparison of key assumptions for April and September 2020 MIRAGRODEP-COVID 19 scenarios

	Scenario	
	April 2020	**September 2020**
Health and pandemic projections	Imperial College (Walker et al., 2020); March 26th version	London School of Hygiene and Tropical Medicine (Pearson et al., 2020); June 5th, 2020 version)
Health (non-pharmaceutical) mitigation policies	Imperial College, "Social distancing of the whole population" scenario for all countries	Countries mapped to 10 types of responses based on policy descriptions & mobility metrics (Google, 2020; per August 4th, 2020)
Social distancing parameter (e.g., number of workdays lost)	12 weeks of confinement in each country, except for Africa (8 weeks)	Adjusted allowing for country specificities within region (see above)
Value chain disruptions	Post-harvest losses for perishable products: +5 points	Post-harvest losses for perishable products: +5 points
Transportation and logistics	5% reduction in total factor productivity (TFP) in transport sector	5% reduction in total factor productivity (TFP) in transport sector
Preference shifter for face-to-face services	Uniform 25% "shadow tax" equivalent	Country-specific "shadow tax", scaled to social distancing intensity (tax ranging between 13% and 45%)

The changes in results for macroeconomic outcomes, agri-food value added, and poverty are shown in Table 3. While the scenarios are broadly similar in terms of the nature of the drivers, the magnitudes of the shocks have been updated and made more country specific. The broad upshot is that the global recession is expected to be even deeper in 2020 (a 7.1% decline in global GDP instead of a 5.1% decline). The revised assumptions do not change the earlier expectation that the agri-food sector has held up relatively well, showing resilience compared to the rest of the economy. Globally, the agri-food sector could even expand as agricultural production has remained relatively stable while costs are down with the drop in prices for manufacturing and services.

Table 3 Poverty and Macroeconomic Impacts of MIRAGRODEP-COVID 19 scenarios for 2020 (April and September 2020 Scenarios)

	MIRAGRODEP COVID-19 Scenario	
	April 2020	**September 2020**
Real GDP (percentage change from previous year)		
World	-5.1	-7.1
Low- and middle-income countries	-3.6	-5.5
Africa, South of Sahara	-8.9	-5.8
South Asia	-5.0	-12.9
Agri-food real value added (percentage change from previous year)		
World	-1.8	2.5
Low- and middle-income countries	0.1	2.3
Africa, South of Sahara	3.9	2.0
South Asia	-2.0	0.1
Changes in extreme poverty ($1.90 pp/pd poverty line, millions of people; changes from baseline)		
Low- and middle-income countries	147.5	149.7
Africa, South of Sahara	79.4	50.5
South Asia	42.1	72.5

Source: MIRAGRODEP and POVANA Simulations (April and September 2020 scenarios)

The aggregate findings of the updated scenario for global poverty are practically unchanged, with the number of poor expected to rise by just under 150 million. However, the regional distribution of poverty increases differs substantially from that presented in the previous sections. In the new scenario, the economic crisis is expected to be deeper than previously anticipated in South Asia, particularly in India, and milder in Africa. As a result, this simulation projects a smaller, though still significant increase in poverty sub-Saharan Africa (50 million instead of near 80 million) and the larger increase affecting people in South Asia (72 million instead of 42 million).

7 Conclusions

The key goal of this paper was to provide a rigorous framework to assess the risks pandemics like COVID-19 pose to global poverty and food security. Accordingly, we first considered the nature of the relationships between the COVID-19 pandemic and the overall economy. This made clear that the major impacts of the pandemic on poverty and food security are more likely to come from shocks to household incomes, and hence to food access, than from impacts on food markets directly. However, we recognize that there are important direct impacts of the disease on food markets, particularly in the more labor-intensive parts of the food chain, and in areas such as food services, where the need for social distancing is sharply reducing the operation of restaurants.

Given the multiplicity of links between the pandemic, household incomes and food security, we concluded that a framework linking economy-wide modeling with household models was needed to capture the impacts of the shock on poverty. We used the MIRAGRODEP global computable general equilibrium model linked to epidemiological models to capture the impacts on the global economy, and the POVANA household models to capture the impacts at the household level.

The simulation experiments were designed to capture the impacts of the crisis begin with the direct, thus far seemingly minor, impacts of the disease on labor supply resulting from increases in morbidity and mortality. The next key shock was the impacts of social distancing, whether undertaken out of concern about catching the disease or as part of a concerted policy of suppressing the disease—a very important channel of effect with highly specific impacts by sector and type of labor. In addition, we considered the impacts of increases in logistical costs associated with the disease.

Our initial results suggested that COVID-19 would cause a decline in global GDP of about 5% in 2020, with a similar decline in South Asia and a larger decline (-9%) in Africa South of the Sahara, and much larger declines in global trade because of both increases in logistical costs and declines in investment as consumers and governments seek to reduce the adverse impacts of the crisis on living standards by reducing private and government savings. Consumers are also expected to have shifted their food purchases, buying less nutrient dense, but more expensive, products such as fruits and vegetables, meat and dairy products, and buying more calorie-rich and cheaper cereals and processed foods. In an updated scenario, however, using new information about – inter alia – the spread of COVID-19 and related social distancing measures, particularly taking into account the more reduced spread of the disease in Africa than previously anticipated, we expect that the global recession could be steeper than previously anticipated, driven in part by a much stronger economic decline in South Asia.

To better understand these results, we decomposed them by major drivers. The economic consequences of reduced labor supply and social distancing drive most of the impacts on GDP worldwide. Fiscal stimulus in high-income countries and declines in private savings mitigate some, but far from all, the adverse impact on total and food consumption.

The analysis concludes that the pandemic will likely increase the number of people in poverty by about 150 million people, or 20% of current poverty levels. In our reference scenario, most of this increase in extreme poverty was expected to occur in Africa South of the Sahara and South Asia, where many people are currently close to this poverty line. An updated analysis suggests that the increase in poverty may be smaller than originally anticipated in Africa and larger in South Asia, with the global total impact remaining very similar at just under 150 million.

The analytical framework that we use captures many important non-neutralities in the effects of the crisis that are ignored in simpler analyses assuming all incomes change equally. For example, we find that poverty increases are likely to be smaller, both in absolute numbers and relative to current poverty rates, in rural areas which are likely less hard hit by the crisis. An analysis of these poverty results suggests that accounting for just the average changes in incomes and in consumer prices would capture only about three quarters of the total impact of the crisis on poverty rates. Many of the impacts are non-neutral between the poor and the rich and outcomes for the poor are, on average, substantially worse for higher income and more educated people, many of whom can continue to work productively at a distance.

