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Long-run impacts of the conflict in Ukraine on grain imports and prices in Africa

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Abstract

Russia's invasion of Ukraine has threatened global grain supplies as it reduces production and exports while increasing trade costs. While the overall share of Africa's trade with Ukraine and Russia is small, the concentration of imports in products such as wheat, other grains, and fertilizer is critical to food security. This paper investigates the long-term impacts of the conflict on grain imports and prices in Africa. We use a long-run general equilibrium trade model to study three scenarios that may evolve as a consequence of the conflict: (1) a heavily reduced Ukrainian production of wheat and other grains; (2) rising trade costs with Ukraine and Russia due to disrupted trade routes in the Black Sea and the sanctions against trading with Russia; and (3) an outright ban on Russian grain export. The model simulations show that the conflict severely affects grain imports, raising local prices for wheat and other grains, with especially strong effects in high import-dependent countries. That creates risks for food security in some African countries.

KEYWORDS

agriculture, food insecurity, food prices, grain, trade, trade disruptions, war, wheat

1 | INTRODUCTION

Grains are staple foods in almost all countries and therefore critical to food security. Being easy to store, they are well-suited for international trade. A steady and cheap supply has made many countries import-dependent. The global supply-chain disruptions created by the Russian invasion of Ukraine come at a time when the world has been grappling with two major global crises—the COVID-19 pandemic and soaring global food prices. The COVID-19 pandemic has disrupted global supply chains and has had lasting consequences on livelihoods, especially of the urban poor, who have not fully recovered financially.[1] In addition, increasingly poor harvests resulting from droughts and climate change have affected local producers, exerting upward pressure on prices. Also, the "Desert locust swarm" in East Africa, a region where about 250 million people live, further increased the pressure on the prices of grains, affecting Somalia (which heavily relies on wheat imports from Ukraine and Russia), Kenya, Ethiopia, and Sudan.

These adverse shocks have spurred global demand for existing grain stocks, which has put upward pressure on food prices worldwide. According to *Welthungerhilfe*, an organization that computes the Global Hunger Index, almost 50

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countries are at risk of failing to reach the goal of zero hunger by 2030 (Welthungerhilfe, 2022). In addition, the situation for many African countries severely worsened due to the war between Russia and Ukraine—two of the world's largest producers of agricultural commodities (Food and Agriculture Organization of the United Nations, 2022). Russia and Ukraine produce and export more than 10% of global wheat. And, while geographically distant from Africa, many African countries depend on imported grains from Russia and Ukraine to meet their consumption needs (Saverimuttu & Rempel, 2004).

Food security is of course broader than the availability of affordable grain. According to a common definition (Food and Agriculture Organization of the United Nations, 2008), food security is ensured if "all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Food security can be measured in detail using measures such as the Food Consumption Score (FCS) or the Household Dietary Diversity Score (HDDS). In this paper, we focus on a specific aspect of food security: the availability of grains in African countries through international trade with Ukraine and Russia and the resulting price differences.

There are several channels through which Russia's invasion of Ukraine can affect grain imports and prices in Africa. The first channel is through a direct reduction in the quantity and the soaring price of wheat imports for some African countries. In Ukraine, factors of production—labor and capital—are shifted towards military defensive uses, or agricultural activities are put on pause as fields cannot be used due to the conflict. This leads to falling production and export of grains. At the same time, Russia has temporarily banned grain exports to the Eurasian Economic Union states, a trading bloc of former Soviet countries, to protect its domestic market due to the massive sanctions placed upon the country (World Grain, 2022). Also, the invasion of key ports and the fighting along the Black Sea disrupted trade routes and destroyed critical Ukrainian infrastructure, making trade more difficult and costly. The disruption of agricultural production, agricultural inputs, and exports, more generally, is expected to decrease the supply of grains in the world grain markets and cause an increase in prices.

The second channel is the disruption of the markets for agricultural inputs, mainly natural gas and fertilizers, which directly affect food insecurity in some African countries. That will reduce access to or increase prices of important yield-enhancing agricultural production technology, reducing domestic production of wheat and other agricultural commodities and leading to even higher food prices. While all net consumers of food will be hit, the poor are the hardest hit by any given food price increase because they tend to spend a higher proportion of their income on food than richer households (e.g., Muhammad et al., 2011; Nsabimana et al., 2020). The effects are expected to be especially pronounced in the poorest countries and among those that import more grains and agricultural inputs, mainly fertilizers. This paper is particularly interested in the "poor" African Development Fund (ADF) recipient countries, according to the ADF classification. In these countries, the population is particularly vulnerable to large-scale shocks because of high poverty rates. In addition, governments' capacity to smooth their population's consumption during crises is the most limited.

The conflict-induced rise in food prices will add to the existing inflationary pressures. For countries that are net importers of food and energy, higher prices coupled with prolonged disruptions in global supply chains could exacerbate food insecurity. The most vulnerable countries are those where a large share of the population spends a high proportion of their incomes on food, particularly wheat, or depends heavily on fertilizer imports. For instance, the populations of countries such as Nigeria and Kenya spend about 59% and 56% of their total consumption expenditure on food consumption, respectively, according to data from 2021 (Our World in Data, 2021). Moreover, wheat consumption has increased during the last 20 years due to growing populations, changing food preferences, and other socioeconomic circumstances associated with urbanization and middle-class growth. Notably, there are vast differences in African countries' import patterns from Russia and Ukraine. For example, Egypt's share of wheat imports from Russia and Ukraine amounts to roughly 80%, whereas the corresponding share in Eritrea is only 40% (United Nations Conference on Trade and Development, 2022).

Beyond its impact on the imports and consumer prices of agricultural commodities, the conflict may have cascading and long-term effects on human capital, among other key socioeconomic outcomes. For instance, previous research shows that adverse shocks to food access and higher food prices lead to child malnutrition (Arndt et al., 2016), poorer health among children (Woldemichael et al., 2022), and lower educational attainment (Wodon & Zaman, 2010). This paper aims to shed light on how Russia's invasion of Ukraine affects grain imports and prices in Africa and investigate its impacts across countries subject to different baseline dependencies of grain import. To this end, we use the Kiel Institute Trade Policy Evaluation (KITE) trade model (Felbermayr et al., 2023). The model simulates the potential

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long-term consequences of the conflict for African countries, depending on the degree of their initial dependence on Ukrainian or Russian imports.

We consider three scenarios that plausibly could, at the time of the modeling in March 2022, evolve due to the conflict. The first scenario solely looks at the effects of decreased productivity in Ukraine, which will result in lower wheat and other grain production. The second scenario adds an increase in trade costs of exports from Ukraine and Russia to the first scenario. The third scenario puts a Russian export ban on wheat and other cereals on top of the two previous scenarios. Due to the uncertainty associated with the invasion, it is impossible to know its actual effects on grain production in Ukraine over a longer time horizon. However, we believe all three scenarios are reasonable outcomes of the invasion and that modeling them helps benchmark these effects and guides policymakers in taking necessary counteracting measures to ensure food security in countries that heavily rely on importing these goods at a time when hard evidence is scarce. From the perspective of over a year after Russia's full-scale invasion, the first two scenarios seem particularly relevant given that much of Ukraine remains occupied or contested, destroyed, or at least heavily affected by mines and explosive remnants. Furthermore, Russia has targeted key civilian infrastructure, such as the port and grain silos in Odesa and elsewhere, which were used to ship grain out of Ukraine at low cost.

