

Agricultural and Economywide Effects of the Conflict in Ukraine

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Ukraine and Russia have become increasingly important suppliers in global agricultural markets, and the war in Ukraine has widespread negative consequences. Lost domestic production in Ukraine and disruptions in international trade threaten global food security and hinder productivity. War-related damages caused immediate and continued injury to Ukraine's agricultural systems that will have lasting effects. This research investigates the agricultural and economywide effects of the conflict in Ukraine by simulating production losses and conflict-related trade actions with a computable general equilibrium (CGE) modeling framework.

As the world was moving forward from the consequences of COVID-19, conflict erupted when Russia invaded Ukraine in February 2022. The implications of this conflict are far reaching as both nations are key suppliers of agricultural products, and Russia is a dominant fertilizer source for inputs used around the world. Combined, Russia and Ukraine account for 12% of global agricultural exports and 20% of fertilizer exports (Glauber and Laborde, 2022). The conflict negatively affects agricultural markets given lost Ukrainian production and exports and trade restrictions imposed on Russia and Russian allies that disrupt global commodity markets. Negative consequences are widespread and affect consumers and producers around the world with especially damaging effects on food security in developing nations.

Agricultural production is central to Ukraine's economy and is critical for Russia. More than 55% of the land in Ukraine is highly fertile, arable land, and agriculture accounts for approximately 20% of the Ukrainian economy (USDA FAS, 2022). Agriculture contributes approximately 4% to Russia's GDP (World Bank, 2022). Ukraine and Russia have grown in importance for global agricultural markets over the past three decades with increased agricultural productivity despite noteworthy productivity gaps relative to export competitors. Unfortunately, the onset of Russia's invasion of Ukraine brought destruction to agricultural production in Ukraine that has consequences spanning beyond the region.

The war in Ukraine is responsible for an estimated \$4.3 billion in damages to agricultural systems equal to nearly 15% of Ukraine's agricultural capital stock (Neyter et al. 2022a). Ukrainian agricultural damages account for the destruction of tangible assets and inventories from the invasion and vary across the supply chain. Satellite images and photos show devastation across Ukrainian farms including bombed and burned fields, destroyed capital and equipment, damaged transport systems, and lost livestock. Destruction to farmland and unharvested crops comprise 50% of total damages valued at \$2.135 billion. Machinery damages equal to \$926 million account for 22% of total damages. Additional damages are estimated for stored products (14%, \$613 million), storage facilities (6%, \$272 million), livestock (3%, \$136 million), inputs (3%, \$120 million), and perennial crops (2%, \$89 million).

The damages to agricultural supply chains do not reflect the extensive losses to the Ukrainian agricultural economy including lost revenue from decreased production and additional war-related production costs. Ukraine experienced \$23.3 billion in total estimated agricultural losses, which is equal to approximately 50% of the value of 2021 Ukrainian agricultural output (Neyter

et al. 2022b). While these estimates show losses for 2022, continued conflict will amplify losses and destruction across Ukraine.

Lost trade is another casualty resulting from the conflict. Russia initially blocked Ukrainian exports, and though trade subsequently resumed, export potential for Ukraine remains uncertain. Concurrently, Western countries imposed trade sanctions on Russian goods in response to the invasion. Lost trade of food and agricultural products negatively impacts agricultural producers and consumers. Ukraine and Russia are major producers and exporters of grains and vegetable oils, and exports from Ukraine and Russia are central to import bills in Least Developed Countries (LDC) in the Middle East, Africa, and other regions. Together, Ukraine and Russia provide 12% of calories traded globally (Glauber and Laborde, 2022). Further work to understand the global, economywide effects of the conflict is warranted.

This research employs scenarios in a Global Trade Analysis Project (GTAP) modeling framework to simulate war-related shocks on the Ukrainian agricultural sector based on production loss estimates by the research team given varying timelines for continued conflict. Key results will describe war-related changes in prices, output, bilateral trade, GDP, and welfare across regions. One key advantage of employing a CGE model for this analysis is the ability to investigate potential changes in bilateral trade flows in response to economic shocks from the conflict. The GTAP database and CGE modeling approach is one of the most widely used frameworks to investigate the interregional and intersectoral effects of global market shocks, as well as international trade and policy measures, and is well-suited to focus on impacts from Ukrainian agricultural losses and conflict-related trade restrictions. CGE models include interactions between producers, consumers, investors, households, and governments, and are useful to characterize linkages between sectors and investigate policies that have economywide impacts such as the supply chain shocks addressed in this work. Documentation of the GTAP model structure can be found in Corong et al. (2017).

The GTAP model and version 11 database are employed for this work. We aggregate geographic regions based on key agricultural exporters and importers and sectoral aggregation focuses on agricultural products. We update the GTAP database from the 2014 base year to 2021 given changes in macroeconomic variables including population, investment, and Gross Domestic Product (GDP), following the literature (Hertel et al., 2010; Diffenbaugh et al., 2012; Boulanger et al., 2016; Beckman and Countryman, 2021). Data on population, investment and GDP are collected from the World Bank and the International Monetary Fund (IMF).

Global agricultural prices were high, and supplies were tight before the war in Ukraine given disruptions from COVID-19 and other market dynamics including decreased world supplies from drought. Commodity prices increased exponentially since 2020 and are amplified by war and trade restrictions (Baffes and Temaj, 2022). The perfect storm of tight supplies, high prices, and amplified market volatility has negative consequences for global agricultural markets, food security, and productivity, especially in LDCs. This research provides insight into the global, economywide effects of the conflict in Ukraine, which is relevant for policy makers and agricultural stakeholders around the world.

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