The actual implications of COVID-19 for poverty and food security will depend on a wide range factors, many of which are simply unknown at this point—such as resurgence of the disease during the northern winter and the efficacy and adoption of potential vaccines. Thus, the results in this paper should not be taken in any way as a precise forecast of the outcome. Rather, the paper provides an approach for evidence-based “what-if” scenario analysis of the impacts of broad-based shocks such as COVID-19 for poverty, food insecurity, and dietary change. As such it should help better understand the relative importance of the multiple channels of transmission and inform policymakers about the socio-economic consequences of mitigation measures taken to reduce public health risks and, hence, the potential trade-offs between efforts to safeguard lives and those to protect livelihoods.

References

ADB (2020). *Asian development outlook 2020 update: wellness in worrying times,* Asian Development Bank.

Anderson, K., Ivanic, M. & Martin, W. (2014). Food price spikes, price insulation and poverty' in Chavas, J-P, Hummels, D. & Wright, B. eds. *The economics of food price volatility*. University of Chicago Press for NBER.

Abate, G., de Brauw, A. & Hirvonen, K. (2020). Food and nutrition security in Addis Ababa, Ethiopia during COVID-19 Pandemic. Strategy Support Program Paper 145, International Food Policy Research Institute, June. https://tinyurl.com/yaffcdgf

Dingel, J. & Neiman, B. (2020). How many jobs can be done from home? White Paper by Becker Friedman Institute, University of Chicago. https://tinyurl.com/rgt3bmz

Google (2020). Google COVID-19 Community mobility reports. https://www.google.com/covid19/mobility / Accessed: 4 August 2020.

Goolsbee, A. & Syverson, C. (2020). Fear, lockdown and diversion: comparing drivers of pandemic economic decline 2020, NBER Working Paper 27432, National Bureau of Economic Research.

Hummels, D. & Schaur, G. (2013). Time as a trade barrier. *American Economic Review*, 103(7), 2935-59. DOI: 10.1257/aer.103.7.2935

ILO (2020a). ILO Monitor: COVID-19 and the world of work. Sixth edition Updated estimates and analysis. International Labour Organization. September 30. https://tinyurl.com/y4t22exl

ILO (2020b). ILO Monitor: COVID-19 and the world of work. Third edition Updated estimates and analysis. International Labour Organization. April 29. https://tinyurl.com/ybhf6n2m

IMF (2020). *World economic outlook.* International Monetary Fund, Washington D.C. https://tinyurl.com/u7dzvnk

Keynes, J.M. (1936). *The general theory of employment, interest and money*. Macmillan.

Laborde, D. & Martin, W. (2018). Implications of the global growth slowdown for rural poverty. *Agricultural Economics*, 49(3): 325-338.

Laborde, D., Martin, W., Swinnen, J. & Vos, R. (2020). COVID-19 risks to global food security. *Science,* 369(6503), 500-502 (31 July 2020).

Mahler, D., Lakner, C, Castaneda Aguilar, R. & Wu, H. (2020). *The impact of COVID-19 (Coronavirus) on global poverty: Why Sub-Saharan Africa might be the region hardest hit*. World Bank Data Blog. April 20**.** https://tinyurl.com/yalblur8

Martin, W. & Glauber, J. (2020). Trade policy and food security. Ch 6 in Baldwin, R. and Evenett, S. eds. *COVID-19 and trade policy: Why turning inward won't work.* VoxEU Book, CEPR Press.

McKibbin, W. & Fernando, R. (2020). The global macroeconomic impacts of COVID-19: Seven scenarios, CAMA Working Paper 19/2020, Australian National University, March. https://tinyurl.com/yb6ybdmw

Pearson, C., Van Zandvoort, K, Jarvis, C., Davies, N., Thompson, S, Checchi, F, Jit, M, Eggo, R. & LSHTM CMMID COVID-19 Working Group (2020), Projections of COVID-19 epidemics in LMIC countries. London School of Hygiene & Tropical Medicine. https://doi.org/10.17037/DATA.00001564 .

Schultz, T.W. (1964). *Transforming traditional agriculture.* Yale University Press.

Sen, A. (1981). *Poverty and famines. An essay on entitlement and deprivation*. Clarendon Press.

Sumner, A., Hoy, C. & Ortiz-Juarez, E. (2020). Estimates of the impact of COVID-19 on global poverty. WIDER Working Paper 2020/43. UN WIDER.

Swinnen, J. (2020). 'COVID-19 is exacerbating inequalities in food security' in Swinnen, J. and McDermott, J. eds *COVID-19 and global food security*, International Food Policy Research Institute.

Tamru, S., Hirvonen, K., & Minten, B. (2020). Impacts of the COVID-19 crisis on vegetable value chains in Ethiopia. IFPRI blog, available at: https://tinyurl.com/yct7wfb6

Vos, R., Martin, W. & Laborde, D. (2020). How much will global poverty increase because of COVID-19? IFPRI Blog, March 20. https://tinyurl.com/y73ln9hg

Walker, P. et al. (2020). The global impact of COVID-19 and strategies for mitigation and suppression. Imperial College COVID-19 Response Team Report 12. Imperial College, London. https://tinyurl.com/ydgglerl

World Bank (2020a). Assessing the economic impact of COVID-19 and policy responses in Sub-Saharan Africa. *Africa's Pulse* 21, April. https://tinyurl.com/wfo9x59

World Bank (2020b). *Poverty and shared prosperity 2020: reversals of fortune:* World Bank.