The findings show that Russia's invasion of Ukraine will have a considerable long-term effect on imports of wheat and domestic prices of wheat and other cereals, such as maize (corn), sorghum, and barley.[2] Under the baseline scenario in which the war only affected Ukrainian agricultural productivity, the simulated impacts on the volume of wheat and other cereals imports are negative for about 16 African countries, with the highest for Egypt at a 12.2% reduction. The study also shows that domestic prices would increase significantly, increasing the price of wheat in Kenya by about 5.8% and the price of other cereals by 10.3% in Tunisia. Under the second scenario, in which the war reduces productivity in Ukraine's agricultural sector and increases trade costs, the results show that the long-run wheat imports would decrease significantly in about 20 African countries, with the most affected countries being Egypt, Tunisia, and Ethiopia. Overall, the impacts are heterogeneous depending on the degree of dependence on imports of cereals, fertilizers, and energy from Ukraine and Russia, as well as countries' domestic demand and production.

The study is not without limitations. We focus on the long-term implications of the war, ignoring the short-run effects. In the transition phase, impacts are likely higher than in the long run, especially in heavy net importers of key products. Also, some of the simulation results could be sensitive to model assumptions. The model also ignores UN-backed deals temporarily allowing the sale of wheat and other cereals from Ukraine. Nonetheless, the study provides important policy evidence on the potential implications of Russia's invasion of Ukraine on grain imports and prices in Africa that would help policymakers make informed and timely decisions.

In Section 2, we discuss the closely related literature. Section 3 provides a brief background on the importance of wheat imports from Ukraine and Russia for African countries. Section 4 explains the KITE model used in the study before Section 5 introduces the scenarios considered in the simulation and discusses the results, before Section 6 concludes the study.

2 | RELATED LITERATURE ON THE IMPACT OF THE RUSSIAN WAR ON UKRAINE

When writing this study in March 2022, it was the first quantitative paper on the impact of Russia's invasion of Ukraine on key aspects of food security, especially in Africa. Since then, several studies assessing the global effects of the war have come out, but studies that quantitatively assess the economic and food security impacts or important mechanisms, like in our paper, are relatively few and far between. We highlight a few studies that stand out.

Liadze et al. (2023) study the economic costs of the Russia–Ukraine conflict on the global economy and the Euro area. They find that the conflict could reduce global GDP by 1% by 2023. One important feature of this study is that it uses a global model, which allows for properly capturing the trade relationship between any country and country grouping with Russia and Ukraine and assessing the impact of trade disruptions. However, their econometric model does not capture the direct and indirect effects of the conflict nor the impact of policy responses. Caldara et al. (2022) study the effect of the war in Ukraine on global activity and inflation. The authors find that the rise in geopolitical risks seen since the Russian invasion of Ukraine will have non-negligible macroeconomic effects in 2022. Specifically, they find that the war would reduce global GDP by about 1.5%,

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leading to a rise in global inflation of about 1.3 percentage points. Izzeldin et al. (2023) assess the impact of the Russian–Ukrainian war on global financial markets. They find that stock markets and commodities respond most rapidly to the Russian invasion, and post-invasion crisis intensity is noticeably smaller compared to both the COVID-19 pandemic and the global financial crisis.

Regarding grains and food security, Mottaleb et al. (2022) conduct a quantitative analysis in which they seek to estimate what can best be interpreted as a very short-run impact on prices and wheat consumption under the assumption that trade patterns and production do not adjust. Using annual data for 2016–2019, they estimate a price elasticity and then plug it into a regression that predicts yearly per capita consumption based on country dummies for food crises, GDP per capita, the annual GDP growth rate, and the urbanization rate.

Lin et al. (2023) is the closest paper to ours, relying on a quantitative general equilibrium trade model but with a lower country and sector resolution. In their counterfactual, the authors solely focus on wheat production in Ukraine. Using Landsat and Sentinel-2 satellite data, they estimate how much wheat production fell short in 2022 compared to previous years. The authors then simulate three scenarios: First, a production of 20–21 million tons; second, 16 million tons; and third, 13 million tons. For comparison, the 2021 harvest was about 32 million tons. One key difference between their paper and ours is that Lin et al. do not cover the vast majority of African countries, which is the focus of our paper. Regarding the impacts of the Russian invasion of Ukraine on Africa, there are merely a few purely descriptive studies so far.

3 | UKRAINE'S AND RUSSIA'S IMPORTANCE FOR GRAIN SUPPLY IN AFRICA

This section provides stylized facts on African countries' trade with Russia and Ukraine using UN COMTRADE data for 2021. In 2020, Russia's top five exports to ADF member countries were wheat, petroleum oils, fertilizers, primary forms of iron (or steel), and maize. Wheat alone accounted for 31.5% (US$1.13 billion) of ADF countries' total wheat imports of almost US$3.2 billion. For Ukraine, wheat, maize, vegetable fats, and oils comprised 43% of total goods exported to ADF countries. Of the US$1.13 billion worth of agricultural products that ADF countries imported from Russia in 2020, about 87% was wheat, and 7% was sunflower oil. These figures suggest that the disruption of agricultural production caused by the conflict between Ukraine and Russia will significantly impact ADF countries relying on grain imports.

The most vulnerable ADF countries are those whose populations spend more of their incomes on food consumption. For instance, in Cameroon, Ethiopia, and Uganda, 40% and 45% of households' total consumption expenditures are on food. Across ADF countries, wheat consumption has steadily increased during the past 20 years because of a growing population, changing food preferences, and socioeconomic change associated with urbanization and a growing middle class. The importance of imported grain for food security also extends to some non-ADF countries, particularly in North Africa. In Egypt, for instance, wheat represented over 35% of caloric intake per person in recent years (see International Food Policy Research Institute, 2022).

As Figure 1 shows, in per capita terms, the two countries most dependent on wheat imports from Russia are Benin and Mozambique. However, the overall dependence on volumes is far greater in countries like Sudan, Tanzania, and Kenya, which have higher per capita consumption and larger populations. Partly also driven by their larger populations, larger non-ADF countries such as Senegal, Namibia, and Egypt have the greatest absolute import dependence.

Wheat constitutes the most important of the three main global staple grains (wheat, maize, rice) regarding the impact of the Russian War on Ukraine for Africa. Maize is particularly important for food security in Eastern and Southern Africa, with an estimated 64 kg consumed per person per year (Erenstein et al., 2022). Conditional on growing conditions, dependence can be far higher, for example, in Malawi. Rice is a staple grain along the West African coast between Senegal and Côte d'Ivoire and in Madagascar, but Ukraine is not a major rice producer. There is considerable rice production in Southern Russia, close to the Ukrainian border, but it is not a major rice exporter. In Africa, other grains such as millet, sorghum, and teff are the main staples and are typically locally produced. In some countries, tubers such as cassava or sweet potatoes and plantain are important sources of carbohydrates, creating an alternative to grains.