World Bank (2020c). Phase II: COVID-19 crisis through a migration lens. *Migration and development brief 33*. World Bank https://tinyurl.com/y26sf66p

Appendices A.1–A.5

Appendix A.1: The Integrated Modeling Framework: MIRAGRODEP and POVANA

A.1.1 The MIRAGRODEP model

MIRAGRODEP is a global Computable General Equilibrium (CGE) model based on MIRAGE (Decreux & Valin, 2007). The model was developed and improved with the support of the African Growth and Development Policy Modeling Consortium (AGRODEP). It is a multi-region, multi-sector, dynamically recursive CGE model. The model allows for a detailed and consistent representation of the economic and trade relations between countries (Laborde, Robichaud & Tokgoz, 2013). In each country, a representative consumer maximizes a CES-LES (Constant Elasticity of Substitution-Linear Expenditure System) utility function subject to an endogenous budget constraint to generate the allocation of expenditures across goods. This functional form replaces the Cobb-Douglas structure of the Stone-Geary function (that is, LES) with a CES structure that retains the ability of the LES system to incorporate different income elasticities of demand (Stone, 1954), with those for food typically lower than those for manufactured goods and services, while attenuating the strong link between income and price elasticities characteristic of the LES. The demand system is calibrated on the income and price elasticities estimated by Muhammad et al. (2017). Once total consumption of each good has been determined, the origin of the goods consumed is determined by another CES nested structure, following the Armington assumption of imperfect substitutability between imported and domestic products.

On the production side, demands for intermediate goods are determined through a Leontief production function that specifies intermediate input demands in fixed proportions to output. Total value added is determined through a CES function of unskilled labor and a composite factor of skilled labor and capital. This specification assumes a lower degree of substitutability between the last two production factors. In agriculture and mining, production also depends on land and natural resources. In the present application of the model, we assume that new capital investment is perfectly mobile across sectors, while installed capital is immobile. Furthermore, skilled labor is assumed to be fully mobile across sectors, while unskilled labor is only partially mobile between agricultural and non-agricultural sectors. Due to the, presumed, short-term nature of the COVID-19 shock, we divide the original substitution elasticity for factors of production in the production tree by a factor of two, as substitution effects tend to be smaller in the short run. Indeed, we allow producers very little ability to change the capital-labor utilization ratio within a single year.

For the present scenario analysis, we assume further that investment is savings-driven in each country and, hence, will fall with any drop in savings. The real exchange rate is assumed to be flexible, that is, it adjusts endogenously such that the current account balance of the balance of payments remains constant as a share of each individual country's GDP. It implies we also assume that foreign savings are fixed as a share of GDP. To guarantee the supply of external finance matches demand in the global capital market, capital inflows towards countries with a current account deficit are "scaled" up or down by a homogenous factor to capture the scarcity or abundance of international capital. Hence, we assume portfolio preferences and capacity to borrow on international markets remain constant for all countries.

For the present analysis, we do not consider endogenous tax policy responses by governments. Instead, we consider that, except for those countries where we model a budgetary policy response (such as the economic stimulus measures taken by many of the richer nations; see the section on scenario assumptions in the paper), a reduction in tax receipts is associated with a reduction in public spending, thus keeping the public deficit/surplus to GDP constant. This default assumption is used to avoid creating apparent welfare gains by supporting current consumption through an increase in public debt without considering the future welfare costs of the debt.

As in Laborde and Martin (2018), we use the GTAP 9.1 database as MIRAGRODEP's main source of data and parameters. This database allows us to readily use up to 140 regions/countries and 65 products and production sectors. In addition, the database is enhanced by datasets on land use, agricultural production, food balance sheets, agricultural domestic support measures and trade policies, as well as updated Social Accounting Matrices for all individually specified countries. A realistic baseline is constructed aligned with the United Nations' demographic projections and updated IMF economic growth estimates and projections to bring the base year values (2011) to those of the actual year of simulation (2020) and the preceding year (2019).

For this specific study, we condense the model to 29 sectors, of which 18 are related to agri-food activities (primary production and downstream activities) and 36 regions/countries.[21] For a given year (2020 in the present case), the model consists of 310,345 equations and (non-zero) variables.

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[21] Details available at https://public.tableau.com/profile/laborde6680#!/vizhome/IFPRI_Blog_Coronavirus_LMV_032020/MainStory (select "model nomenclature").

A.1.2 The POVANA framework

To translate the CGE model simulation results into poverty impacts, we rely on the POVANA dataset and follow an approach like Ivanic and Martin (2018). The coverage of the POVANA dataset and the most recent documentation is available online[22] and the survey coverage for the present analysis is specified in Appendix A.1.3 below. For the sake of comparison using the most recent peer-review publications on the topic, we use the same version of the POVANA dataset as in Laborde and Martin (2018).

While the household coverage, largely composed of LSMS survey data, for 31 countries, includes more than 300,000 representative households, we retain and use directly the information available from household surveys on the income sources and expenditure patterns in each of just over 285,000 sample households. Our approach requires consistency between the expenditure and income information for each household, and we adjust where possible to reconcile data across sources. However, household records requiring very large adjustments for this reason were excluded.

Appendix A.1.3 below explains more formally how the global CGE findings are linked to the POVANA household model. Intuitively, there are two key linkages between the macro findings and the household models. The first is through exogenous shocks, such as changes in farm productivity, that are imposed at both the economy-wide and the household level. The second is through changes in prices and wages that are endogenous to the economy-wide model and imposed on the household model. A simple example of a direct effect is a decline in labor supply due to illness that exogenously lowers the household's labor supply. Another relatively simple case arises from a shock that results in a sizeable change in the price of a food commodity for which a poor household is a net seller or net buyer. The short-run effect of such a shock on real household incomes can be estimated with information in the POVANA database on the degree to which households are net sellers or net buyers of the product.

[22] https://public.tableau.com/profile/laborde6680#!/vizhome/POVANA_Surveys/POVANA

Appendix A.1.3: Linking MIRAGRODEP to the POVANA model

To understand the poverty estimates reported in this study, we first determine the nominal income (x) of household i as

$$x_i = \pi_i(\vec{p}, \vec{p}^*) + \vec{w}_i' \vec{v}_i + t_i + \phi_i + \rho_i$$

where π_i is the profit function for any unincorporated business activities of household i, defined over a vector of output prices $\vec{p}$, input prices (goods and wages) $\vec{p}^*$. Output quantities $\vec{q}_i$ and input demands (hired labor and other inputs in terms of good and services) $\vec{r}_i$ are implicit in this profit function, and $\vec{q}_i$ is related to input quantities through the production relation τ_i such that $\vec{q}_i = \tau_i(\vec{r}_i)$. Household income may also be derived from labor and other factors supplied, with this income represented by the inner product of $\vec{w}_i$ and the vector of factors sold by the household $\vec{v}_i$. Other sources of household income include net public transfers received/paid by the household t_i; the net international remittances received/paid by the household ϕ_i; and other net domestic private transfers ρ_i. Similarly, expenditures including self-consumption, are defined by the expenditure function $e_i(u_i, \vec{p}^*) = \vec{c}_i \vec{p}^*$with $\vec{c}_i$ the vector of quantities consumed.