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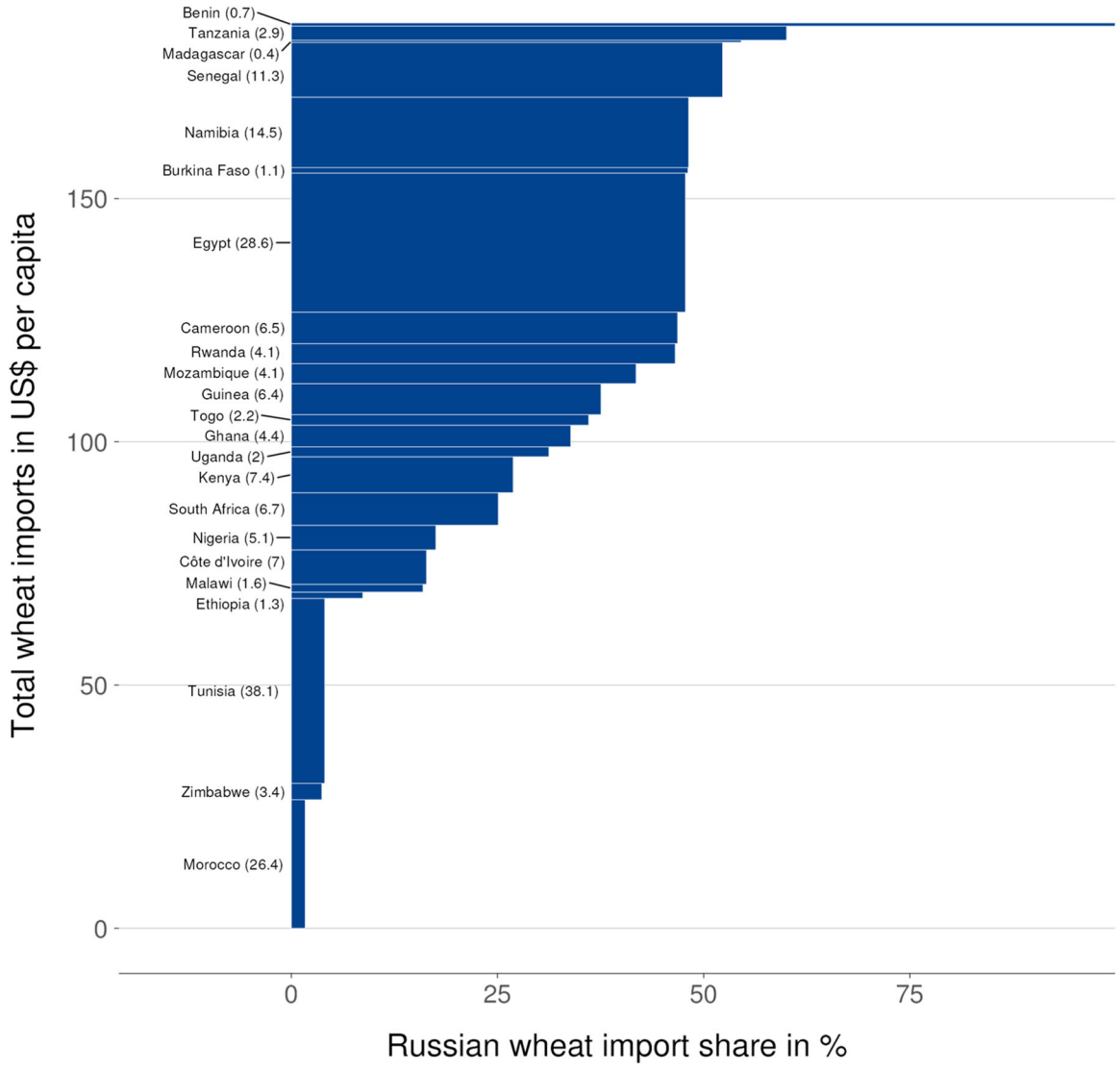

FIGURE 1 The share of wheat imports from Russia (total wheat imports per capita in brackets) in 2019. Own calculation based on Comtrade and WDI. [Color figure can be viewed at wileyonlinelibrary.com]

4 | THE KITE MODEL

We conduct scenario analyses using the KITE model (Felbermayr et al., 2023). The model was originally developed by Caliendo and Parro (2015). They built a multi-sector version of the Ricardian trade model of Eaton and Kortum (2002), where countries produce and sell domestically and internationally according to their relative comparative advantage. The model extends this framework by allowing for extensive intra- and international input-output linkages where goods and services may enter as both final and intermediate goods. Trade policy is conducted through the tightening or easing of trade barriers in the form of tariffs and non-tariff measures. The model features a representative consumer per country with Cobb–Douglas preferences over consumption of sectoral goods. Labor and intermediate inputs are the only production factors, and labor markets clear. The labor force is mobile across sectors but not between countries. In all markets, there is perfect competition. The sectoral production function is Cobb–Douglas, with a constant elasticity of substition (CES) nest over intermediate goods. Countries source their imports from the lowest cost supplier, under differences in bilateral trade costs.

Using a state-of-the-art trade model to analyze the impacts of the war on grain imports and prices has the advantage that several substitution mechanisms are taken explicitly into account: (1) substitution through trade diversion from Ukrainian and Russian food imports to other trading partners; (2) substitution through an increase in domestic

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production; and (3) consumption substitution to other grains whose prices are less affected by the world market. Though it is not a formal food security model, it endogenously determines world market effects and national adaptations to that exogenous policy shock for a key type of staple food.

The model uses version 10 of the Global Trade Analysis Project database (GTAP) (Aguiar et al., 2019). GTAP provides us with detailed information about intra- and international input–output linkages and, thus, about global value chains. It contains 65 sectors in 141 countries, covering more than 98% of economic activity worldwide and 92% of the world's population. From GTAP, we derive all but one of our model parameters, such as bilateral trade, consumption, and production shares, input coefficients, expenditures, tariffs, export subsidies, and value-added. This procedure offers a theory-consistent model calibration. The key structural parameter for any trade model—trade elasticity—is sourced from the literature (Fontagné et al., 2018). Equipped with this data, we define our model's baseline scenario (status quo) and perform a counterfactual analysis of trade cost and productivity changes in the wake of the Russian invasion. Therefore, direct and indirect trade effects, such as trade diversion and real income effects, can be quantified, and international value chains are explicitly considered. Due to limited data coverage, GTAP groups some African countries,[3] implying detailed simulation results for countries with complete data. However, the model still simulates effects for the entire African continent.

The KITE model provides long-run estimates. That means the results indicate the new equilibrium after producers in other countries have adjusted their production in response to changes in the prices of products and inputs. Short-term price increases and the transition paths to a new equilibrium are not investigated using the model and are hence not part of our analysis. The model also features full employment and a frictionless transition from one sector to another. That highlights the long-run horizon of the model. Therefore, it underestimates the short-term consequences of the subsequent scenarios.

Although grain is traded on the world market, differences in price impacts between countries can arise because of differences in trade costs. Relative to countries with low trade costs, countries that face high trade costs will, all else equal, benefit less from other producers stepping in to make up for shortfalls in supply from Ukraine and Russia. Thus, in the new equilibrium, the long-run price increase is expected to be higher for countries that face high trade costs during supply disruption.

We use the KITE model to examine three scenarios of how Russia's invasion of Ukraine affects imports and prices of wheat and cereals in Africa in the long run, depending on their initial dependence on Ukrainian or Russian imports. We discuss these scenarios and the corresponding simulation results below.

5 | SCENARIOS AND RESULTS

5.1 | Scenario 1: Reduced Ukrainian productivity

The first scenario estimates the long-run effects of Russia's invasion of Ukraine on African grain imports due to a reduction in Ukrainian agricultural productivity. To estimate the impact of such a scenario, we assume a baseline setting in which the invasion hampers Ukraine's production capabilities. Due to the invasion, Ukraine can no longer use part of its land for agricultural production, and relevant production inputs such as energy must be shifted towards defensive purposes. We model this scenario by assuming that Ukraine's agricultural productivity falls by 50%. This number is of course arbitrary, but it was deemed a realistic scenario in March 2022. As Ukraine is one of the largest grain exporters in the world—and especially relevant to Africa—and given that the invasion took place shortly before the start of the sowing season in early 2022 (during which we formulated the scenarios and ran our estimations), such an adverse shock is expected to reduce access to grains across the African continent noticeably.