Initially, we check that $x_i = e_i + s_i$, where s_i represents the savings of household i. In this simulation, we consider that s_i at the household level is exogenous. Indeed, we want to compute the compensation measures of welfare changes at fixed initial utility (u_i) and net savings, to avoid associating decreasing savings—a normal coping strategy—with a positive utility outcome (increased consumption). When using the extreme poverty line, households at this income level or around it, have extremely scarce available savings so this assumption is not critical in our assessment. For many households, ρ_i (transfers) need to be adjusted to balance income and expenditures in the baseline. Please note that, as explained above, first round impacts on savings are considered in the CGE model.

Because we assume in this scenario analysis that the COVID-19 shock is short lived (the shock and the response take place within the same year), we follow Deaton (1989) and consider only the first-order impacts on π_i and on $e_i(u_i, \vec{p}^*)$. We measure changes in welfare or real income as $\Delta y_i = \Delta x_i + \Delta e_i + \Delta s_i$ to obtain the hypothetical transfer from the rest of the world needed to hold utility at its initial level following changes in nominal income arising from price or productivity changes and associated changes in the cost of living. Using hat notation, with $\hat{y} = \frac{dy}{y}$ for the proportional change in a variable, dropping the household i index and introducing k as an index over goods and services, we obtain:

$$\Delta y = \sum_k \hat{p}_k \bar{p}_k \bar{q}_k + \sum_k \hat{q}_k \bar{q}_k p_k - \sum_k \hat{r}_k r_k \bar{p}_k^* - \sum_k \hat{p}_k^* \bar{p}_k^* \bar{r}_k + \widehat{wu}.\overline{wu}.\overline{ku} + \widehat{wm}.\overline{wm}.\overline{km}$$
$$+ + \widehat{ku}.\overline{ku}.\overline{wu} + \widehat{km}.\overline{km}.\overline{wm} + \hat{t}\bar{t} + \hat{r}\bar{r} + \hat{\rho}\bar{\rho} + \sum_k \hat{c}_k \bar{c}_k \bar{p}_k^* + \sum_k \hat{p}_k^* \bar{p}_k^* \bar{c}_k + \hat{s}\bar{s}$$

where vu represents the labor endowment of household i sold on the labor market outside the household's business activity at wage rate wu, and vm is a composite of other factors of production (capital, land, etc.…) owned by the household and rented out on markets at rental rate wm. This general case incorporates a wide range of household circumstances. Importantly, for many poor households, the initial values of many of these variables, such as property taxes, are generally zero.

Due to the presumed short-term nature of the shock and limited coping capacities of household, we neglect a number of possible adjustment strategies, such as sales of non-labor assets ($\widehat{vm} = 0$), production inputs ($\hat{r}_k = 0$) and consumption pattern ($\hat{c}_k = 0$). This approach allows us to obtain a first-order estimate of the welfare impact of the shock on households—providing a compensation-based money measure of the impact. It also avoids having to make specific assumptions about which coping strategy household choose to mitigate reductions in their consumption bundle. As indicated above, we further assume households do not reduce savings as a coping strategy ($\hat{s} = 0$). In addition, we further assume governments do not adjust income tax rates as a COVID-19 response ($\hat{t}$=0).

Adjustments of other variables in the above specifications are endogenous as determined by the MIRAGRODEP-structural model equations. Household, firm and government behavior all vary by country (or region). For the geographical entity represented in the model to which the individual household belongs:

- $\hat{p}_k$ is the relative producer price change as defined in the CGE for the good or service k, or group of goods or services in which it is included.
- $\hat{p}_k^*$ is the relative consumer price change as defined in the CGE for the commodity k, or group of commodities in which it is included. This price includes the import price index based on the Armington assumption (true price index of the associated good or services at the consumer level).

- For any goods or services y, for which a specific household i, produces a significant amount for self-consumption, $\hat{p}_k^*$ is assumed to be equal to the producer price change, instead of the consumer price change.
- Due to our focus on the left tail of the income distribution, we consider that all labor is unskilled labor and $\widehat{wu}$ is the relative change in the wage of unskilled workers. Since MIRAGRODEP considers two labor markets, rural and urban, $\widehat{wu}$ is specified separately for rural and urban workers, depending on the household location. The location of workers remains constant in the simulation.
- Variable $\widehat{wm}$ represents the relative change of payments to non-labor endowments in the CGE (country level weights), including land, capital and natural resources.
- For each household, we implement a reduction in labor supplied to the market, $\widehat{ku}$, identical to the reduction of unskilled labor supply introduced in the CGE (exogenous scenario shifter) as a consequence of lockdown and/or disease. We assume that "unsold" labor by the household, captured by $\widehat{wu}$, is not recycled in the incorporated business activity, leading to additional production (or, put differently: $\frac{dq_k}{dwu} = 0$). Similarly, the initial amount of labor used internally by the household is not assumed to change due to confinement measures.
- $\hat{\rho}$ is assumed to be equal to $\widehat{wm}$. Various assumptions have been experimented in the past and there is no perfect solution. The ρ_i term captures many elements, including statistical adjustment. Leaving this constant in nominal terms would lead to a significant amount of "dark matter" in the system, stabilizing the system without any justification. While the transfers and "rents" captured by this measure may be stabilizing, assuming $\hat{\rho} = 0$ would be an excessive assumption, and an inconsistent one since from a CGE point of view, no "values" should remain fixed. Any value/price should be indexed on at least one price in the system to avoid violation of Walras Law. Accordingly, we link $\hat{\rho}$ and $\widehat{wm}$;
- We consider that $\hat{q}_k$ is only impacted by the changes in labor productivity driven by the CGE model. Indeed, one of our strong assumption is that we do not consider disruption, including for hired labor, in the availability of inputs used by the household, so we do not consider changes in $\vec{r}$. Logically, no change in $\vec{r}$ does not lead to changes in $\vec{q}$. Actually, this assumption has very limited implication for the assessment of the impacts of COVID-19 on global poverty, since households living in extreme poverty which are self-employed and own a microenterprise or small farm typically rely on few assets, intermediate inputs, or hired labor, and mostly rely on the labor, administrative and management skills of their families.

Still, we want to capture a productivity effect by indexing $\hat{q}_k$ to the relative change in output per unit of labor and by sector, to guarantee the consistency of the framework regarding relative wage changes, productivity changes and prices changes. Since, we use wage changes from the CGE that capture the evolution of the marginal labor productivity in value, due to price and productivity effect, we need to have the various elements in the framework to avoid a systematic bias about self-employment.

With these assumptions, the model estimates a new income level for each household and hence a new income distribution for each new scenario. The per capita incomes for each household in each household survey are subsequently compared with the international (extreme) poverty line of $1.90 per person, per day at 2011 purchasing power parity (PPP) dollar values (using PPP conversion factors as available at PovcalNet to convert the poverty line into domestic prices). The poverty rate is calculated as the share of the population with an income below the indicated poverty line. This calibration process allows us to define the nominal per capita income, $Pline_r$, at base prices associated with our poverty definition. We can also define this value as a real income poverty line at base prices. For any level of income, the number of poor people is defined by $NP = \sum_0^N w_i \times \delta^i(x_i)$ where i is the household index, N the overall household set in the household survey for the country r, w_i the demographic weight of this household, and $\delta^i(\quad)$ a dummy variable defined on the income level indicating if the household is above or below the poverty line such as: $\delta^i(x_i) = \begin{cases} 0 \; if \; x_i > Pline_r \\ 1 \; if \; x_i \leq Pline_r \end{cases}$. The poverty incidence in the total population is equal to $P^0 = \frac{NP}{\sum_0^N w_i}$. We compute poverty headcount and poverty incidence for sub-groups of population, e.g. urban/rural, farmer/non farmer for instance $NP = NP^{Rural} + NP^{Urban}$, by changing the composition of N. But the poverty line is not specific to any group. When doing simulations, we look at the real income change of households and see how many households are actually crossing this poverty line in one direction or another, considering a new vector $\delta^i(\bar{x}_i + \Delta y_i)$, with Δy_i as defined previously and $\bar{x}_i$ the initial income.

Our sample of countries has wide geographic coverage and includes 65% of the world's extreme poor. In order to obtain estimates of poverty changes at the global level, we need to associate each country, not included in the POVANA sample, with a weighted vector of in-sample countries. As specified below, these weights are estimated by minimizing the quadratic distance between a vector, for the real country, defined by a set of ex-ante variables (initial level of poverty, share of rural population from the World Development Indicators) and ex-post variables (impact on GDP and farm value added), and the same vector for the weighted constructs. Combining ex-ante and ex-post elements is important since two countries with similar structural features at the macroeconomic level (poverty rate, GDP per capita, share of rural population) could be impacted differently due to various sectoral specialization, or idiosyncratic shocks (infection rates) or policy responses (confinement).

To summarize, for each country included in the POVANA dataset, we define the changes in the number of poor people as $\Delta NP = \sum_0^N w_i \times \delta^i(\bar{x}_i + \Delta y_i) - \sum_0^N w_i \times \delta^i(\bar{x}_i)$. Since, the current size of the population is not significantly modified by the nature of the shock (low mortality), the changes in poverty rates are driven by the changes in the numerator, i.e. the number of poor people.

For a country *r* not included in the POVANA sample, we compute the ΔNP_r such as:

$\Delta NP_r = \overline{NP}_r^{urban} \times \sum_j \ w_{r,j} \frac{\Delta NP_j^{rural}}{\overline{NP}_j^{rural}} + \overline{NP}_r^{rural} \times \sum_j \ w_{r,j} \frac{\Delta NP_j^{urban}}{\overline{NP}_j^{urban}}$ with $w_{r,j}$ is the weight of country *j* in the linear combination used for country *r,* and $\overline{NP}_j$ the initial number of poor people in the base data for each relevant country group/countries. This approach allows variations in impacts between urban and rural people to be captured in a consistent manner.

The weighting procedure for countries not included in the household database is as follows. The distance that minimizes a weighted squared difference between country's i specific variables and those of a group of reference countries is defined as:

$$Distance_{i,s} = 0.5 * \frac{\left(\widehat{AgProduction}_{i,s} - \sum_{j\in J} w_{i,j,s}\widehat{AgProduction}_{j,s}\right)^2}{\sum_{k\in K} abs(\widehat{AgProduction}_{k,s})/card(K)}$$

$$+ \sum_{f\in F} 0.1 * \frac{\left(component_{f,i} - \sum_{j\in J} w_{i,j,s} component_{f,j}\right)^2}{\sum_{k\in K} \frac{component_{f,k}}{card(K)}} \ \forall i \in I, \forall s \in S$$

$$s.t.\ w_{i,j,s} \geq 0\ ,\ \sum_{j\in J}^{w_{i,j,s}>0} 1 \leq 5,\ \sum_{j\in J} w_{i,j,s} = 1\ and\ \forall i \in I,\ \forall s \in S$$

where *I* is the set of every country in the world in our global household dataset; *K* is the same set as *I*; *J* is the set of 31 countries included in our global household dataset[23] and *j* an element of *J;* $w_{i,j,s}$ is the weight of country *j* in the linear combination used for country *i;* $\widehat{AgProduction}_{i,s}$ is the relative change in the total value of agricultural production of country *i* in a given scenario *s*. *S* being

[23] *Card(K)* is the cardinal of the set *K*, and therefore *card(K)=211.* For missing countries in FAOSTAT, like the Democratic Republic of Congo, we use a proxy country, in this case, the Central Africa Republic.

the scenario space. This change is computed by combining FAOSTAT data on individual crop production and prices for each country and the quantity and price changes obtained in the CGE, either for the country, if singled out in the model, or the region to which the country belongs. This top-down approach allows us to capture, at the country level, for each country of the world, one of the key drivers, i.e. farm income, of the results for a given scenario. Indeed, we need to rely on this approach, capturing ex-post elements, since the price changes driven by the productivity changes are region, production, and scenario specific and focusing on ex-ante clustering analysis would miss this point.

$Component_{f,i}$ stands for a set of country-level variables that are used to bring together similar countries. The set *F* includes the following variables for 2013, extracted from the World Development Indicators database: GDP per capita in PPP$ (2011), poverty incidence (measured against the PPP$1.90 pp/pd poverty line), prevalence of undernourishment, share of agriculture in total GDP, and share of rural population.