Figure 2 shows the model's predicted change in wheat and cereals[4] import by country. The estimate is on total imports regardless of the source, which accounts for a scenario in which countries could source their wheat and other cereals from other producers, but price changes and sectoral reallocation will induce changes. The result shows that the conflict will reduce imports and considerably increase the prices of wheat and other cereals. Regarding reduced wheat imports, the most heavily affected countries are Egypt, with a 12.2% reduction, followed by Tunisia (10.5%) and Ethiopia (6.9%). For other cereals such as corn or sorghum, the most affected countries are Tunisia (−10.5%), Egypt (−12.2%), and South Africa (−5.1%). These results suggest that already the war-induced reduction in Ukraine's

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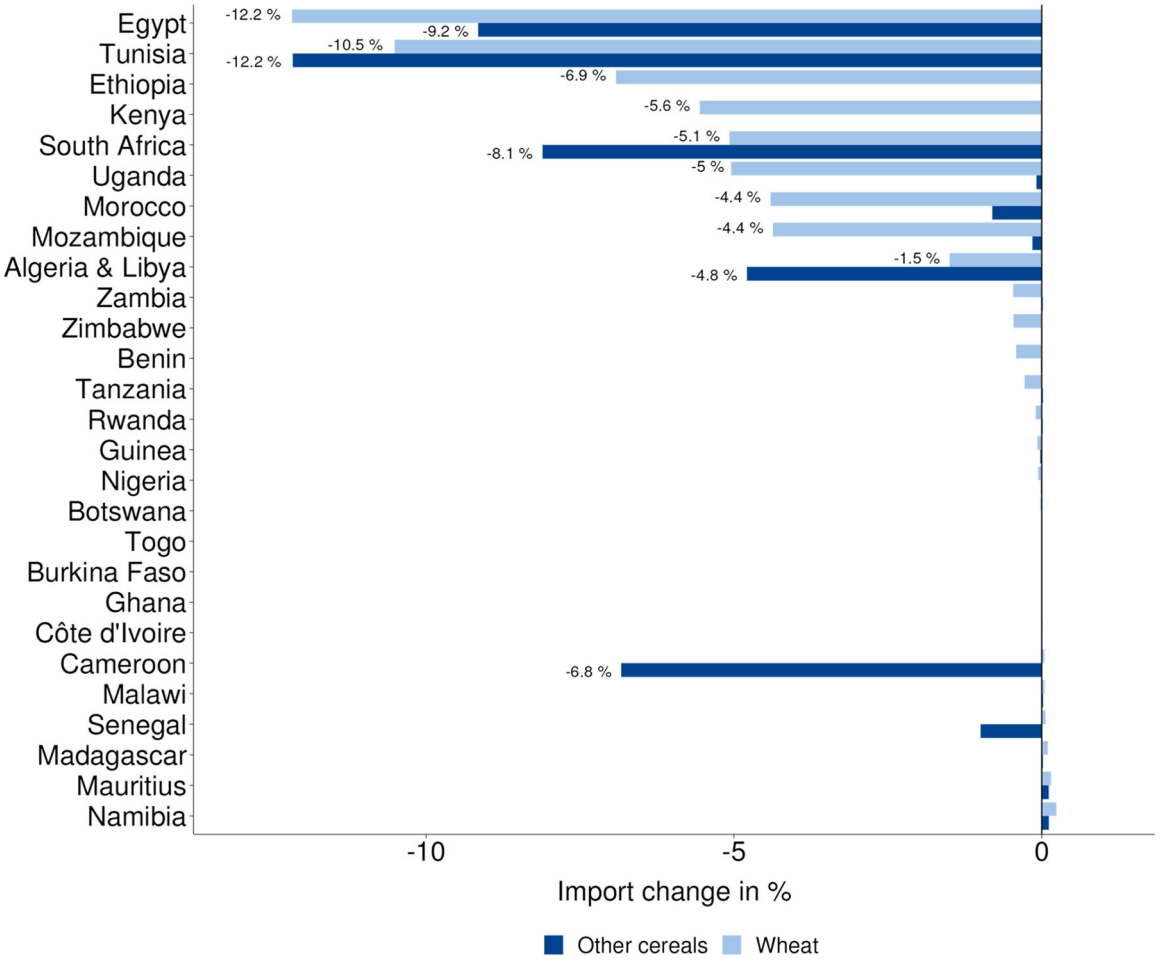

FIGURE 2 Change in wheat and cereals imports under scenario 1. [Color figure can be viewed at wileyonlinelibrary.com]

agricultural productivity, keeping everything else the same, would significantly impact African grain imports. The result also shows important heterogeneity across countries, revealing their varying degrees of exposure and vulnerability to shocks in grain trade with Ukraine. The effect is especially pronounced in countries that consume imported grains.

The impacts are also not limited to a reduction in imports and soaring prices. As a result of contracted grain production, prices will rise, in some cases dramatically. The results from the model under the first scenario are shown in Figure 3. It shows the corresponding long-term effects of Russia's invasion of Ukraine on wheat and other cereal prices under the scenario that the conflict reduces only agricultural productivity in Ukraine, with everything else remaining the same. The simulated long-run increase in wheat price would be nearly 6% in Kenya, 5.3% in Uganda, and over 3% in Tunisia. According to the simulation, other cereals would become more expensive. The largest simulated increase in the prices of other cereals is in Tunisia, with more than 10%, followed by Algeria and Libya, with an almost 4% increase, and more than a 2% increase in Egypt. Note that other cereals comprise, among others, corn and barley, which are imported in substantial volumes by countries such as Tunisia to feed animals and are especially relevant whenever grazing land is stressed. To summarize, the simulated long-term impacts of Russia's invasion of Ukraine on imports and prices in African countries under scenario 1 seem to be severe but vary tremendously across countries. Among the highly impacted top five African countries, Uganda and Mozambique are the hardest hit ADF countries.

One of the key shortcomings of scenario 1 is that it ignores other channels through which the war in Ukraine affects grain imports and prices in Africa. As mentioned above, in addition to reducing Ukraine's agricultural productivity, hence reducing its export of wheat and other cereals and agricultural technologies, it has a huge impact on trade costs.

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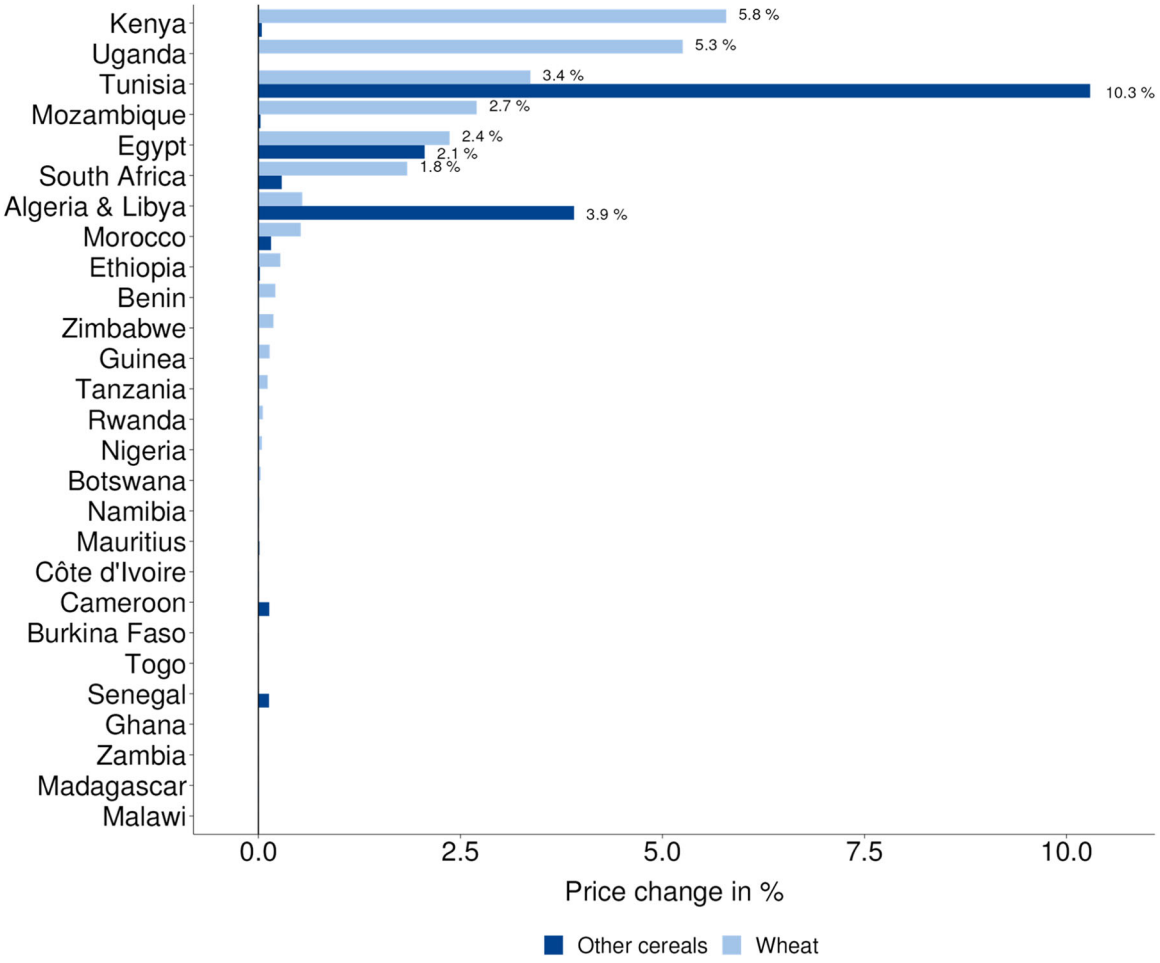