Appendix A.2: Household surveys used in this study

The POVANA household model uses data on the full income distribution for around 300,000 households in 31 countries. The country and survey coverages for the analysis in the present study are listed in Table A2 below. For the latest coverage of the POVANA data base, see: **https://public.tableau.com/profile/laborde6680#!/vizhome/POVANA_Surveys/POVANA.**

Table A2: Coverage of household surveys in POVANA database

Country name	*Year*	*Survey name*
Albania	2005	Living Standards Measurement Survey
Armenia	2004	Integrated Survey of Living Standards
Bangladesh	2005	Household Income-Expenditure Survey
Belize	2009	Household Income and Expenditure Survey
Cambodia	2003	Household Socio-economic Survey
China	2002	Chinese Household Income Project
Côte d'Ivoire	2002	Enquete Niveau de Vie des Ménages
Ecuador	2006	Encuesta Condiciones de vida
Guatemala	2006	Encuesta Nacional de Condiciones de Vida
India	2005	India Human Development Survey (IHDS)
Indonesia	2007	Indonesia Family Life Survey
Malawi	2004	Second Integrated Household Survey
Moldova	2009	Cercetarea Bugetelor de Familie
Mongolia	2002	Household Income and Expenditure Survey
Nepal	2002	Nepal Living Standards Survey II
Nicaragua	2005	Encuesta Nacional de Hogares sore Medicion de Nivel de Vida
Niger	2007	Enquete National sur Le Budget et la Consommation des Menages
Nigeria	2003	Nigeria Living Standards Survey
Pakistan	2005	Pakistan Social and Living Standards Measurement Survey
Panama	2003	Encuesta de Niveles de Vida
Peru	2007	Encuesta Nacional de Hogares
Rwanda	2005	Integrated Household Living Conditions Survey
Sierra Leone	2011	Sierra Leone Integrated Household Survey
Sri Lanka	2007	Household Income and Expenditure Survey
Tajikistan	2007	Living Standards Measurement Survey
Tanzania	2008	National Panel Survey
Timor-Leste	2007	Poverty Assessment Project
Uganda	2005	Socio-Economic Survey
Viet Nam	2010	Household Living Standard Survey
Yemen	2006	Household Budget Survey
Zambia	2010	Living Conditions Monitoring Survey

Source: MIRAGRODEP and POVANA model database.

Appendix A.3: Use of epidemiological models

As explained in the main text, we consider two broad impacts on labor markets. The first is the direct impact of mortality and morbidity on labor supply. The second is the impacts on labor supply of social distancing actions needed to reduce transmission of the disease. The first impact is linked to the direct impact of the disease.

For the reference scenario, we use the estimates provided by the Imperial College for each country in the world on March 26, 2020 (Walker et al., 2020). Specifically, we use the "Social distancing of the whole population" scenario for all countries. Since their online materials do not provide results by age cohorts, we re-estimate those by considering that for a given country *r*:

$Number\ of\ Infections_r = \sum_c \gamma_r \varphi_c Pop_{c,r}$ and $Number\ of\ Deaths_r = \sum_c \delta_r \mu_c \varphi_c Pop_{c,r}$,

where $Pop_{c,r}$ refers to the population size in the age cohort *c* in country *r; φ_c* is the default probability of infection by age cohort; and μ_c is the mortality rate by age cohort. The latter two parameters are taken from observed values in existing studies,[24] while δ_r and γ_r are calibrated for each country. This allows us to recompute consistent distributions of infections and deaths by age cohort.

To calculate the implications for the workforce, we then consider the number of cases in the active population (defined over the 15 to 65 years old population) to impact the share of working days lost days. We consider that the death of an individual occurring in month *x* of the year results in a loss of $\frac{(12-x)}{12}$ of annual labor supply; while sickness is associated with 15 days of lost labor supply (15/365). In this scenario, we do not differentiate cases by degree of severity with differentiated coefficients for infected/hospitalized/intensive-care treatments cases. The direct relative reduction in labor supply due to the disease directly is estimated as

$$\widehat{l_r} = \frac{\sum_{c\subset[15;65]} \gamma_r \varphi_c Pop_{c,r} \times \frac{15}{365} + \sum_c \delta_r \mu_c \varphi_c Pop_{c,r} \times \frac{(12-x)}{12}}{\sum_{c\subset[15;65]} Pop_{c,r}}$$

Note that this direct effect is generally quite small due compared to the next type of disruption.[25]

[24] https://www.worldometers.info/coronavirus/coronavirus-age-sex-demographics/

[25] When providing numbers per capita in our results and models, we did not correct the total population used in the counter-factual by the number of deaths. This omission does not affect outcomes in any significant way as the number of deaths relative to the total population is very low.

Due to the confinement measures used in attempting to internalize the externalities associated with the COVID-19 pandemic, we also allow for the fact that some willing workers become unable to sell their labor because of social distancing policies. We use as a base value the "social-distancing" parameter included in the Imperial College estimates, and assume that 12 weeks of confinement is imposed in each country, except in African countries, for which we limit it to 8 weeks, due to the more limited ability of poor populations to manage long periods of economic disruption; the younger average age of people in the region and the consequent more relaxed implementation of confinement policies. These assumptions result in reductions in the labor supply of 23% in most countries or 15% in Africa. We consider that 1/3 of skilled workers impacted by social distancing can continue working through telecommuting. This crude estimate is based on our review of the ILO's early review of the impact of Covid-19 on jobs (ILO, 2020) and Dingel and Neiman (2020). Hence, confinement measures lead to an additional reduction of β_r^h for country r and level of skill h, $h \in \{skilled, unskilled\}$ such that $\beta_r^h = \text{Social\_distance}_r \times \theta_r \times \vartheta_h \times \frac{12}{52}$ with $\theta_r = 2/3$ if r in Sub-Saharan Africa, and 1 otherwise, and ϑ_h=$2/3$ if $h =$ "$skilled$" and 1 otherwise.