FIGURE 3 Change in wheat and cereal prices under scenario 1. [Color figure can be viewed at wileyonlinelibrary.com]

5.2 | Scenario 2: Reduced Ukrainian productivity and rising trade costs

The second scenario considers that the invasion impacts not only Ukraine's production capabilities but also increases overall trade costs due to its destructive and obstructive impact on infrastructure vital to trade, as well as the sanctions on Russia. That is particularly important as critical infrastructure, such as bridges, roads, and especially ports, have been destroyed in Ukraine, and the cost of shipping in the Black Sea has risen dramatically (e.g., Food and Agriculture Organization of the United Nations, 2022).[5] The heavy sanctions imposed on Russia also increased the costs of engaging in trade with Russia. Taking these cases into account, the second scenario presumes that, in addition to Ukrainian productivity being reduced by half, the war increases trade costs with Ukraine by 50% and with Russia by 25%. That also changes the prices at which other goods exported from Ukraine or Russia are available on the world market, for example, because they depend on fertilizer.

The main difference in mechanisms compared to scenario 1 is that due to increased trade costs affecting all sectors of the Ukrainian and Russian economies, the second scenario also allows for spillovers to arise via other supply chains. This implies that trade costs could further exacerbate the decline in agricultural productivity and propagate an economy-wide productivity decline in Ukraine as the production costs in every productive sector increase. It also implies that economy-wide productivity in Russia decreases as producers start to incur higher trade costs due to the sanction.

Figure 4 shows the model's predictions on the impacts of the conflict, under scenario 2, on the import of wheat and other cereals by African countries. Compared to scenario 1, the simulation shows a larger import reduction and substantial effects on more countries. Imports of wheat fall for about 20 countries under this scenario compared to 16 countries under scenario 1. However, there is also a slight increase in imports from a few other countries, such as Zimbabwe and Madagascar. One of the reasons for such heterogeneous impacts on imports is that not all African

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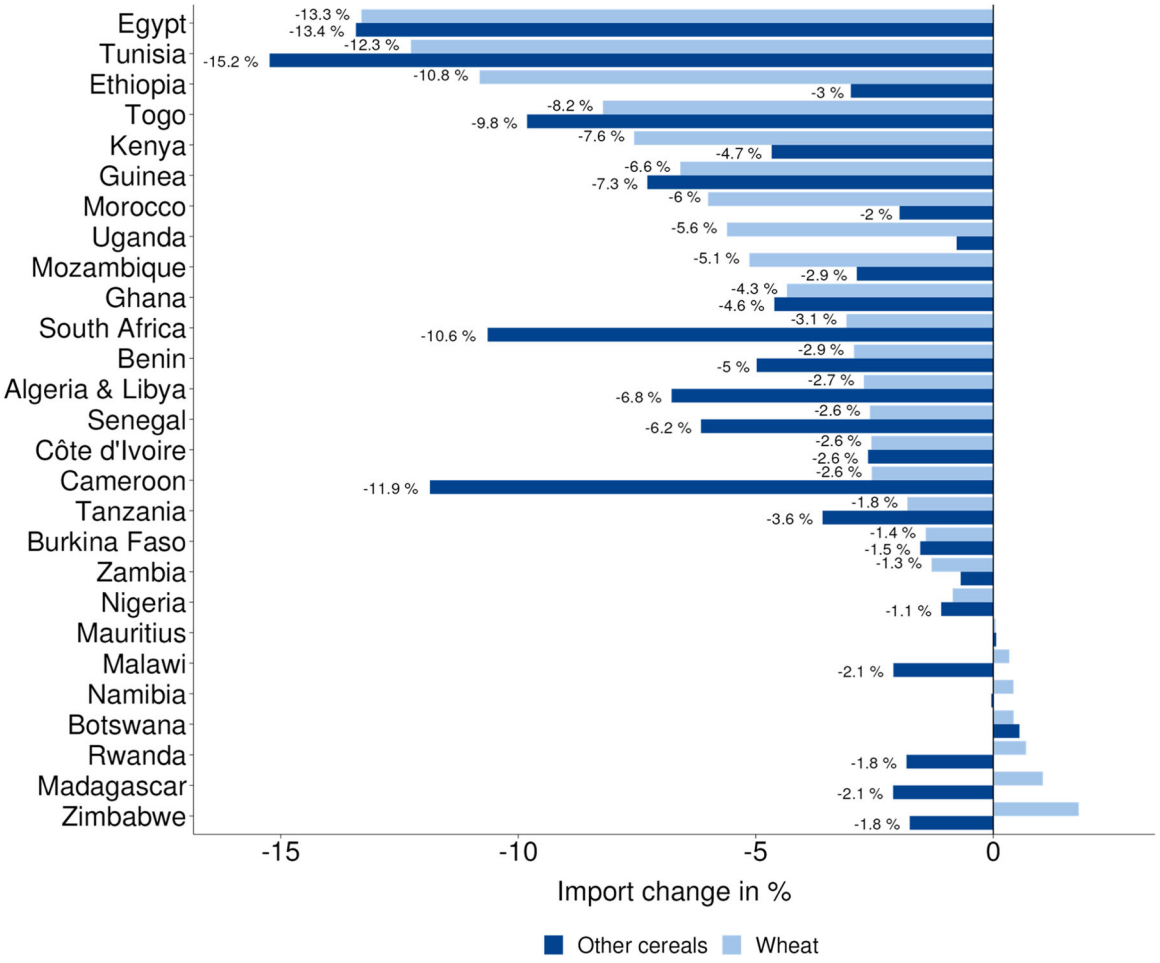

FIGURE 4 Change in wheat and cereals imports under scenario 2. [Color figure can be viewed at wileyonlinelibrary.com]

countries are dependent on Ukrainian grains, but the effects of rising trade costs are more widespread because they affect other commodities or goods. For example, machinery and fertilizer are among the most important categories of Ukrainian exports. In this scenario, wheat imports fall most heavily in Egypt (−13.3%), Tunisia (−12.3%), and Ethiopia (−10.8%). For other cereals, Tunisia (−15.2%), Egypt (−13.4%), and Cameroon (−11.9%) are the most affected.

Figure 5 shows the simulated impacts of the war on the prices of wheat and other cereals under scenario 2. Similar to the impacts on imports, the price impacts are more widespread and pronounced across Africa compared to scenario 1. The most notable long-run price increase for wheat occurs in Kenya, with a 5.8% increase, followed by Uganda (5.2%) and Tunisia (4.3%). The figure indicates that local prices of certain grains fall slightly for a few ADF countries, which may result from producing more wheat domestically in the long run.

5.3 | Scenario 3: Reduced Ukrainian productivity, rising trade costs, and a Russian wheat export ban

In the third and final scenario, we consider a case where, on top of scenario 2, Russia bans its producers from supplying wheat to the world market. This scenario is largely hypothetical. However, Russia has temporarily banned exports to a bloc of former Soviet states (World Grain, 2022), rendering this scenario not wholly unrealistic.