For the updated scenario, we use the same procedure to link epidemiological projections to the global CGE model, but now using projections from a different epidemiologic model, that is, those of the London School of Hygiene & Tropical Medicine (LHSTM). The projections are described in Pearson et al. (2020). The outcomes of this model provide us with greater detail and flexibility to map individual country projections to actual policy responses. The LSHTM analysis provides ten alternative mitigation scenarios in addition to the unmitigated ones. The process to link these outputs to the economic model through the labor supply restrictions remain the same. The main differences are in how we account for health impacts. These projected impacts, even in the unmitigated scenarios, differ significantly across epidemiologic models, as a result of great disparity in country-specific parameters such as Social_distance_r, or θ_r. The scenario-country mapping is based on a policy-response review,[26] or social-distancing proxy, using Google Mobility reports. Further detail on this mapping can be provided upon request.

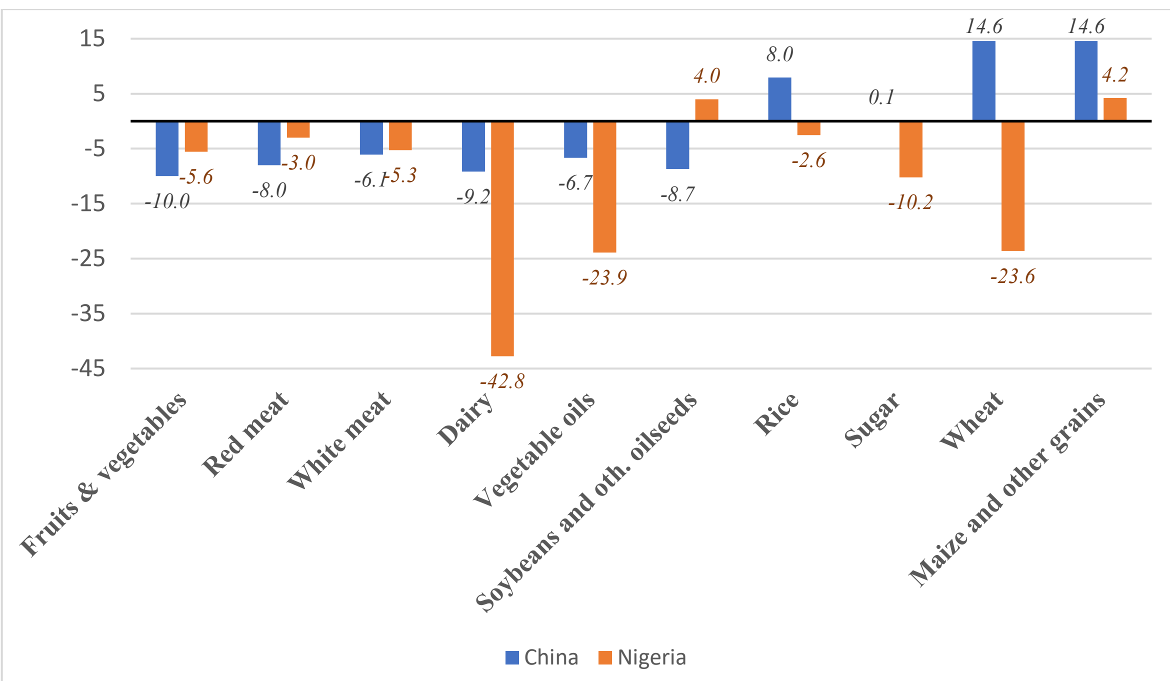
[26] See for instance the IFPRI COVID-19 Policy Response Portal (https://www.ifpri.org/project/covid-19-policy-response-cpr-portal) and the Oxford COVID-19 Government Response Tracker by Hale, Webster, Petherick, Phillips and Kira (2020).

Appendix A.4. Impacts of COVID-19 for food consumption in China and Nigeria

As noted in Section 5 of the paper, and particularly in Figure 4, the changes in consumption can be considerably sharper at the country level than at the global level. Figure A4 below shows that the dietary shift follows the global pattern in China, but with a markedly stronger increase towards greater consumption of wheat, maize and other grains, while growth of rice—the main staple food—is more modest. The decline in demand for non-staples (fruits and vegetables, animal-sourced products, and vegetable oils) is in line with the global average, albeit slightly stronger. In Nigeria, the picture is more context specific, showing a sharp decline in dairy and vegetable oil consumption along with reductions in demand for certain staple crops, including wheat, as well as sugar and rice. The dietary shift is towards mainly locally produced staples, like maize and other basic grains. In developing countries as a group, consumers shift to maize and other grains while cutting back on vegetables and fruits, fats and oils and dairy products. Even in developed countries, consumption of vegetables and fruits falls substantially.

Figure A4 COVID-19 impacts on diets in China and Nigeria

(Percentage change in household consumption by product)



Source: MIRAGRODEP Simulation (April 2020 scenario).

Note: Results are based on changes in the volume of consumption for each national representative household.

Appendix A.5: Summary of Available Results on the Impact of COVID-19

A range of studies summarized in Table A5 has attempted to assess the impacts of COVID-19 on the world economy, on developing economies, and on the poor. Because the magnitude of the economic shocks resulting from COVID-19 was not immediately obvious, many early studies provided much smaller estimates of impact than later reporting studies. Accordingly, the estimates are categorized by whether they were based on the March, June or September quarters. Because most people vulnerable to absolute poverty are in Africa or South Asia, estimates of GDP and poverty impacts are presented for these regions as well as globally.

The IMF World Economic Outlook (WEO) estimates for GDP declines relative to the January 2020 forecast are a useful place to begin. The April WEO suggested a change in global GDP of -6.3% relative to the January forecast, with changes of -5.1% in Africa and -4.1% in India. By June, the global estimate had risen to -8.2%, with a decline of -6.7% in Africa and -10.5% in India. By September, the global estimate had risen slightly, partly because of a more rapid than expected upturn in China, but the outlook for India had deteriorated sharply, with growth of -16.3%. A comparable deterioration in the growth outlook for South Asia and improvement in Africa is evident as we move from the Reference to the October scenarios in this study.

The earliest estimates of the impacts of COVID-19 in Table A5 are those by Maliszewska et al. (2020) and Vos et al. (2020). These studies project declines in global GDP of 2.1% and 3.0% respectively. Based on that modest decline in GDP, Vos et al. (2020) concluded that poverty would rise by 48 million for every 1 percentage point decline in global GDP. This estimate is similar to that of Mahler et al. (2020), who used a much larger estimate of GDP impacts, -6.2%. Part of the difference likely results from the use of uniform income shocks in the Mahler et al study which, as seen in Figure 7 in the main text, is likely to substantially understate the impact of this type of shock on the poor. World Bank (2020a) similarly assumes uniform income shocks, yielding a smaller poverty impact than this study, which differentiates the income shocks and accounts for general equilibrium effects on income distribution.