Figure 6 shows the estimated impacts on imports under scenario 3. The model predictions from scenarios 1 and 2 are also reflected mainly under scenario 3, but the magnitude of impacts is considerably larger under scenario 3. In addition, in this scenario, we note substantial differences across the two categories of grains. That is partly due to Russia being a significant exporter of wheat and more specialized in wheat production and export compared to Ukraine. The estimated impact is thus almost entirely on wheat imports rather than the import of

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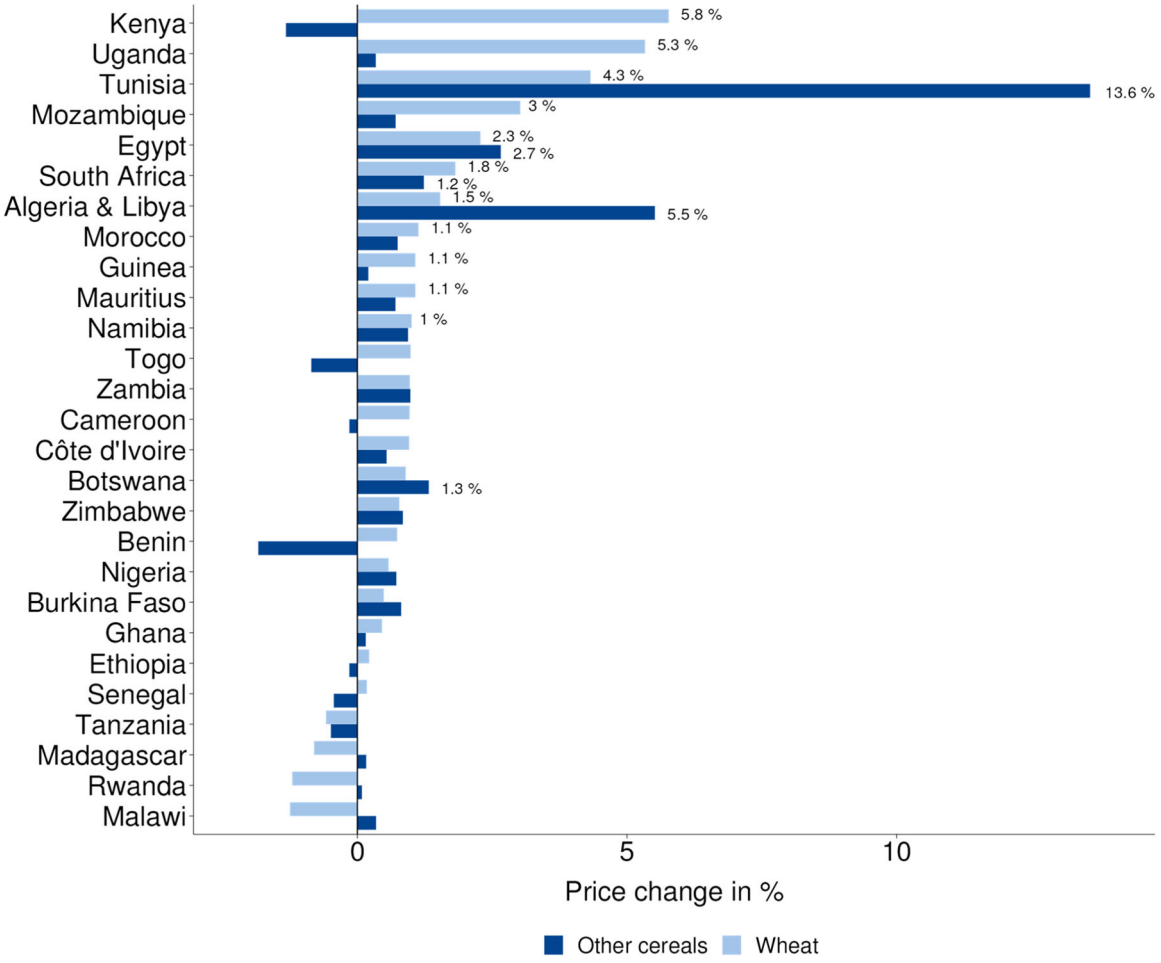

FIGURE 5 Change in wheat and cereal prices under scenario 2. [Color figure can be viewed at wileyonlinelibrary.com]

other cereals. The reduction of wheat imports under scenario 3 is the largest for Rwanda (−48.4%), Egypt (−48.2%), and South Africa (−40.7%). The hypothetical Russian ban on grain exports would thus amplify the wheat-related effects in the models.

The simulated impact of the conflict long-run prices under scenario 3 is also severe. Figure 7 shows the simulated impacts on wheat prices and other cereals under the third scenario. The three most affected countries in terms of wheat prices under this scenario are Malawi, with wheat prices estimated to increase by 36.7%, followed by Kenya (32.4%) and Rwanda (29.6%). Notably, the impact on other cereal prices is rather subdued in these countries. However, in non-ADF countries such as Tunisia, Algeria, Libya, and Egypt, we observe that the impact of the war under scenario 3 on the prices of other cereals is much more pronounced compared to the impact on wheat prices.

The results presented above could be sensitive to model assumptions and recent developments warranting discussion. The first shortcoming of the study relates to the KITE model, which is a long-run model that ignores short-run effects and possibly underestimates the overall impacts. Although the model accounts for tariff and non-tariff barriers, it assumes perfectly competitive markets in all other factor and output markets, which might not be the case in most African countries covered under the study. Second, the assumptions about the fall in agricultural productivity in Ukraine and the extent of trade cost in both countries provide a plausible idea of the size of possible effects and the relative importance of transmission channels. The aim is not to get as close as possible to the actual effects of the war, which are still unknown. However, in the absence of data on the actual decline in productivity and given that the war is still ongoing, a 50% decline in agricultural productivity and a 50% increase in trade cost for Ukraine could be on the lower end of the actual figures, given the destructive nature of the war. Such stringent assumptions about the extent of productivity decline and the rise in trade cost

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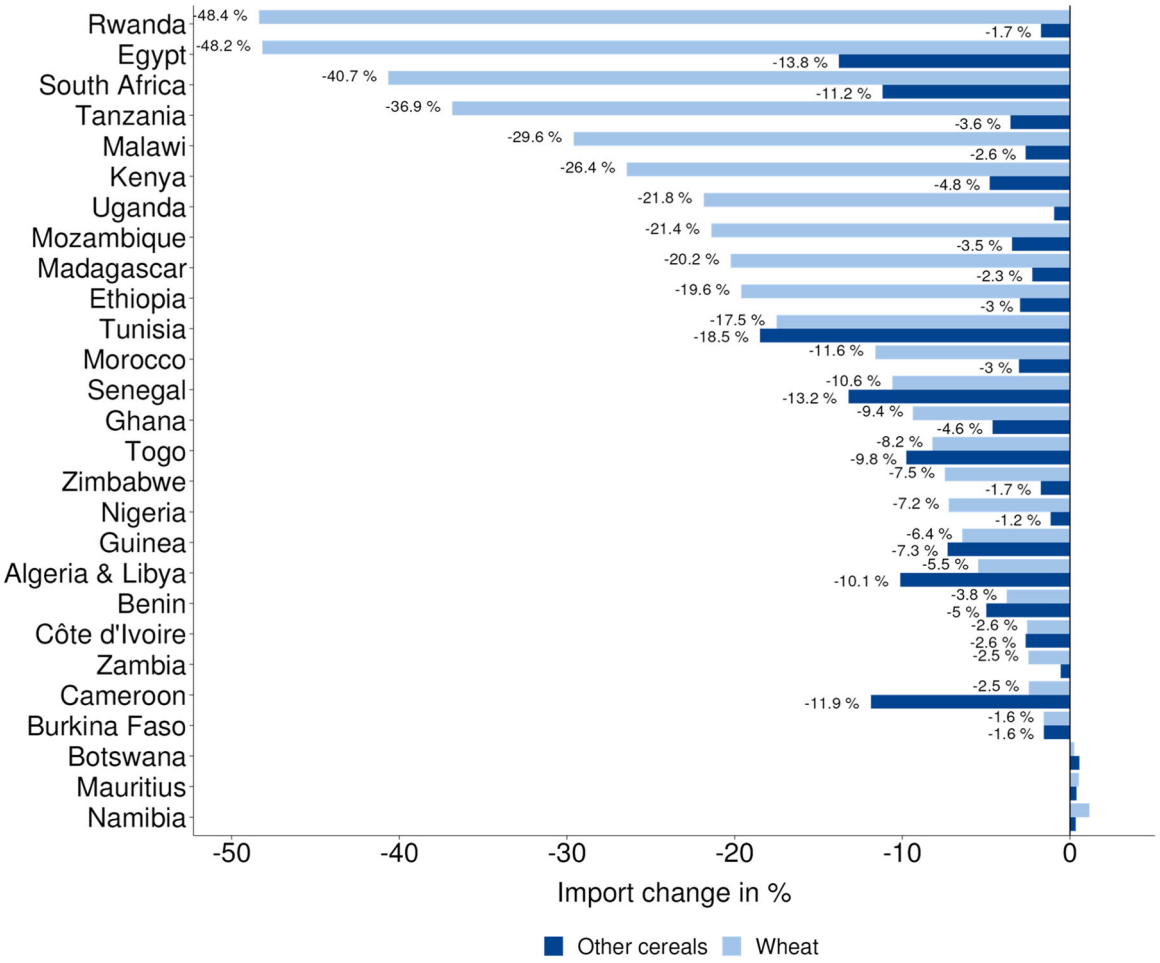

FIGURE 6 Change in wheat and cereals imports under scenario 3. [Color figure can be viewed at wileyonlinelibrary.com]

in Ukraine could make our estimate a lower bound. However, although the trade sanctions on Russia are severe, particularly on the energy sector, the country has continued trading with trading partners in the East, including China and India, and the net effect in terms of trade cost could be lower or higher than 25%. As a result, the effects on imports and prices could be overestimated or underestimated. Third, we considered only three cases with productivity decline in Ukraine and trade cost increase in both countries. However, the actual scenarios could be different. Fourth, our model is based on 2014 productivity levels that will determine the extent of domestic production response to the shock. If a country has innovated considerably since then, we might underestimate the extent of the local production increase. Yet, strong increases in domestic production are possible even in the model as part of the general equilibrium effects the model is built for. The last potential shortcoming is that the GTAP 10 data used in the model is infrequently updated every four years with reference years and, hence, cannot capture short-term and high-frequency changes in the structure of global value chains. However, in the absence of actual world Input-Output data, the GTAP 10 database is the best available source that approximates global value chains.

The effects could also be sensitive to changes such as the UN-brokered "Black Sea Grain Initiative," which was signed on July 17, 2022. The initiative allowed Russia to export food and fertilizers to the global market and guaranteed the Ukrainian grain export from three ports in the Black Sea.[6] According to the UN Joint Coordination Center, which was set up to coordinate the implementation of the agreement, as of November 17, 2022, there were about 941 inbound and outbound vessel voyages carrying a total of 11.2 million metric tons of grain and other foodstuffs exported from the three Ukrainian ports. Given that our computation does not account for the additional 11.2 million metric tons of grain and other foodstuffs from Ukraine that enter the global market, our estimates on price hikes and import declines could potentially be overstated. However, given that millions of tons of grain are still stranded in Ukraine and that the

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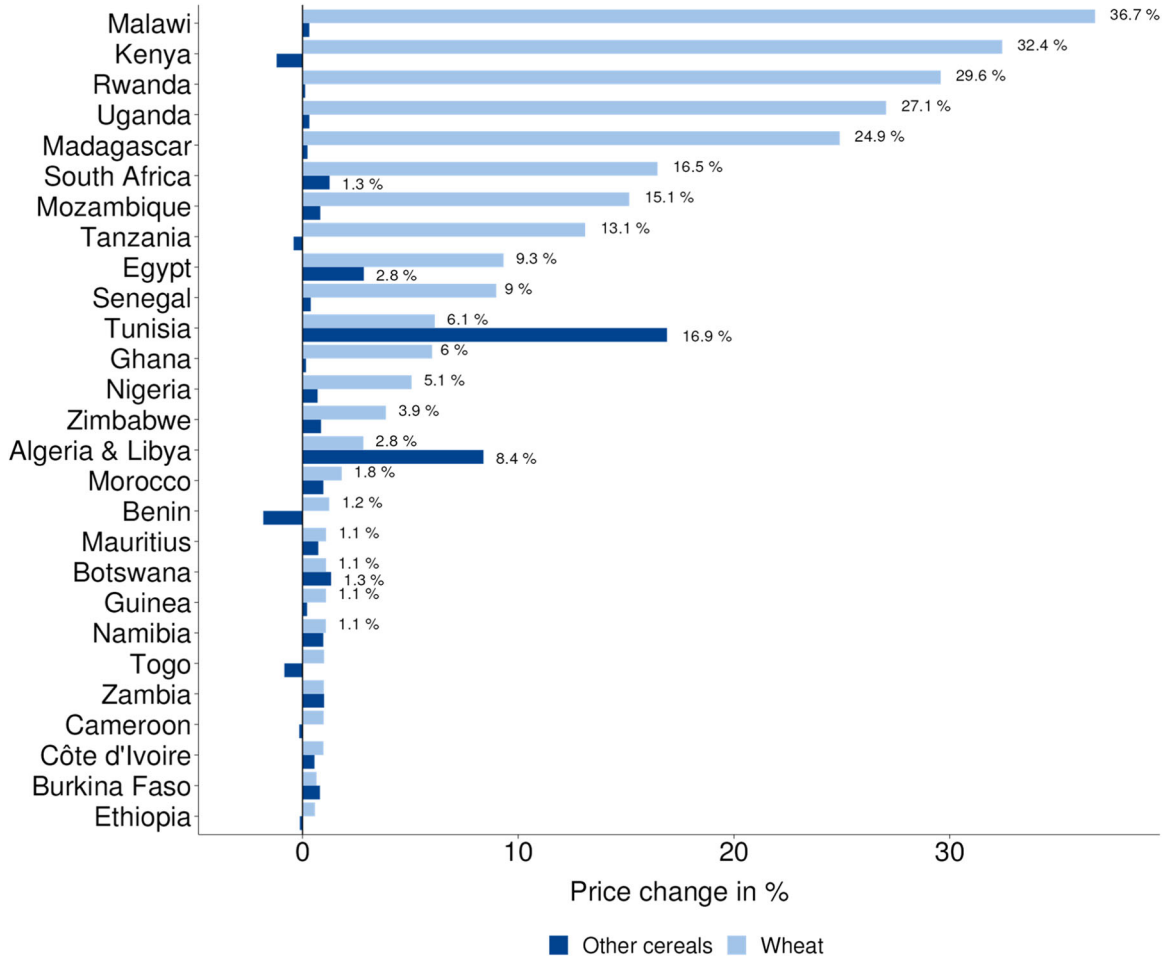

FIGURE 7 Change in wheat and cereal prices under scenario 3. [Color figure can be viewed at wileyonlinelibrary.com]

additional 11.2 million metric tons of grain exported from Ukraine and Russia under the Black Sea Grain Initiative is a fraction of the total import by African countries, the potential overestimation of impacts on prices and import volumes could be negligible. Further study on the topic using the latest data could provide precise estimates.