Table A.5. Estimated Impacts of COVID-19 on GDP and on Poverty

	Institution	World GDP March	World GDP June	World GDP Sept	GDP Africa	GDP S. Asia	Poverty Headcount World	Remarks
This study		%	%	%	%	%	millions	
Reference scenario	IFPRI	-5.1			-8.9	-5.0	148	Combined CGE & household models
September scenario	IFPRI			-7.1	-5.8	-12.9	150	"
Vos et al. (2020)	IFPRI	-3.0					48	"
WEO April	IMF	-6.3			-5.1	-4.1		Relative to Jan 2020 WEO
WEO June	IMF		-8.2		-6.7	-10.5		"
WEO Oct	IMF			-7.7	-6.5	-16.3		"
Kharas (2020)	Brookings						144	https://tinyurl.com/y3oyehys
Kharas & Hamel (2020)	Brookings	-6.2					40-60	April vs Oct 19 WEO, Poverty Clock
Mahler et al (2020)	WB		-6.2				49	April vs Oct 19 WEO, Povcalnet
Maliszewska et al. (2020)	WB	-2.1			-1.4-3.0	-2.4-5.0		ENVISAGE model
McKibbin/Fernando (2020	ANU		-19.4					17tn of $87.7tn; from estimated impacts
OECD	OECD		-7.6			-7.0		India for South Asia
Sumner et al (2020)	WIDER	5-20					110-500	Uses PovcalNet
World Bank (2020a)	WB			-5-8			88-115	Based on Global Ec Prospects & Povcalnet
World Bank (2020b)	WB			-5-8				-5 is abs change, -8 change from Jan fcast
WTO (2020)	WTO	-2 to -9			-4 to -9	-5 to -13		https://tinyurl.com/y2zdcpb7

References for Appendices:

Deaton, A. (1989). Rice prices and income distribution in Thailand: A non-parametric analysis. *Economic Journal,* 99 (395), 1–37.

Decreux, Y. & Valin, H. (2007). MIRAGE, updated version of the model for trade policy analysis: Focus on agriculture and dynamics, Working Papers 2007-15, CEPII, Paris http://cepii.fr/PDF_PUB/wp/2007/wp2007-15.pdf

Dingel, J. & Neiman, B. (2020). How many jobs can be done from home? White Paper by Becker Friedman Institute, University of Chicago. https://tinyurl.com/rgt3bmz

ILO. (2020). ILO Monitor: COVID-19 and the world of work. Third edition updated estimates and analysis. International Labour Organization. April 29. https://tinyurl.com/ybhf6n2m

IMF (2020). *World economic outlook.* International Monetary Fund, Washington DC. https://www.imf.org/en/Publications/WEO

Ivanic, M. & Martin, W. (2018). Sectoral productivity growth and poverty reduction: national and global impacts. *World Development*. 109, 429-439. https://doi.org/10.1016/j.worlddev.2017.07.004

Kharas, H. (2020). The Impact of COVID-19 on global extreme poverty, Blog Post, The Brookings Institution, Washington DC. https://tinyurl.com/y3oyehys

Kharas, H. & Hamel, K. (2020). Turning back the clock: how will COVID-19 impact the world's poorest people? Brookings Institution, Washington DC. https://tinyurl.com/y3exwj5v

Laborde, D. & Martin, W. (2018). Implications of the global growth slowdown for rural poverty. *Agricultural Economics*, 49(3), 325-338.

Laborde, D., Robichaud, V. & Tokgoz, S. (2013), MIRAGRODEP 1.0: documentation, AGRODEP Technical Note, International Food Policy Research Institute, December.

Mahler, D., Lakner, C, Castaneda Aguilar, R. & Wu, H. (2020). *The impact of COVID-19 (Coronavirus) on global poverty: Why Sub-Saharan Africa might be the region hardest hit*? World Bank Data Blog. April 20**.** https://tinyurl.com/yalblur8

Maliszewska, M., Mattoo, A. & van der Mensbrugghe, D. (2020). The potential impact of COVID-19 on GDP and Trade: A preliminary assessment. World Bank Policy Research Working Paper 9211. Washington D.C.: The World Bank.

McKibbin, W. & Fernando, R. (2020). Global macroeconomic scenarios of the COVID-19 pandemic. Centre for Applied Macroeconomic Analysis (CAMA) Working Paper 62/2020. The Australian National University. https://tinyurl.com/y9fafd5t

Muhammad, A., D'Souza, A. Meade, B. Micha, R. & Mozaffarian, D. (2017). The influence of income and prices on global dietary patterns by country, age, and gender. *Economic Research Report* No. ERR-225, US Department of Agriculture. (March). https://tinyurl.com/y3umwq34

OECD (2020). *OECD Economic Outlook,* OECD, June.

Pearson, C., Van Zandvoort, K, Jarvis, C., Davies, N., Thompson, S, Checchi, F, Jit, M, Eggo, R., & LSHTM CMMID COVID-19 Working Group (2020). Projections of COVID-19 epidemics in LMIC countries. London School of Hygiene & Tropical Medicine, London, UK. https://doi.org/10.17037/DATA.00001564.

Stone, R. (1954). Linear expenditure systems and demand analysis: an application to the pattern of British demand. *The Economic Journal*, *64*(255), 511-27.

Sumner, A., Hoy, C. & Ortiz-Juarez, E. (2020). Estimates of the impact of COVID-19 on global poverty. WIDER Working Paper 2020/43. UN WIDER.

Vos, R., Laborde, D. & Martin, W. (2020). How much will global poverty increase because of COVID-19?, IFPRI Blog Research Post, https://www.ifpri.org/blog/how-much-will-global-poverty-increase-because-covid-19

Walker, P. et al. (2020). The global impact of COVID-19 and strategies for mitigation and suppression. Imperial College COVID-19 Response Team Report 12. Imperial College. https://tinyurl.com/ydgglerl

World Bank (2020a). *Poverty and shared prosperity 2020: reversals of fortune*. World Bank.

World Bank (2020b). *Global Economic Prospects*. World Bank.

WTO (2020). 'Methodology for the WTO Trade Forecast of April 8 2020, Mimeo, World Trade Organization, Geneva. https://tinyurl.com/y2zdcpb7

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