Despite some possible limitations, the simulation results of the study provide important and suggestive evidence of the potential impacts of Russia's invasion of Ukraine on grain imports and prices in African countries. In the absence of actual data, such simulation studies are essential for prompt policy interventions to alleviate potential impacts on grain imports and prices.

6 | CONCLUDING REMARKS

Russia's invasion of Ukraine has severely impacted the global supply of wheat and other grains. Given that Russia and Ukraine are two of the world's largest suppliers of wheat and other grains, there is a growing concern by policymakers that the impacts on food security across the developing world will likely be severe as the conflict continues. This is particularly important as many African countries import grains from Russia and Ukraine, and their access to food may be at risk due to the conflict, causing a hunger crisis with detrimental long-term consequences. In this paper, we investigate the long-run impacts of the war on imports of wheat and domestic prices in Africa, which will affect food security. We use a general equilibrium trade model to estimate the long-run impact under three scenarios that may plausibly evolve due to the conflict: heavily reduced Ukrainian productivity in wheat and other grains, rising trade costs with Ukraine and Russia due to disrupted trade routes in the Black Sea, and a hypothetical ban of Russian grains' exports.

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Our model estimates show that all three scenarios severely affect grain imports and prices in some African countries. Countries differ in the extent to which they depend on Ukraine and Russia in their wheat imports and other grains. The strength of the effect of wheat imports depends on the extent of import dependence and local consumption patterns. Countries with higher per capita wheat imports, because they consume substantial amounts and produce little, are hardest hit.

What policy responses can be used to ensure food security and cushion the effects for consumers? Food prices can be stabilized in the short term through targeted release and replenishment of food reserves and policies that build national food reserve systems. Several countries have in the past shielded their populations from global price increases through subsidies, particularly price controls. However, these kinds of subsidies risk not being well-targeted. Debt sustainability issues also mean that the fiscal space to cushion the population from price increases is limited. In the short run, several African countries will need financial support to deal with this and the previous crises.

Our model estimations are long-run estimates, so they speak most readily to the longer-term impacts of policies. One lesson of the current crisis is that countries should avoid being overly dependent on any single supplier of food and should diversify their imports of crucial goods and commodities to be more resilient to idiosyncratic shocks. Higher diversification was not conducted previously because it increased import costs. However, the geopolitical risks and consequences for grain imports and prices that have been laid bare should be considered by policymakers in the future.

The longer-run response can also include creating higher degrees of self-sufficiency in food in African countries and encouraging trade across the continent. Surplus production in well-suited growing locations in Southern Africa could then be exported to countries like Egypt, which are key net importers. An important factor in this will be increasing agricultural productivity and yield through, for instance, mechanization, adaptation of suitable new varieties, and complementary infrastructure and market access vital to linking local producers with global markets. To ensure that capital, labor, and land are not misdirected, it will be important to consider how competitive wheat production can become when planning such interventions.

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ENDNOTES

[1] See, for instance, Agyei et al. (2021), Aragie et al. (2021), Ibukun and Adebayo (2021), and Diouf et al. (2022).

[2] Effects on imports and prices of these grains are not necessarily synonymous with changes in food security. However, since these grains are used in food production for the vast majority of the countries we consider, changes in grain supply and prices can have dramatic consequences for food availability and food security.

[3] For instance, Burundi, Comoros, Djibouti, Eritrea, Seychelles, Somalia, and Sudan are grouped as "Rest of Eastern Africa," and Angola and the Democratic Republic of the Congo are grouped as "South of Central Africa" in GTAP. For further details on the grouping of countries, see https://www.gtap.agecon.purdue.edu/databases/v10/index.aspx.

[4] Other cereals: maize (corn), sorghum, barley, rye, oats, millets, other cereals.

[5] Rising trade costs reflect both that the insurance cost of shipping goods via the Black Sea has increased and that producers now must use alternative means of transportation such as railway. This raises costs due to the change in means of transportation and the longer travel routes.

[6] United Nations Press Releases and Statements. Last updated on December 28, 2022.

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APPENDIX A

Figure A1

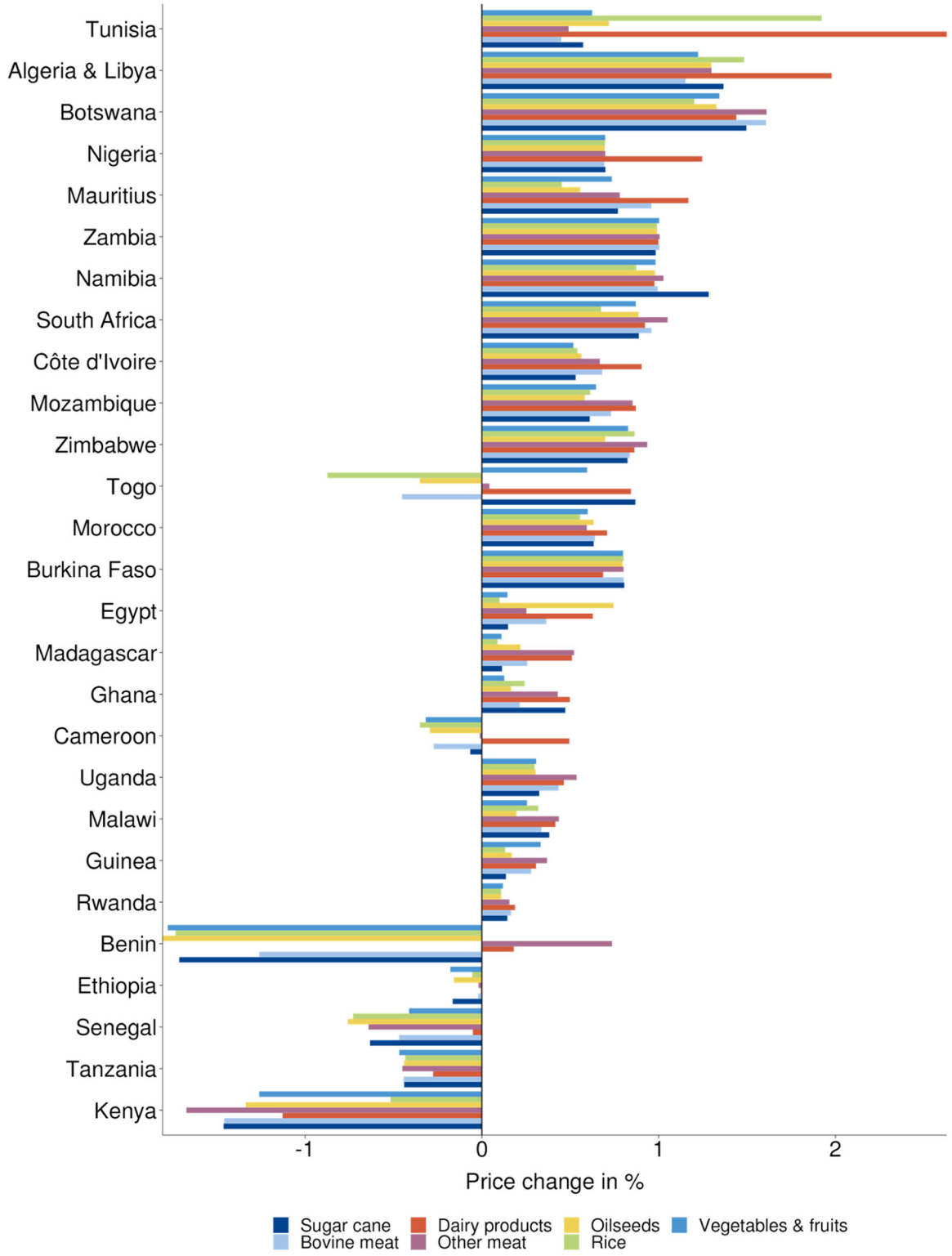

FIGURE A1 Change in other food prices under scenario 3. [Color figure can be viewed at wileyonlinelibrary.com]

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